John Walton.

ENCYCLOPÆDIA BRITANNICA.

ENCYCLOPÆDIA BRITANNICA.

Encyclopaedia Britannica:

OR, A

DICTIONARY

OF

ARTS, SCIENCES, AND MISCELLANEOUS LITERATURE;

ENLARGED AND IMPROVED.

THE SIXTH EDITION.

Illustrated with nearly six hundred Engravings.

VOL. VII.

INDOCTI DISCANT; AMENT MEMINISSE PERITI.

EDINBURGH:
PRINTED FOR ARCHIBALD CONSTABLE AND COMPANY;
AND HURST, ROBINSON, AND COMPANY, 90, CHEAPSIDE,
LONDON.

1823.

ENCYCLOPÆDIA BRITANNICA.

CRYSTALS, in *Chemistry*, salts or other matters which assume a regular form. See CHEMISTRY *Index;* and CRYSTALLIZATION.

CTESIAS, a native of Cnidos, who accompanied Cyrus the son of Darius in his expedition against his brother Artaxerxes; by whom he was taken prisoner. But curing Artaxerxes of a wound he received in the battle, he became a great favourite at the court of Persia, where he continued practising physic for 17 years, and was employed in several negotiations. He wrote the History of Persia in 23 books, and a History of the Indies; but these works are now lost, and all we have remaining of them is an abridgement compiled by Photinus. The most judicious among the ancients looked upon Ctesias as a fabulous writer; yet several of the ancient historians and modern Christian writers have adopted in part his chronology of the Assyrian kings.

CTESIBIUS, a mathematician of Alexandria, about 120 years before Christ. He was the first who invented the pump. He also invented a clepsydra, or water-clock. This invention of measuring time by water was wonderful and ingenious. Water was let drop upon wheels which it turned: the wheels communicated their regular motion to a small wooden image, which by a gradual rise pointed with a stick to the proper hours and minutes, which were engraven on a column near the machine. This ingenious invention gave rise to many improvements; and the modern method of measuring time with an hour-glass is in imitation of the clepsydra of Ctesibius.

CTESIPHON, a celebrated Greek architect, who gave the designs of the famous temple of Ephesus, and invented a machine for bringing thither the columns to be used in that noble structure. He flourished 544 B. C.

CTESIPHON, in *Ancient Geography*, a large village, or rather a fine city, of Chalonitis, the most southern province of Assyria. It was situated on the left or east side of the Tigris, opposite to Seleucia on this side; and built by the Parthians, to rival Seleucia. Here the kings of Parthia passed the winter (Strabo); as they did the summer at Ecbatana.

CTESIPHON was also the name of several noted persons of antiquity. 1. An Athenian, who advised his fellow citizens to crown publicly Demosthenes with a golden crown for his probity and virtue. This was opposed by the orator Æschines, the rival of Demosthenes, who accused Ctesiphon of seditious views. Demosthenes undertook the defence of his friend, in a celebrated oration still extant, and Æschines was banished. 2. A Greek architect, who made the plan of Diana's temple at Ephesus. 3. An elegiac poet, whom King Attalus set over his possessions in Æolia. 4. A Greek historian, who wrote a history of Bœotia.

CUB, a bear's whelp. Among hunters, a fox and marten of the first year are also called *cubs.* See URSUS.

CUBA, a large and very important island in the West Indies, belonging to Spain. On the south-east it begins at 20. 10. N. Lat. touches the tropic of Cancer on the north, and extends from 74. to 85. 15. W. Long. It is 764 miles long, lies 60 miles to the west of Hispaniola, 25 leagues north of Jamaica, 100 miles to the south of Cape Florida; and commands the entrance of the gulfs both of Mexico and Florida, as also the windward passages. By this situation it may be called the *key* of the West Indies. It was discovered by Columbus in 1492, who gave it the name of Ferdinando, in honour of King Ferdinand of Spain; but it quickly after recovered its ancient name of *Cuba.* The natives did not regard Columbus with a very favourable eye at his landing; and the weather proving very tempestuous, he soon left this island, and sailed to *Hayti*, now called *Hispaniola*, where he was better received. The Spaniards, however, soon became masters of it. By the year 1511 it was totally conquered; and in that time they had destroyed, according to their own accounts, several millions of people. But the possession of Cuba was far from answering the expectations of the Spanish adventurers, whose avarice could be satiated with nothing but gold. These monsters, finding that there was gold upon the island, concluded that it must come from mines; and therefore tortured the few inhabitants they had left, in order to extort from them a discovery of the places where these mines lay. The miseries endured by these poor creatures were such that they almost unanimously resolved to put an end to their own lives; but were prevented by one of the Spanish tyrants called *Vasco Porcellos.* This wretch threatened to hang himself along with them, that he might have the pleasure, as he said, of tormenting them in the next world worse than he had done in this; and so much were they afraid of the Spaniards, that this threat

threat diverted these poor savages from their desperate resolution. In 1511, the town of Havannah was built, now the principal place on the island. The houses were at first built only of wood; and the town itself was for a long time so inconsiderable, that in 1536 it was taken by a French pirate, who obliged the inhabitants to pay 700 ducats to save it from being burnt. The very day after the pirate's departure, three Spanish ships arrived from Mexico, and having unloaded their cargoes, sailed in pursuit of the pirate ship. But such was the cowardice of the officers, that the pirate took all the three ships, and returning to the Havannah, obliged the inhabitants to pay 700 ducats more. To prevent misfortunes of this kind, the inhabitants built their houses of stone; and the place has since been strongly fortified. See HAVANNAH.

According to the Abbé Raynal, the Spanish settlement at Cuba is very important, on three accounts; 1. The produce of the country, which is considerable. 2. As being the staple of a great trade; and, 3. As being the key to the West Indies. The cultivation of sugar is carried on to a great extent, no fewer than 480 sugar engines having been erected, and the quantity exported having amounted on an average from 1801 to 1810 to 644,000 cwt. per annum. Coffee began to be planted in Cuba after the destruction of the coffee plantations in St Domingo; and in 1803 it produced about 12,000 quintals, or 18 millions of pounds. In 1763 some emigrants introduced bees, which multiplied with such rapidity in the hollows of old trees, that the inhabitants had ample supplies of honey for their own consumption, besides a surplus for exportation. Although the surface of the island is in general uneven and mountainous, yet it has plains sufficiently extensive, and well enough watered, to supply the consumption of the greatest part of Europe with sugar. The incredible fertility of its new lands, if properly managed, would enable it to surpass every other nation, however they may have now got the start of it: yet such is the indolence of the Spaniards, that to this day they have comparatively but few plantations, where, with the finest canes, they make but a small quantity of coarse sugar at a great expence. This serves partly for the Mexican market, and partly for the mother-country. It has been expected with probability, that the tobacco imported from Cuba would compensate this loss; for after furnishing Mexico and Peru, there was sufficient, with the little brought from Caracca and Buenos Ayres, to supply all Spain. But this trade too has declined through the mismanagement of the court of Madrid. The article is monopolized for the benefit of the crown; and the planters have been exposed to such vexations, that its cultivation in 1803 had declined to 3,750,000 pounds, from 7,873,000 its amount in 1794. Cuba furnished considerable quantities of gold when the Spaniards first seized it, and it still yields some small supplies of this metal. The Spanish colonies have an universal trade in skins; and Cuba supplies annually about 10 or 12 thousand. The number might easily be increased in a country abounding with wild cattle, where some gentlemen possess large tracts of ground, that for want of population can scarce be applied to any other purpose than that of breeding cattle. The hundredth part of this island is not yet cleared. The true plantations are all confined to the beautiful plains of the Havannah, and even those are not what they might be. The number of inhabitants has increased rapidly. In 1774 they amounted to 220,000; but in 1804 the number was 432,000, including 108,000 slaves. The food of these different species consists of excellent pork, very bad beef, and cassava bread. The colony would be still more flourishing, if its productions had not been made the property of a company, whose exclusive privilege operates as a constant and invariable principle of discouragement. If any thing could supply the want of an open trade, and atone for the grievances occasioned by this monopoly at Cuba, it would be the advantage which this island has for such a long time enjoyed, in being the rendezvous of almost all the Spanish vessels that sail to the new world. This practice commenced almost with the colony itself. Ponce de Leon, having made an attempt upon Florida in 1512, became acquainted with the new canal of Bahama. It was immediately discovered that this was the best route the ships bound from Mexico to Europe could possibly take; and to this the wealth of the island is principally, if not altogether, owing.

CUBE, in *Geometry*, a solid body consisting of six equal sides. See GEOMETRY.

CUBE-Root of any Number or Quantity, is such a number or quantity, which, if multiplied into itself, and then again the product thence arising by that number or quantity, being the cube-root, this last product shall be equal to the number or quantity whereof it is the cube-root; as 2 is the cube-root of 8; because two times two is 4, and two times 4 is 8; and $a+b$ is the cube-root of $a^3+3\,a\,a\,b+3\,a\,b\,b+b^3$. See ALGEBRA.

CUBEBS, in the *Materia Medica*, a small dried fruit resembling a grain of pepper, but often somewhat longer, brought into Europe from the island of Java. In aromatic warmth and pungency, they are far inferior to pepper.

CUBIC EQUATION. See ALGEBRA.

CUBIDIA, a genus of spars. The word is derived from κυϐος, "a die;" and is given them from their being of the shape of a common die, or of a cubic figure. These bodies owe this shape to an admixture of lead, and there are only two known species of the genus. 1. A colourless crystalline one, with thin flakes, found in the lead mines of Yorkshire, and some other parts of the kingdom; and, 2. A milky white one with thicker crusts. This is found in the lead-mines of Derbyshire and Yorkshire, but is usually small, and is not found plentifully.

CUBIT, in the mensuration of the ancients, a long measure, equal to the length of a man's arm, from the elbow to the tip of the fingers.

Dr Arbuthnot makes the English cubit equal to 18 inches; the Roman cubit equal to 1 foot 5.406 inches; and the cubit of the Scripture equal to 1 foot 9.888 inches.

CUBITÆUS MUSCLES, the name of two muscles of the hand. See ANATOMY, *Table of the Muscles*.

CUBITUS, in *Anatomy*, a bone of the arm, reaching from the elbow to the wrist; otherwise called *ulna*, or the *greater fossile*. Some use the word for all that part of the arm between the elbow and the wrist; including the *ulna* or *cubitus*, properly so called, and the *radius*.

CUBOIDES, or *Os CUBIFORME*, in *Anatomy*, the seventh

seventh bone of the foot, so called from its being in form of a cube or die.

CUCKING-STOOL, an engine invented for punishing scolds and unquiet women, by ducking them in water; called in ancient times a *tumbrel*, and sometimes a *trebuchet*. In Domesday, it is called *cathedra stercoris;* and it was in use even in the Saxon times, by whom it was described to be *cathedra in qua rixosæ mulieres sedentes aquis demergebantur*. It was anciently also a punishment inflicted upon brewers and bakers transgressing the laws; who were thereupon in such a stool immerged over head and ears *in stercore*, some stinking water. Some think it a corruption from *ducking-stool;* others from *choaking-stool*, *quia hoc modo demersæ aquis fere suffocantur*. See CASTIGATORY.

CUCKOW. See CUCULUS, ORNITHOLOGY, *Index*.

CUCKOW-Spit, the same with froth-spit. See *FROTH-Spit*, and CICADA.

CUCUBALUS, BERRY-BEARING CHICK-WEED, a genus of plants belonging to the decandria class; and in the natural method ranking under the 22d order, *Caryophyllei*. See BOTANY *Index*.

CUCULUS, the CUCKOW, a genus of birds belonging to the order of picæ. See ORNITHOLOGY *Index*.

CUCUMBER. See CUCUMIS, BOTANY *Index*.

CUCUMIS, the CUCUMBER: a genus of plants belonging to the monœcia class; and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

Four varieties of the cucumis sativus are chiefly cultivated in this country. They are raised at three different seasons of the year: 1. on hot-beds, for early fruit; 2. under bell or hand-glasses, for the middle crop; 3. on the common ground, which is for a late crop, or to pickle. The cucumbers which are ripe before April are unwholesome; being raised wholly by the heat of the dung without the assistance of the sun. Those raised in April are good, and are raised in the following manner.

Towards the latter end of January, a quantity of fresh horse-dung must be procured with the litter among it; and a small proportion of sea-coal ashes should be added to it. In four or five days the dung will begin to heat; at which time a little of it may be drawn flat on the outside, and covered with two inches thickness of good earth: this must be covered with a bell glass; and after two days, when the earth is warm, the seeds must be sown on it, covered with a quarter of an inch of fresh earth, and the glass then set on again. The glass must be covered with a mat at night, and in four days the young plants will appear. When these are seen, the rest of the dung must be made up into a bed for one or more lights. This must be three feet thick, beat close together, and covered three inches deep with fine fresh earth; the frame must then be put on, and covered at night, or in bad weather, with mats. When the earth is hot enough, the young plants from under the bell must be removed into it, and set two inches distant. The glasses must be now and then a little raised, to give air to the plants, and turned often, to prevent the wet from the steam of the dung from dropping down upon them. The plants must be watered at proper times; and the water used for this purpose must be set on the dung till it becomes as warm as the air in the frame: and as the young plants increase in bulk, they must be earthed up, which will give them great additional strength. If the bed is not hot enough, some fresh litter should be laid round its sides: and if too hot, some holes should be bored into several parts of it with a stake, which will let out the heat; and when the bed is thus brought to a proper coolness, the holes are to be stopped up again with fresh dung. When these plants begin to shoot their third or rough leaf, another bed must be prepared for them like the first; and when it is properly warm through the earth, the plants of the other bed must be taken up, and planted in this, in which there must be a hole in the middle of each light, about a foot deep, and nine inches over, filled with light and fine fresh earth laid hollow in form of a bason: in each of these holes there must be set four plants: these must be, for two or three days, shaded from the sun, that they may take firm root: after which they must have all the sun they can, and now and then a little fresh air, as the weather will permit. When the plants are four or five inches high, they must be gently pegged down towards the earth, in directions as different from one another as may be; and the branches afterwards produced should be treated in the same manner. In a month after this the flowers will appear, and soon after the rudiments of the fruit. The glasses should now be carefully covered at night; and in the daytime the whole plants should be gently sprinkled with water. These will produce fruit till about midsummer; at which time the second crop will come in to supply their place; these are to be raised in the same manner as the early crop, only they do not require so much care and trouble. This second crop should be sown in the end of March or beginning of April. The season for sowing the cucumbers of the last crop, and for pickling, is towards the latter end of May, when the weather is settled: these are sown in holes dug to a little depth, and filled up with fine earth, so as to be left in the form of a bason; eight or nine seeds being put into one hole. These will come up in five or six days; and till they are a week old, are in great danger from the sparrows. After this they require only to be kept clear of weeds, and watered now and then. There should be only five plants left at first in each hole; and when they are grown a little farther up, the worst of these is to be pulled up, that there may finally remain only four. The plants of this crop will begin to produce fruit in July.

CUCURBIT, the name of a chemical vessel employed in distillation, when covered with its head. Its name comes from its elongated form in shape of a gourd: some cucurbits, however, are shallow and wide-mouthed. They are made of copper, tin, glass, and stone ware, according to the nature of the substances to be distilled. A cucurbit, provided with its capital, constitutes the vessel for distillation called an *alembic*.

CUCURBITA, the GOURD, and POMPION; a genus of plants belonging to the monœcia class; and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See BOTANY *Index*.

All the species of gourds and pompions, with their respective varieties, are raised from seed sown annually in April or the beginning of May, either with or without the help of artificial heats. But the plants fowarded in a hot bed till about a month old, produce fruit a month or six weeks earlier on that account, aud ripen proportionably sooner. The first species particularly will scarce ever produce tolerably sized fruit in this country, without the treatment above mentioned.

In this country these plants are cultivated only for curiosity; but in the places where they are natives, they answer many important purposes. In both the Indies, bottle-gourds are very commonly cultivated and sold in the markets. They make the principal food of the common people, particularly in the warm months of June, July, and August. The Arabians call this kind of gourd *charrah*. It grows commonly on the mountains in their deserts. The natives boil and season it with vinegar; and sometimes, filling the shell with rice and meat, make a kind of pudding of it. The hard shell is used for holding water, and some of them are capacious enough to contain 22 gallons; these, however, are very uncommon. The fruit of the pompion likewise constitutes a great part of the food of the common people during the hot months, in those places where they grow. If gathered when not much bigger than a hen or goose egg, and properly seasoned with butter, vinegar, &c. they make a tolerable good sauce for butcher's meat, and are also used in soups. In England they are seldom used till grown to maturity. A hole is then made in one side, through which the pulp is scooped out; after being divested of the seeds, it is mixed with sliced apples, milk, sugar, and grated nutmeg, and thus a kind of pudding is made. The whole is then baked in the oven, and goes by the name of a *pumpkin pye*. For this purpose the plants are cultivated in many places in England by the country people, who raise them upon old dung-hills. The third species is also used in North America for culinary purposes. The fruit is gathered when about half grown, boiled and eaten as sauce to butcher's meat. The squashes are also treated in the same manner, and by some people esteemed delicate eating.

CUCURBITACEÆ, the name of the 34th order in Linnæus's fragments of a natural method, consisting of plants which resemble the gourd in external figure, habit, virtues, and sensible qualities. This order contains the following genera, viz. gronovia, melothria, passiflora, anguria, bryonia, cucumis, cucurbita, sevillea, momordica, sicyos, trichosanthes.

CUCURUCU, in *Zoology*, the name of a serpent found in America, growing 10 or 12 feet long. It is also very thick in proportion to its length, and is of a yellowish colour, strongly variegated with black spots, which are irregularly mixed among the yellow, and often have spots of yellow within them. It is a very poisonous species, and greatly dreaded by the natives; but its flesh is a very rich food, and much esteemed among them, when properly prepared.

CUD, sometimes means the inside of the throat in beasts; but generally the food that they keep there, and chew over again. See ANATOMY *Index*.

CUDDALORE, a town on the coast of Coromandel in India, belonging to the English, very near the place where Fort St David once stood. N. Lat. 11. 30. E. Long. 79. 53. 30. This place was reduced by the French in the year 1781; and in 1783 underwent a severe siege by the British forces commanded by General Stuart. At this time it was become the principal place of arms held by the enemy on that coast: they had exerted themselves to the utmost in fortifying it; and it was garrisoned by a numerous body of the best forces of France, well provided with artillery, and every thing necessary for making a vigorous defence.

Previous to the commencement of the siege, they had constructed strong lines of defence all along the fort, excepting one place where the town was covered by a wood, supposed to be inaccessible. Through this wood, however, General Stuart began to cut his way; on which the besieged began to draw a line of fortification within that also. The British commander then determined to attack these fortifications before they were quite completed; and for this purpose a vigorous attack was made by the troops under General Bruce. The grenadiers assailed a redoubt which greatly annoyed them, but were obliged to retire; on which the whole army advanced to the attack of the lines. The French defended themselves with resolution; and as both parties charged each other with fixed bayonets, a dreadful slaughter ensued. At last the British were obliged to retreat; but the French having imprudently come out of their lines to pursue them, were in their turn defeated, and obliged to give up the lines they had constructed with so much pains, and so gallantly defended. The loss on the part of the British amounted to near 1000 killed and wonnded, one half of whom were Europeans; and that of the French was not less than 600.

Though the British proved victorious in this contest, yet the victory cost so dear that there was not now a sufficient number to carry on the siege with any effect. The troops also became sickly; and their strength diminished so much, that the besieged formed a design of not only obliging them to raise the siege, but of totally destroying them. For this purpose 4000 men were landed from the squadron commanded by M. Suffrein; and the conduct of the enterprise committed to the Chevalier de Damas, an experienced and valiant officer. On the 25th of June 1783, he sallied out at the head of the regiment of Aquitaine, supposed to be one of the best in the French service, and of which he was colonel; with other troops selected from the bravest of the garrison. The attack was made by day-break; but though the British were at first put into some disorder, they quickly recovered themselves, and not only repulsed the enemy, but pursued them so warmly, that the Chevalier de Damas himself was killed, with about 200 of his countrymen, and as many taken prisoners.

This engagement was attended with one of the most remarkable circumstances that happened during the whole war, viz. a corps of sepoy grenadiers encountering the French troops opposed to them with fixed bayonets, and overcoming them. This extraordinary bravery was not only noticed with due applause, but procured for that corps a provision for themselves and families from the presidencies to which they belonged. No other operation of any consequence took place during the siege, which was now soon ended by the news of peace having taken place between the belligerent powers of Europe.

CUDDY, in a first-rate man of war, is a place lying between the captain-lieutenant's cabin and the quarter-deck; and divided into partitions for the master and other officers. It denotes also a kind of cabin near the stern of a lighter or barge of burden.

CUDWEED. See GNAPHALIUM, BOTANY *Index*.

CUDWORTH, RALPH, a very learned divine of the church of England in the 17th century. In January 1657, he was one of the persons nominated by a committee of the parliament to be consulted about the English translation of the bible. In 1678 he published his True Intellectual System of the Universe; a work which met with great opposition. He likewise published a treatise, entitled, *Deus justificatus:* " or, " The divine goodness of God vindicated, against the assertions of absolute and unconditionate reprobation." He embraced the mechanical or corpuscular philosophy: but with regard to the Deity, spirits, genii, and ideas, he followed the Platonists. He died at Cambridge in 1688. The editor of the new edition of the Biographia Britannica observes, that it is not easy to meet with a greater storehouse of ancient literature than the " Intellectual System;" and various writers, we believe, have been indebted to it for an appearance of learning which they might not otherwise have been able to maintain. That Dr Cudworth was fanciful in some of his opinions, and that he was too devoted a follower of Plato and the Platonists, will scarcely be denied even by those who are most sensible of his general merit. The reflections that have been cast upon such a man as the author, by bigotted writers, are altogether contemptible. It is the lot of distinguished merit to be thus treated. Lord Shaftesbury, speaking on this subject, has given an honourable testimony to the memory of Dr Cudworth." " You know (says his lordship) the common fate of those who dare to appear fair authors. What was that pious and learned man's case, who wrote the Intellectual System of the Universe! I confess it was pleasant enough to consider, that though the whole world were not less satisfied with his capacity and learning, than with his sincerity in the cause of Deity; yet he was accused of giving the upper hand to the atheists, for having only stated their reasons, and those of their adversaries, fairly together."

It is observed by Dr Birch, that Dr Cudworth's Intellectual System of the Universe has raised him a reputation, to which nothing can add but the publication of his other writings still extant in manuscript. That these writings are very valuable cannot be doubted. We may be assured that they display a great compass of sentiment and a great extent of learning. Nevertheless, from their voluminous quantity, from the abstruseness of the subjects they treat upon, and from the revolutions of literary taste and opinion, it is morally certain that the publication of them would not be successful in the present age. Dr Cudworth's daughter Damaris, who married Sir Francis Masham of Oates in Essex, was a lady of genius and learning: she had a great friendship for Mr Locke, who resided several years at her house at Oates, where he died in 1704.

CUE, an *item* or *inuendo*, given to the actors on the stage what or when to speak. See PROMPTER.

CUENZA, a town of Spain, in New Castile, and in the territory of the Sierra, with a bishop's see. It was taken by Lord Peterborough in 1706, but retaken by the duke of Berwick. It is seated on the river Xucar, in W. Long. 1. 45. N. Lat. 40. 10.

CUERENHERT, THEODORE VAN, a very extraordinary person, was a native of Amsterdam, where he was born in 1522. It appears, that early in life he travelled into Spain and Portugal; but the motives of his journey are not ascertained. He was a man of science, and according to report, a good poet. The sister arts at first he considered as an amusement only; but in the end he was, it seems, obliged to have recourse to engraving alone for his support. And though the different studies in which he employed his time prevented his attachment to his profession being so close as it ought to have been, yet at least the marks of genius are discoverable in his works. They are slight, and hastily executed with the graver alone; but in an open careless style, so as greatly to resemble designs made with a pen. He was established at Haerlem; and there pursuing his favourite studies in literature, he learned Latin, and was made secretary to that town, from whence he was sent several times as ambassador to the prince of Orange, to whom he addressed a famous manifesto, which that prince published in 1566. Had he stopped here, it had been well; but directing his thoughts into a different channel, he undertook an argument as dangerous as it was absurd. He maintained, that all religious communions were corrupted; and that, without a supernatural mission, accompanied with miracles, no person had a right to administer in any religious office: he therefore pronounced that man to be unworthy the name of a Christian who would enter any place of public worship. This he not only advanced in words, but strove to show the sincerity of his belief by practice; and for that reason would not communicate with either Protestant or Papist. His works were published in three volumes folio in 1630; and though he was several times imprisoned, and at last sentenced to banishment, yet he does not appear to have altered his sentiments. He died at Dergoude in 1590, aged 68 years. It is no small addition to the honour of this singular man, that he was the instructor of that justly celebrated artist Henry Goltzius. Cuerenhert worked jointly with the Galles and other artists, from the designs of Martin Hemskerck. The subjects are from the Old and New Testament, and consist chiefly of middling-sized plates lengthwise. He also engraved several subjects from Franc. Floris.

CUERPO. To *walk in cuerpo*, is a Spanish phrase for going without a cloak; or without all the formalities of a full dress.

CUFF, HENRY, the unfortunate secretary of the unfortunate earl of Essex, was born at Hinton St George in Somersetshire, about the year 1560, of a genteel family, who were possessed of considerable estates in that county. In 1576, he was entered of Trinity college Oxford, where he soon acquired considerable reputation as a Grecian and disputant. He obtained a fellowship in the above-mentioned college; but was afterwards expelled for speaking disrespectfully of the founder (A). He was, however, soon after admitted of Merton college; of which, in 1586, he was elected probationer, and in 1588 fellow. In this year he took the degree of master of arts. Some time after he was elected Greek professor, and in 1594 proctor of the university. When he left Oxford is uncertain; nor are we better informed as to the means of his introduction to the earl of Essex. When that nobleman was made lord lieutenant of Ireland, Mr Cuff was appointed his secretary, and continued intimately connected with his lordship until his confinement in the Tower; and he is generally supposed to have advised those violent measures which ended in their mutual destruction. The earl indeed confessed as much before his execution, and charged him to his face with being the author of all his misfortunes. Mr Cuff was tried for high treason, convicted, and executed at Tyburn on the 30th of March 1601. Lord Bacon, Sir Henry Wotton, and Camden, speak of him in very harsh terms. He was certainly a man of learning and abilities. He wrote two books: the one entitled, The Differences of the Ages of Man's Life; the other, *De Rebus Gestis in Sancto Concilio Nicæno*. The first was published after his death; the second is still in manuscript.

CUJAS, James, in Latin *Cujacius*, the best civilian of his time, was born at Toulouse, of obscure parents, in 1520. He learned polite literature and history; and acquired great knowledge in the ancient laws, which he taught with extraordinary reputation at Toulouse, Cahors, Bourges, and Valence in Dauphiné. Emmanuel Philibert, duke of Savoy, invited him to Turin, and gave him singular marks of his esteem. Cujas afterwards refused very advantageous offers from Pope Gregory XIII. who was desirous of having him teach at Bologna; but he chose rather to fix at Bourges, where he had a prodigious number of scholars; whom he not only took great pleasure in instructing, but assisted with his substance, which occasioned his being called the *Father of his Scholars*. He died at Bourges in 1590, aged 70. His works are in high esteem among civilians.

CUJAVIA, a territory of Great Poland, having on the north the duchy of Prussia, on the west the palatinate of Kalisk, and on the south those of Licici and Rava, and on the west that of Ploczko. It contains two palatinates, the chief towns of which are Inowloez and Brest, and now belongs partly to Russia, and partly to Prussia.

CUIRASS, a piece of defensive armour made of iron plate, well hammered, serving to cover the body, from the neck to the girdle, both before and behind. Some derive the word, by corruption, from the Italian *cuore*, "heart," because it covers that part: others from the French *cuir*, or the Latin *corium*, "leather;" whence *coriaceous;* because defensive arms were originally made of leather. The cuirass was not brought into use till about the year 1300, though they were known both to the ancient Greeks and Romans in different forms.

CUIRASSIERS, cavalry armed with cuirasses, as many of the Germans are: The French have regiments of cuirassiers; but we have had none in the British army since the Revolution.

CULDEE, in church-history, a sort of monkish priests formerly inhabiting Scotland and Ireland. Being remarkable for the religious exercises of preaching and praying, they were called, by way of eminence, *cultores Dei;* from whence is derived the word *culdees*. They made choice of one of their own fraternity to be their spiritual head, who was afterwards called the *Scots bishop*.

CULEMBACH, a district or marquisate of the circle of Franconia, in Germany. It is bounded on the west by the bishopric of Bamberg; on the south by the territory of Nuremberg; on the east by the palatinate of Bavaria and Bohemia; and on the north by Voegtland and part of the circle of Upper Saxony. It is about 50 miles in length from north to south, and 30 in breadth from east to west. It is full of forests and high mountains; the most considerable of the latter are those of Frichtelberg, all of them covered with pine-trees. Here are the sources of four large rivers, the Maine, the Sala, the Eger, and the Nab. Since 1814 this marquisate has formed part of the territories of Bavaria.

Culembach, a town of Germany, in Franconia, the capital of the marquisate of the same name. It has good fortifications, and is seated at the confluence of two branches of the river Maine. It was pillaged and burnt by the Hussites in 1430, and by the inhabitants of Nuremberg in 1573. E. Long. 11. 28. N. Lat. 50. 12.

CULEUS, in Roman antiquity, the largest measure of capacity for things liquid, containing 20 amphoræ, or 40 urnæ. It contained 143 gallons 3 pints, English wine-measure, and was 11,095 solid inches.

CULEX, the Gnat; a genus of insects belonging to the order of diptera. See Entomology *Index*.

CULIACAN, a province of North America, in the audience of Guadalajara. It is bounded on the north by New Mexico, on the east by New Biscay and the Zacatecas, on the south by Chiametlan, and on the west by the sea. It is a fruitful country, and has rich mines.

CULLIAGE, a barbarous and immoral practice, whereby the lords of manors anciently assumed a right to the first night of their vassals brides.

CULLEN,

(A) The founder of Trinity college was Sir Thomas Pope, who, it seems, would often take a piece of plate from a friend's house, and carry it home concealed under his gown, out of fun, no doubt. Cuff, being merry with some of his acquaintance at another college, happened to say, alluding to Sir Thomas Pope's usual joke above mentioned, "A pox on this beggarly house! why, our founder stole as much plate as would build such another." This piece of wit was the cause of his expulsion. The heads of colleges in those days did not understand humour. Anthony Wood was told this story by Dr Bathurst.

Cullen.

CULLEN, a borough town in the county of Banff in Scotland. It is situated on the sea-coast. W. Long. 2. 12. N. Lat. 57. 38. The manufacture of linen and damask has been established in this town for more than 50 years. Population 1070 in 1811.

Cullen, *Dr William*, an eminent physician and distinguished medical teacher, was born in Lanarkshire, in the west of Scotland, 11th December, 1712. His father was for some time chief magistrate of the town of Hamilton; but though a very respectable man, his circumstances were not such as to permit him to lay out much money on the education of his son. William therefore, after serving an apprenticeship to a surgeon apothecary in Glasgow, went several voyages to the West Indies as a surgeon in a trading vessel from London: but of this employment he tired, and settled himself, at an early period of life, as a country surgeon in the parish of Shotts, where he staid a short time practising among the farmers and country people, and then went to Hamilton with a view to practise as a physician, having never been fond of operating as a surgeon.

While he resided near Shotts, it chanced that Archibald duke of Argyle, who at that time bore the chief political sway in Scotland, made a visit to a gentleman of rank in that neighbourhood. The duke was fond of literary pursuits, and was then particularly engaged in some chemical researches, which required to be elucidated by experiment. Eager in these pursuits, his grace, while on his visit, found himself much at a loss for the want of some small chemical apparatus, which his landlord could not furnish: but happily recollecting young Cullen in the neighbourhood, he mentioned him to the duke as a person who could probably furnish it. —He was accordingly invited to dine; was introduced to his grace,—who was so much pleased with his knowledge, his politeness and address, that he formed an acquaintance which laid the foundation of all Dr Cullen's future advancement.

The name of Cullen by this time became familiar at every table in that neighbourhood; and thus he came to be known, by character, to the duke of Hamilton, who then resided, for a short time, in that part of the country: and that nobleman having been suddenly taken ill, the assistance of young Cullen was called in; which proved a fortunate circumstance in serving to promote his advancement to a station in life more suited to his talents than that in which he had hitherto moved.

The duke was highly delighted with the sprightly character and ingenious conversation of his new acquaintance. Receiving instruction from him in a much more pleasing, and an infinitely easier way than he had ever before obtained, the conversation of Cullen proved highly interesting to his grace. —No wonder then that he soon found means to get his favourite doctor, who was already the esteemed acquaintance of the man through whose hands all preferments in Scotland were obliged to pass, appointed to a place in the university of Glasgow, where his singular talents for discharging the duties of the station he now occupied soon became very conspicuous.

During his residence in the country, however, several important incidents occurred, that ought not to be passed over in silence. It was during this time that was formed a connection in business in a very humble line between two men, who became afterwards eminently conspicuous in much more exalted stations. William, afterwards Doctor Hunter, the famous lecturer on anatomy in London, was a native of the same part of the country; and not being in affluent circumstances more than Cullen, these two young men, stimulated by the impulse of genius to prosecute their medical studies with ardour, but thwarted by the narrowness of their fortune, entered into a copartnery business as surgeons and apothecaries in the country. The chief end of their contract being to furnish the parties with the means of prosecuting their medical studies, which they could not separately so well enjoy, it was stipulated, that one of them alternately should be allowed to study in what college he inclined, during the winter, while the other should carry on the business in the country, for the common advantage. In consequence of this agreement, Cullen was first allowed to study in the university of Edinburgh for one winter; but when it came to Hunter's turn next winter, he, preferring London to Edinburgh, went thither. There his singular neatness in dissecting, and uncommon dexterity in making anatomical preparations, his assiduity in study, his mildness of manner, and pliability of temper, soon recommended him to the notice of Dr Douglas, who then read lectures upon anatomy and midwifery there; who engaged Hunter as an assistant, and whose chair he afterwards filled with so much honour to himself and satisfaction to the public.

Cullen.

Thus was dissolved, in a premature manner, a copartnery perhaps of as singular a kind as is to be found in the annals of literature: nor was Cullen a man of that disposition to let any engagement with him prove a bar to his partner's advancement in life. The articles were freely departed from by him; and Cullen and Hunter ever after kept up a very cordial and friendly correspondence; though, it is believed, they never from that time had a personal interview.

During the time that Cullen practised as a country surgeon and apothecary, he formed another connection of a more permanent kind, which happily for him, was not dissolved till a very late period of his life. With the ardour of disposition he possessed, it cannot be supposed he beheld the fair sex with indifference. Very early in life he took a strong attachment to an amiable woman, a Miss Johnston, daughter to a clergyman in that neighbourhood, nearly of his own age, who was prevailed on to join with him in the sacred bonds of wedlock, at a time when he had nothing else to recommend him to her except his person and dispositions. After giving to him a numerous family, and participating with him the changes of fortune which he experienced, she died in summer 1786.

In the year 1746, Cullen, who had now taken the degree of doctor in physic, was appointed a lecturer in chemistry in the university of Glasgow: and in the month of October began his lectures in that science. His singular talents for arrangement, his distinctness of enunciation, his vivacity of manner, and his knowledge of the science he taught, rendered his lectures interesting to the students to a degree that had been till then unknown at the university. He became, therefore, in some measure, adored by the students. The former professors were eclipsed by the brilliancy of his reputation; and he had to experience all those little rubs that envy and disappointed ambition naturally threw in his way. Regardless, however, of these secret chagrins, he pressed forward with ardour in his literary career; and, supported by the favour of the public, he consoled himself for the contumely he met with from a few individuals. His practice as a physician increased from day to day; and a vacancy having occurred in the year 1751, he was then appointed by the king professor of medicine in that university. This new appointment served only to call forth his powers, and to bring to light talents that it was not formerly known he possessed; so that his fame continued to increase.

As, at that period, the patrons of the university of Edinburgh were constantly on the watch for the most eminent medical men to support the rising fame of the college, their attention was soon directed towards Cullen; who, on the death of Dr Plummer, professor of chemistry, was, in 1756, unanimously invited to accept the vacant chair. This invitation he accepted: and having resigned all his employments in Glasgow, he began his academical career in Edinburgh in the month of October of that year; and there he resided till his death.

If the admission of Cullen into the university of Glasgow gave great spirit to the exertions of the students, this was still, if possible, more strongly felt in Edinburgh. Chemistry, which had been till that time of small account in that university, and was attended to by very few of the students, instantly became a favourite study; and the lectures upon that science were more frequented than any others in the university, anatomy alone excepted. The students, in general, spoke of Cullen with the rapturous ardour that is natural to youth when they are highly pleased. These eulogiums appeared extravagant to moderate men, and could not fail to prove disgusting to his colleagues. A party was formed among the students for opposing this new favourite of the public; and these students, by misrepresenting the doctrines of Cullen to others who could not have an opportunity of hearing these doctrines themselves, made even some of the most intelligent men in the university think it their duty publicly to oppose these imaginary tenets. The ferment was thus augmented; and it was some time before the professors discovered the arts by which they had been imposed upon, and universal harmony restored.

During this time of public ferment, Cullen went steadily forward, without taking any part himself in these disputes. He never gave ear to any tales respecting his colleagues, nor took any notice of the doctrines they taught: That some of their unguarded strictures might at times come to his knowledge is not impossible; but if they did, they seemed to make no impression on his mind.

These attempts of a party of students to lower the character of Cullen on his first outset in the university of Edinburgh having proved fruitless, his fame as a professor, and his reputation as a physician, became more and more respected every day. Nor could it well be otherwise: Cullen's professional knowledge was always great, and his manner of lecturing singularly clear and intelligible, lively and entertaining; and to his patients, his conduct in general as a physician was so pleasing, his address so affable and engaging, and his manner so open, so kind, and so little regulated by pecuniary considerations, that it was impossible for those who had occasion to call once for his medical assistance, ever to be satisfied on any future occasion without it. He became the friend and companion of every family he visited; and his future acquaintance could not be dispensed with.

But if Dr Cullen in his public capacity deserved to be admired, in his private capacity by his students he deserved to be adored. His conduct to them was so attentive, and the interest he took in the private concerns of all those students who applied to him for advice, was so cordial and so warm, that it was impossible for any one who had a heart susceptible of generous emotions, not to be enraptured with a conduct so uncommon and so kind. Among ingenuous youth, gratitude easily degenerates into rapture—into respect nearly allied to adoration. Those who advert to this natural construction of the human mind, will be at no loss to account for that popularity which Cullen enjoyed—a popularity, that those who attempt to weigh every occurrence by the cool standard of reason alone, will be inclined to think excessive. It is fortunate, however, that the bulk of mankind will ever be influenced in their judgment not less by feelings and affections than by the cold and phlegmatic dictates of reason. The adoration which generous conduct excites, is the reward which nature hath appropriated exclusively to disinterested beneficence. This was the secret charm that Cullen ever carried about with him, which fascinated such numbers of those who had intimate access to him. This was the power which his envious opponents never could have an opportunity of feeling.

The general conduct of Cullen to his students was this. With all such as he observed to be attentive and diligent, he formed an early acquaintance, by inviting them by twos, by threes, or by fours at a time, to sup with him, conversing with them on these occasions with the most engaging ease, and freely entering with them on the subject of their studies, their amusements, their difficulties, their hopes, and future prospects. In this way, he usually invited the whole of his numerous class, till he made himself acquainted with their abilities, their private character, and their objects of pursuit. Those among them whom he found most assiduous, best disposed, or the most friendless, he invited the most frequently, till an intimacy was gradually formed, which proved highly beneficial to them. Their doubts, with regard to their objects of study he listened to with attention, and solved with the most obliging condescension. His library, which consisted of an excellent assortment of the best books, especially on medical subjects, was at all times open for their accommodation; and his advice, in every case of difficulty to them, they always had it in their power most readily to obtain. They seemed to be his family; and few persons of distinguished merit have left the university of Edinburgh in his time, with whom he did not keep up a correspondence till they were fairly established in business. By these means, he came to have a most accurate knowledge of the state of every country, with respect to practitioners in the medical line; the only use he made of which knowledge, was to direct students in their choice of places, where they might have an opportunity of engaging in business with a reasonable prospect of success.

success. Many, very many, able men has he thus put into a good line of business, where they never could have thought of it themselves; and they are now reaping the fruits of this beneficent foresight on his part.

Nor was it in this way only that he befriended the students at the university of Edinburgh. Possessing a benevolence of mind that made him ever think first of the wants of others, and recollecting the difficulties that he himself had to struggle with in his younger days, he was at all times singularly attentive to their pecuniary concerns. From his general acquaintance among the students, and the friendly habits he was on with many of them, he found no difficulty in discovering those among them who were rather in embarrassed circumstances, without being obliged to hurt their delicacy in any degree. To such persons, when their habits of study admitted of it, he was peculiarly attentive. They were more frequently invited to his house than others; they were treated with more than usual kindness and familiarity; they were conducted to his library, and encouraged by the most delicate address to borrow from it freely whatever books he thought they had occasion for: and as persons in these circumstances were usually more shy in this respect than others, books were sometimes pressed upon them as a sort of constraint, by the doctor insisting to have their opinion of such or such passages they had not read, and desiring them to carry the book home for that purpose. He, in short, behaved to them rather as if he courted their company, and stood in need of their acquaintance than they of his. He thus raised them in the opinion of their acquaintance to a much higher degree of estimation than they could otherwise have obtained; which, to people whose minds were depressed by penury, and whose sense of honour was sharpened by the consciousness of an inferiority of a certain kind, was singularly engaging. Thus they were inspired with a secret sense of dignity, which elevated their minds, and excited an uncommon ardour of pursuit, instead of that melancholy inactivity which is so natural in such circumstances, and which too often leads to despair. Nor was he less delicate in the manner of supplying their wants, than attentive to discover them. He often found out some polite excuse for refusing to take payment for a first course, and never was at a loss for one to an after course. Before they could have an opportunity of applying for a ticket, he would sometimes lead the conversation to some subject that occurred in the course of his lectures; and as his lectures were never put in writing by himself, he would sometimes beg the favour to see their notes, if he knew they had been taken with attention, under a pretext of assisting his memory. Sometimes he would express a wish to have their opinion of a particular part of his course, and presented them with a ticket for that purpose; and sometimes he refused to take payment, under the pretext that they had not received his full course the preceding year, some part of it having been necessarily omitted for want of time, which he meant to include in this course. By such delicate address, in which he greatly excelled, he took care to forerun their wants. Thus he not only gave them the benefit of his own lectures, but by refusing to take their money, he also enabled them to attend those of others that were necessary to complete their course of studies. These were particular devices he adopted to individuals to whom economy was necessary; but it was a general rule with him, never to take money from any student for more than two courses of the same set of lectures, permitting him to attend these lectures as many years longer as he pleased *gratis*.

He introduced another general rule into the university, that was dictated by the same principle of disinterested beneficence, that ought not to be here passed over in silence. Before he came to Edinburgh, it was the custom of medical professors to accept of fees for their medical assistance, when wanted, even from medical students themselves, who were perhaps attending the professor's own lectures at the time. But Cullen never would take fees as a physician from any student at the university, though he attended them, when called in as a physician, with the same assiduity and care as if they had been persons of the first rank, who paid him most liberally. This gradually induced others to adopt a similar practice: so that it is now become a general rule for medical professors to decline taking any fees when their assistance is necessary to a student. For this useful reform, with many others, the students of the university of Edinburgh are solely indebted to the liberality of Dr Cullen.

The first lectures which Cullen delivered in Edinburgh were on chemistry; and for many years he also gave clinical lectures on the cases which occurred in the royal infirmary. In the month of February 1763, Dr Alston died, after having begun his usual course of lectures on the materia medica; and the magistrates of Edinburgh, as patrons of that professorship in the university, appointed Dr Cullen to that chair, requesting that he would finish the course of lectures that had been begun for that season. This he agreed to do; and though he was under a necessity of going on with the course in a few days after he was nominated, he did not once think of reading the lectures of his predecessor, but resolved to deliver a new course entirely his own. The popularity of Cullen at this time may be guessed at by the increase of new students who came to attend his course in addition to the eight or ten who had entered to Dr Alston. The new students exceeded 100. An imperfect copy of these lectures thus fabricated in haste, having been published, the doctor thought it necessary to give a more correct edition of them in the latter part of his life. But his faculties being then much impaired, his friends looked in vain for those striking beauties that characterised his literary exertions in the prime of life.

Some years afterwards, on the death of Dr White, the magistrates once more appointed Dr Cullen to give lectures on the theory of physic in his stead. And it was on that occasion Dr Cullen thought it expedient to resign the chemical chair in favour of Dr Black, his former pupil, whose talents in that department of science were then well known, and who filled the chair till his death with great satisfaction to the public. Soon after, on the death of Dr Rutherford, who for many years had given lectures with applause on the practice of physic, Dr John Gregory (whose name can never be mentioned by any one who had the pleasure of his acquaintance without the warmest tribute of a grateful respect) having become a candidate for this place along with Dr Cullen, a sort of compromise took place between them, by which they agreed each to give lectures alternately on the theory and on the practice of physic during their joint lives, the longest survivor being allowed to hold either of the classes he should incline. In consequence of this agreement, Dr Cullen delivered the first course of lectures on the practice of physic in winter 1766, and Dr Gregory succeeded him in that branch the following year. Never perhaps did a literary arrangement take place that could have proved more beneficial to the students than this. Both these men possessed great talents, though of a kind extremely dissimilar. Both of them had certain failings or defects, which the other was aware of, and counteracted. Each of them knew and respected the talents of the other. They co-operated, therefore, in the happiest manner, to enlarge the understanding, and to forward the pursuits of their pupils. Unfortunately this arrangement was soon destroyed by the unexpected death of Dr Gregory, who was cut off in the flower of life by a sudden and unforeseen event. After this time, Cullen continued to give lectures on the practice of physic till a few months before his death, which happened on the 5th of February 1790, in the 77th year of his age.

In drawing the character of Dr Cullen, his biographer, Dr Anderson observes, that in scientific pursuits men may be arranged into two grand classes, which, though greatly different from each other in their extremes, yet approximate at times so near as to be blended indiscriminately together; those who possess a talent for detail, and those who are endowed with the faculty of arrangement. The first may be said to view objects individually as through a microscope. The field of vision is confined; but the objects included within that field, which must usually be considered singly and apart from all others, are seen with a wondrous degree of accuracy and distinctness. The other takes a sweeping view of the universe at large, considers every object he perceives, not individually, but as a part of one harmonious whole: His mind is therefore not so much employed in examining the separate parts of this individual object, as in tracing its relations, connections, and dependencies on those around it.—Such was the turn of Cullen's mind. The talent for arrangement was that which peculiarly distinguished him from the ordinary class of mortals; and this talent he possessed perhaps in a more distinguished degree than any other person of the age in which he lived. Many persons exceeded him in the minute knowledge of particular departments, who, knowing this, naturally looked upon him as their inferior; but possessing not at the same time that glorious faculty, which, "with an eye wide roaming, glances from the earth to heaven," or the charms which this talent can infuse into congenial minds, felt disgust at the pre-eminence he obtained, and astonishment at the means by which he obtained it. An Aristotle and a Bacon have had their talents in like manner appreciated; and many are the persons who can neither be exalted to sublime ideas with Homer, nor ravished with the natural touches of a Shakespeare. Such things are wisely ordered, that every department in the universe may be properly filled by those who have talents exactly suited to the task assigned them by heaven.

Had Cullen, however, possessed the talents for arrangement alone, small would have been his title to that high degree of applause he has attained. Without a knowledge of *facts*, a talent for arrangement produces nothing but chimeras; without materials to work upon, the structures which an over-heated imagination may rear up are merely "the baseless fabric of a vision." No man was more sensible of the justness of this remark than Dr Cullen, and few were at greater pains to avoid it. His whole life, indeed, was employed, almost without interruption, in collecting facts. Whether he was reading, or walking, or conversing, these were continually falling into his way. With the keen perception of an eagle, he marked them at the first glance; and without stopping at the time to examine them, they were stored up in his memory, to be drawn forth as occasion required, to be confronted with other facts that had been obtained after the same manner, and to have their truth ascertained, or their falsity proved by the evidence which should appear when carefully examined at the impartial bar of justice. Without a memory retentive in a singular degree, this could not have been done; but so very extraordinary was Dr Cullen's memory, that till towards the very decline of life, there was scarcely a fact that had ever occurred to him which he could not readily recollect, with all its concomitant circumstances, whenever he had occasion to refer to it. It was this faculty which so much abridged his labour in study, and enabled him so happily to avail himself of the labour of others in all his literary speculations. He often reaped more by the conversation of an hour than another man would have done in whole weeks of laborious study.

In his prelections, Dr Cullen never attempted to read. His lectures were delivered *viva voce*, without having been previously put into writing, or thrown into any particular arrangement. The vigour of his mind was such, that nothing more was necessary than a few short notes before him, merely to prevent him from varying from the general order he had been accustomed to observe. This gave to his discourses an ease, a vivacity, a variety, and a force, that are rarely to be met with in academical discourses. His lectures, by consequence, upon the same subject, were never exactly the same. Their general tenor indeed was not much varied; but the particular illustrations were always new, well suited to the circumstances that attracted the general attention of the day, and were delivered in the particular way that accorded with the cast of mind the prelector found himself in at the time. To these circumstances must be ascribed that energetic artless elocution, which rendered his lectures so generally captivating to his hearers. Even those who could not follow him in those extensive views his penetrating mind glanced at, or who were not able to understand those apt allusions to collateral objects which he could only rapidly point at as he went along, could not help being warmed in some measure by the vivacity of his manner. But to those who could follow him in his rapid career, the ideas he suggested were so numerous, the views he laid open were so extensive, and the objects to be attained were so important—that every active faculty of the mind was roused; and such an ardour of enthusiasm was excited in the prosecution of study, as appeared to be perfectly inexplicable to those who were merely unconcerned spectators. In consequence of this unshackled freedom in the composition and delivery of his lectures,

tures, every circumstance was in the nicest unison with the tone of voice and expression of countenance, which the particular cast of mind he was in at the time inspired. Was he joyous, all the figures introduced for illustration were fitted to excite hilarity, and good humour: was he grave, the objects brought under view were of a nature more solemn and grand: and was he peevish, there was a peculiarity of manner in thought, in word, and in action, which produced a most striking and interesting effect. The languor of a nerveless uniformity was never experienced, nor did an abortive attempt to excite emotions that the speaker himself could not at the time feel, ever produce those discordant ideas which prove disgusting and unpleasing.

It would seem as if Dr Cullen had considered the proper business of a preceptor to be that of putting his pupils into a proper train of study, so as to enable them to prosecute those studies at a future period, and to carry them on much farther than the short time allowed for academical prelections would admit. He did not, therefore, so much strive to make those who attended his lectures deeply versed in the particular details of objects, as to give them a general view of the whole subject; to shew what had been already attained respecting it; to point out what remained yet to be discovered; and to put them into a train of study that should enable them at a future period, to remove those difficulties that had hitherto obstructed our progress, and thus to advance themselves to farther and farther degrees of perfection. If these were his views, nothing could be more happily adapted to them than the mode he invariably pursued. He first drew, with the striking touches of a master, a rapid and general outline of the subject, by which the whole figure was seen at once to start boldly from the canvas, distinct in all its parts, and unmixed with any other object. He then began anew to retrace the picture, to touch up the lesser parts, and to finish the whole in as perfect a manner as the state of our knowledge at the time would permit. Where materials were wanting, the picture there continued to remain imperfect. The wants were thus rendered obvious; and the means of supplying these were pointed out with the most careful discrimination. The student whenever he looked back to the subject, perceived the defects; and his hopes being awakened, he felt an irresistible impulse to explore that hitherto untrodden path which had been pointed out to him, and fill up the chasm which still remained. Thus were the active faculties of the mind most powerfully excited; and instead of labouring himself to supply deficiencies that far exceeded the power of any one man to accomplish, he set thousands at work to fulfil the task, and put them into a train of going on with it.

It was to these talents, and to this mode of applying them, that Dr Cullen owed his celebrity as a professor; and it was in this manner that he has perhaps done more towards the advancement of science than any other man of his time, though many individuals might perhaps be found who were more deeply versed in the particular departments he taught than he himself was.

Dr Cullen's external appearance, though striking and not unpleasing, was not elegant. He had an expressive countenance and a lively eye. In his person he was tall and thin, stooping much about the shoulders; and when he walked he had a contemplative look, seemingly regarding little the objects around him. According to the observation of one who was well acquainted with the character of Cullen, he was eminently distinguished as a professor for three things. "The energy of his mind, by which he viewed every subject with ardour, and combined it immediately with the whole of his knowledge.

"The scientific arrangement which he gave to his subject, by which there was a *lucidus ordo* to the dullest scholar. He was the first person in this country who made chemistry cease to be a chaos.

"A wonderful art of interesting the students in every thing which he taught, and of raising an emulative enthusiasm among them." *Life of Dr Cullen, by Dr Anderson, in the Bee.*

CULLODEN, a place in Scotland within two miles of Inverness, chiefly remarkable for a complete victory gained over the rebels on the 16th of April 1746. That day the royal army, commanded by the duke of Cumberland, began their march from Nairn, formed into five lines of three battalions each; headed by Major-general Huske on the left, Lord Sempill on the right, and Brigadier Mordaunt in the centre; flanked by the horse under the generals Hawley and Bland, who at the same time covered the cannon on the right and left. In this order they marched about eight miles, when a detachment of Kingston's horse, and of the Highlanders, having advanced before the rest of the army, discovered the van of the rebels commanded by the young Pretender. Both armies immediately formed in the order and numbers shown in the annexed scheme.

About two in the afternoon the rebels began to cannonade the king's army; but their artillery being ill served, did little execution; while the fire from their enemies was severely felt, and occasioned great disorder. The rebels then made a push at the right of the royal army, in order to draw the troops forward; but finding themselves disappointed, they turned their whole force on the left; falling chiefly on Barrel's and Munro's regiments, where they attempted to flank the king's front line. But this design also was defeated by the advancing of Wolfe's regiment, while in the mean time the cannon kept playing upon them with cartridge-shot. General Hawley, with some Highlanders, had opened a passage through some stone walls to the right for the horse which advanced on that side; while the horse on the king's right wheeled off upon their left, dispersed their body of reserve, and met in the centre of their front line in their rear; when being repulsed in the front, and great numbers of them cut off, the rebels fell into very great confusion. A dreadful carnage was made by the cavalry on their backs; however, some part of the foot still preserved their order; but Kingston's horse, from the reserve, gallopped up briskly, and falling upon the fugitives, did terrible execution. A total defeat instantly took place, with the loss of 2500 killed, wounded, and prisoners, on the part of the rebels, while the royalists lost not above 200. The young Pretender had his horse shot under him during the engagement; and after the battle retired to the

Culloden, Culm.

house of a factor of Lord Lovat, about ten miles from Inverness, where he staid that night. Next day he set out for Fort-Augustus, from whence he pursued his journey through wild deserts with great difficulty and distress, till at last he safely reached France, as related under the article BRITAIN, N° 423. (A).

CULM, or CULMUS, among botanists, a straw or haulm; defined by Linnæus to be the proper trunk of the grasses, which elevates the leaves, flower, and fruit.

This sort of trunk is tubular or hollow, and has frequently knots or joints distributed at proper distances through its whole length. The leaves are long, sleek, and placed either near the roots in great numbers, or proceed singly from the different joints of the stalk, which they embrace at the base, like a sheath or glove.

Culm.

The haulm is commonly garnished with leaves: sometimes, however, it is naked; that is, devoid of leaves, as in a few species of cypress-grass. Most grasses have a round cylindrical stalk; in some species of schœnus, scirpus, cypress-grass, and others, it is triangular.

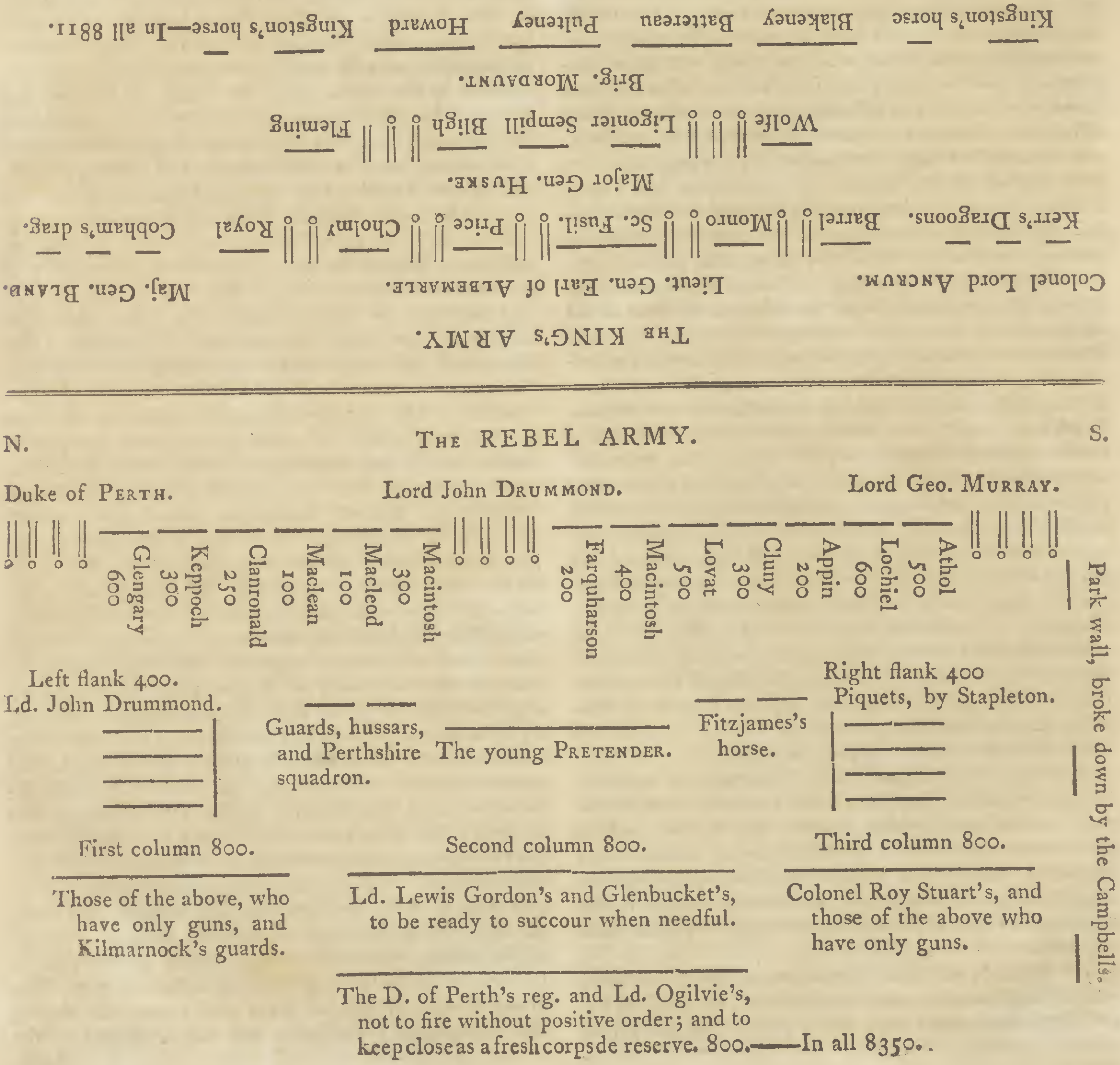
The stalk is sometimes entire, that is, has no branches; sometimes branching, as in *schœnus aculeatus et capensis;* and not seldom consists of a number of scales which lie over each other like tiles.

Lastly, in a few grasses the stalk is not interrupted with joints, as in the greater part. The space contained betwixt every two knots or joints, is termed by botanists *internodium* and *articulus culmi.*

This species of trunk often affords certain marks of distinction in discriminating the species. Thus, in the genus eriocaulon, the species are scarce to be distinguished

---

(A) *Plan of the Battle of Culloden.*



guished but by the angles of the culms or stalks. These in some species are in number 5, in others 6, and in others 10.

CULMIFEROUS plants, (from *culmus*, a straw or haulm): plants so called, which have a smooth jointed stalk, usually hollow, and wrapped about at each joint with single, narrow, sharp-pointed leaves, and the seeds contained in chaffy husks; such are oats, wheat, barley, rye, and the other plants of the natural family of the Grasses.

CULMINATION, in *Astronomy*, the passage of any heavenly body over the meridian, or its greatest altitude for that day.

CULPRIT, a term used by the clerk of the arraignments, when a person is indicted for a criminal matter. See Plea *to Indictment*, par. 11.

CULROSS, a royal borough town in Scotland, situated on the river Forth, about 23 miles north-west of Edinburgh. Here is a magnificent house, which was built about the year 1590 by Edward Lord Kinloss, better known in England by the name of Lord Bruce, slain in the noted duel between him and Sir Edward Sackville. Some poor remains of the Cistercian abbey are still to be seen here, founded by Malcolm earl of Fife in 1217. The church was jointly dedicated to the Virgin and St Serf confessor. The revenue at the dissolution was 768 pounds Scots, besides the rents paid in kind. The number of monks, exclusive of the abbot, was nine. Population 1611 in 1811. W. Long. 3. 34. N. Lat. 56. 8.

CULVERIN, a long slender piece of ordnance or artillery, serving to carry a ball to a great distance. Manege derives the word from the Latin *colubrina*: others from *coluber*, "snake;" either on account of the length and slenderness of the piece, or of the ravages it makes.

There are three kinds of culverins, viz. the extraordinary, the ordinary, and the least sized. 1. The culverin extraordinary has $5\frac{1}{2}$ inches bore; its length 32 calibers, or 13 feet; weighs 4800 pounds; its load above 12 pounds; carries a shot $5\frac{1}{4}$ inches diameter, weighing 20 pounds weight. 2. The ordinary culverin is 12 feet long; carries a ball of 17 pounds 5 ounces; caliber $5\frac{1}{4}$ inches; its weight 4500 pounds. 3. The culverin of the least size, has its diameter 5 inches; is 12 feet long; weighing about 4000 pounds; carries a shot $3\frac{1}{4}$ inches diameter, weighing 14 pounds 9 ounces.

CULVERTAILED, among shipwrights, signifies the fastening or letting of one timber into another, so that they cannot slip out, as the corlings into the beams of a ship.

CUMA, or Cumæ, in *Ancient Geography*, a town of Æolia in Asia Minor. The inhabitants have been accused of stupidity for not laying a tax upon all the goods which entered their harbour during 300 years. They were called *Cumani*.

CUMÆ, or Cuma, in *Ancient Geography*, a city of Campania near Puteoli, founded by a colony from Chalcis and Cumæ of Æolia before the Trojan war. The inhabitants were called *Cumæi*. One of the Sibyls fixed her residence in a cave in the neighbourhood, and was called the *Cumean Sibyl*.

CUMBERLAND, Cumbria, so denominated from the *Cumbri*, or Britons, who inhabited it; one of the most northerly counties in England. It was formerly a kingdom, extending from the vallum of Adrian to the city of Dumbritton, now Dumbarton on the frith of Clyde in Scotland. At present it is a county of England, which gives the title of duke to one of the royal family, and sends two members to parliament. It is bounded on the north and north-west by Scotland; on the south and south-east by part of Lancashire and Westmoreland: it borders on the east with Northumberland and Durham; and on the west is washed by the Irish sea. Its extreme length is 72 miles, its greatest breadth 38, and it incloses an area of 1516 square miles, or 970,240 acres. It is well watered with rivers, lakes, and fountains; but none of its streams are navigable. In some places there are very high mountains, and the climate is moist, as in all hilly countries. The soil varies with the face of the country; being barren on the moors and mountains, but fertile in the valleys and level ground bordering on the sea. In general, the eastern parts of the shire are barren and desolate: yet even the least fertile parts are rich in metals and minerals. The mountains of Copland contain copper, though now little worked. Veins of the same metal, with a mixture of gold and silver, were found in the reign of Queen Elizabeth among the fells of Derwent; and royal mines were formerly wrought at Keswick. The county produces great quantities of coal: it abounds with lead mines, has a mine of black lead, and several mines of lapis calaminaris. The population in 1811 was 133,744. See Cumberland, Supplement.

Cumberland, *Richard*, a learned English divine in the end of the 17th century, was son of a citizen of London, and educated at Cambridge. In 1672 he published a Treatise of the Laws of Nature; and in 1686, An Essay toward the Jewish Weights and Measures. After the Revolution he was nominated by King William to the bishopric of Peterborough. He wrote on history, chronology, and philosophy; and was as remarkable for humility of mind, benevolence of temper, and innocence of life, as for his extensive learning. He died in 1718.

CUMBRAY, Great and Little, two islands in the frith of Clyde, in Scotland. The first is about six miles in circumference, and lies between the isle of Bute and the coast of Ayrshire. The other is of smaller extent, and has a light-house.

CUMINUM, Cumin; a genus of plants belonging to the pentandria class; and in the natural method ranking under the 45th order, *umbellatæ*. See Botany *Index*.

CUNÆUS, Peter, born in Zealand in 1586, was distinguished by his knowledge in the learned languages, and his skill in the Jewish antiquities. He also studied law, which he taught at Leyden in 1615; and read politics there till his death in 1638. His principal work is a treatise, in Latin, on the republic of the Hebrews.

CUNEIFORM, in general, an appellation given to any body having the shape of a wedge.

Cuneiform *Bone*, in *Anatomy*, the seventh bone of the cranium, called also *os basilare*, and *os sphenoides*. See Anatomy *Index*.

CUNEUS, in antiquity, a company of infantry

drawn

drawn up in form of a wedge, the better to break through the enemy's ranks.

CUNICULUS. See LEPUS, MAMMALIA *Index*.

CUNICULUS, in mining, a term used by authors in distinction from *puteus*, to express the several sorts of passages and cuts in these subterranean works. The *cuniculi* are those direct passages in mines where they walk on horizontally; but the putei are the perpendicular cuts or descents. The miners in Germany call these by the name *stollen*, and *schachts*; the first word expressing the horizontal, and the second the perpendicular cuts.

CUNILA, a genus of plants belonging to the monandria class; and in the natural method ranking under the 42d order, *Verticillatæ*. See BOTANY *Index*.

CUNINA, in *Mythology*, a goddess who had the care of little children.

CUNITZ, or CUNITIA, MARIA, astronomer, was the eldest daughter of Hendric Cunitz, doctor of medicine in Silesia, and was born about the beginning of the 17th century. She learned languages with amazing facility; and understood Polish, German, French, Italian, Latin, Greek, and Hebrew. She attained a knowledge of the sciences with equal ease: she was skilled in history, physic, poetry, painting, music, and playing upon instruments; and yet these were only an amusement. She more particularly applied herself to the mathematics, and especially to astronomy, which she made her principal study, and was ranked in the number of the most able astronomers of her time. Her Astronomical Tables acquired her a prodigious reputation: she printed them in Latin and German, and dedicated them to the emperor Ferdinand III. She married Elias de Lewin, M. D. and died at Pistehen in 1664.

CUNNINGHAM, one of the four bailiwicks in Scotland; and one of the three into which the shire of Ayr is subdivided. It lies north-east of Kyle. It contains the sea-port towns of Irvine and Saltcoats.

CUNNINGHAM, *Alexander*, author of a History of Great Britain from the Revolution to the accession of George I. was born in the south of Scotland about the year 1654, in the regency of Oliver Cromwell. His father was minister at Ettrick, in the presbytery and shire of Selkirk. He was educated, as was the custom among the Scottish presbyterian gentlemen of those times, in Holland; where he imbibed his principles of government, and lived much with the English and Scots refugees at the Hague before the revolution, particularly with the earls of Argyle and Sunderland. He came over to England with the prince of Orange, and enjoyed the confidence and intimacy of many leading men among the whig party, that is, the friends and abettors of King William and the revolution. He was employed, at different times, in the character of a travelling companion or tutor; first, to the earl of Hyndford, and his brother Mr William Carmichael, solicitor-general, in the reign of Queen Anne, for Scotland; secondly, with the lord Lorne, afterwards so well known under the name of *John duke of Argyle*; and thirdly, with the lord viscount Lonsdale. In his travels, we find him, at the German courts, in company with the celebrated Mr Joseph Addison, whose virtues he celebrates.

Lord Lorne, at the time he was under the tuition of Mr Cunningham, though not seventeen years of age, was colonel of a regiment, which his father, the earl of Argyle, had raised for his majesty's service in Flanders. Mr Cunningham's connection with the duke of Argyle, with whom he had the honour of maintaining an intimacy as long as he lived, together with the opportunities he enjoyed of learning, in his travels, what may be called *military geography*, naturally tended to qualify him for writing on military affairs.

Mr Cunningham, both when he travelled with the nobleman above mentioned, and on other occasions, was employed by the English ministry in transmitting secret intelligence to them on the most important subjects. He was also, on sundry occasions, employed by the generals of the confederate armies, to carry intelligence, and to make representations to the court of Britain. In Carstaires's State Papers, published by Dr Macormick, principal of the United College of St Andrew's, in 1774, there are two letters from our author, dated Paris the 22d and 26th of August 1701, giving an account of his conferences with the marquis de Torcy, the French minister, relative to the Scots trade with France. This commercial negotiation, from the tenor of Cunningham's letters compared with his history, appears to have been only the ostensible object of his attention: for he sent an exact account to King William, with whom he was personally acquainted, of the military preparations throughout all France.

Mr Cunningham's political friends, Argyle, Sunderland, Sir Robert Walpole, &c. on the accession of George I. sent him as British envoy to the republic of Venice. He arrived in that city in 1715; and continued there, in the character of resident, till the year 1720, when he returned again to London. He lived many years after, which he seems chiefly to have passed in a studious retirement. In 1735, he was visited in London by Lord Hyndford, by the direction of his lordship's father, to whom he had been tutor, when he appeared to be very old. He seems to have lived about two years after: for the body of an Alexander Cunningham lies interred in the vicar chancel of St Martin's church, who died in the 83d year of his age, on the 15th day of May 1737; and who was probably the same person.

His "History of Great Britain, from the revolution in 1688 to the accession of George I." was published in two volumes 4to, in 1787. It was written by Mr Cunningham in Latin, but was translated into English by the reverend William Thomson, L.L.D. The original manuscript came into the possession of the reverend Dr Hollingberry, archdeacon of Chichester, some of whose relations had been connected with the author. He communicated it to the earl of Hardwicke, and to the reverend Dr Douglas, now bishop of Carlisle, both of whom recommended the publication. In a short preface to the work, the archdeacon says, "My first design was to have produced it in the original; but knowing how few are sufficiently learned to understand, and how many are indisposed to read two quarto volumes in Latin, however interesting and entertaining the subject may be, I altered my purpose, and intended to have sent it into the world in a translation.

lation. A nervous fever depriving me of the power, defeated the scheme." But he afterwards transferred the undertaking to Dr Thomson; and Dr Hollingberry observes, that Dr Thomson "has expressed the sense of the author with fidelity." The work was undoubtedly well deserving of publication. It contains the history of a very interesting period, written by a man who had a considerable degree of authentic information, and his book contains many curious particulars not to be found in other histories. His characters are often drawn with judgment and impartiality; at other times they are somewhat tinctured with prejudice. This is particularly the case with respect to Bishop Burnet, against whom he appears to have conceived a strong personal dislike. But he was manifestly a very attentive observer of the transactions of his own time; his work contains many just political remarks; and the facts which he relates are exhibited with great perspicuity, and often with much animation. Throughout his book he frequently intersperses some account of the literature, and of the most eminent persons of the age concerning which he writes; and he has also adorned his work with many allusions to the classics and to ancient history.

Alexander Cunningham, the author of the History of Great Britain, has been supposed to be the same person with Alexander Cunningham who published an edition of Horace at the Hague, in two volumes 8vo, in 1721, which is highly esteemed. But from the best information we have been able to collect, they were certainly different persons; though they were both of the same name, lived at the same time, had both been travelling tutors, were both said to have been eminent for their skill at the game of chess, and both lived to a very advanced age. The editor of Horace is generally said to have died in Holland, where he taught both the civil and canon laws, and where he had collected a very large library, which was sold in that country.

CUNNUS, in *Anatomy*, the *pudendum muliebre*, or the anterior parts of the genitals of a woman, including the *labia pudendi* and *mons veneris*. See ANATOMY, N° 108.

CUNOCEPHALI, in *Mythology*, (from κυων, "dog," and κεφαλη, "head,") a kind of baboons, or animals with heads like those of dogs, which were wonderfully endowed, and were preserved with great veneration by the Egyptians in many of their temples. It is related, that by their assistance the Egyptians found out the particular periods of the sun and moon; and that one half of the animal was often buried, while the other half survived: and that they could read and write. This strange history, Dr Bryant imagines, relates to the priests of Egypt, styled *cahen*, to the novices in their temples, and to the examinations they were obliged to undergo, before they could be admitted to the priesthood. The Egyptian colleges were situated upon rocks or hills, called *caph*, and from their consecration to the sun, *caph-el;* whence the Greeks deduced κεφαλη, and from *cahen-caph-el* they formed κυνοκηφαλος. So that *cahen-caph-el* was some royal seminary in Upper Egypt, whence they draughted novices to supply their colleges and temples. By this etymology he explains the above history. The death of one part, while the other survived, denoted the regular succession of the Egyptian priesthood. The *cunocephali* are also found in India and other parts of the world. These and the *acephali* were thus denominated from their place of residence and from their worship.

CUNODONTES, a people mentioned by Solinus and Isidorus, and by them supposed to have the teeth of dogs. They were probably denominated, says Dr Bryant, from the object of their worship, the deity Chan-Adon, which the Greeks expressed Κυνοδων, and thence called his votaries *Cunodontes*.

CUNONIA, a genus of plants belonging to the decandria class; and in the natural method ranking with those of which the order is doubtful. See BOTANY *Index*.

CUOGOLO, in *Natural History*, the name of a stone much used by the Venetians in glass-making, and found in the river Tesino. It is a small stone of an impure white, of a shattery texture, and is of the shape of a pebble.

CUP, a vessel of capacity of various forms and materials, chiefly to drink out of. In the Ephem. German. we have a description of a cup made of a common pepper-corn by Oswald Nerlinger, which holds 1200 other ivory cups, having each its several handle, all gilt on the edges; with room for 400 more.

CUP, in *Botany*. See CALYX, BOTANY *Index*.

CUP-Galls, in *Natural History*, a name given by authors to a very singular kind of galls, found on the leaves of the oak and some other trees. They are of the figure of a cup, or drinking-glass without its foot, being regular cones adhering by their point or apex to the leaf; and the top or broad part is hollowed a little way, so that it appears like a drinking-glass with a cover, which was made so small as not to close it at the mouth, but fall a little way into it. This cover is flat, and has in the centre a very small protuberance, resembling the nipple of a woman's breast. This is of a pale green, as is also the whole of the gall, excepting only its rim that runs round the top: this is of a scarlet colour, and that very beautiful. Besides this species of gall, the oak leaves furnish us with several others, some of which are oblong, some round and others flatted; these are of various sizes, and appear on the leaves at various seasons of the year. They all contain the worm of some small fly; and this creature passes all its changes in this its habitation, being sometimes found in the worm, sometimes in the nymph, and sometimes in the fly state, in the cavity of it.

CUPANIA, in *Botany*, a genus of plants belonging to the monœcia class; and in the natural method ranking under the 38th order, *Tricoccæ*. See BOTANY *Index*.

CUPEL, in *Metallurgy*, a small vessel which absorbs metallic bodies when changed by fire into a fluid scoria; but retains them as long as they continue in their metallic state. One of the most proper materials for making a vessel of this kind is the ashes of animal bones; there is scarcely any other substance which so strongly resists vehement fire, which so readily imbibes metallic scoriæ, and which is so little disposed to be vitrified by them. In want of these, some make

Cupel, Cupellation.

use of vegetable ashes, freed by boiling in water from their saline matter, which would cause them melt in the fire.

The bones, burnt to perfect whiteness, so that no particle of coaly or inflammable matter may remain in them, and well washed from filth, are ground into moderately fine powder; which in order to its being formed into cupels, is moistened with just as much water as is sufficient to make it hold together when strongly pressed between the fingers; some direct glutinous liquids, as whites of eggs or gum-water, in order to give the powder a greater tenacity: but the inflammable matter, however small in quantity, which accompanies these fluids, and cannot be easily burnt out from the internal part of the mass, is apt to revive a part of the metallic scoria that has been absorbed, and to occasion the vessel to burst or crack. The cupel is formed in a brass ring, from three quarters of an inch to two inches diameter, and not quite so deep, placed upon some smooth support: the ring being filled with moistened powder, which is pressed close with the fingers; a round-faced pestle, called a *monk*, is struck down into it with a few blows of a mallet, by which the mass is made to cohere, and rendered sufficiently compact, and a shallow cavity formed in the middle: the figure of the cavity is nearly that of a sphere, that a small quantity of metal melted in it may run together into one bead. To make the cavity the smoother, a little of the same kind of ashes levigated into an impalpable powder, and not moistened, is commonly sprinkled on the surface, through a small fine sieve made for this purpose, and the monk again struck down upon it. The ring or mould is a little narrower at bottom than at top; so that by pressing it down on some of the dry powder spread upon a table, the cupel is loosened, and forced upwards a little; after which it is easily pushed out with the finger; and is then set to dry in a warm place free from dust.

CUPELLATION, the act of refining gold or silver by means of a cupel. For this purpose another vessel, called a *muffle*, is made use of, within which one or more cupels are placed. The muffle is placed upon a grate in a proper furnace, with its mouth facing the door, and as close to it as may be. The furnace being filled up with fuel, some lighted charcoal is thrown on the top, and what fuel is afterwards necessary is supplied through a door above. The cupels are set in the muffle; and being gradually heated by the successive kindling of the fuel, they are kept red hot for some time, that the moisture which they strongly retain may be completely dissipated: for if any vapours should issue from them after the metal is put in, they would occasion it to sputter, and a part of it to be thrown off in little drops. In the sides of the muffle are some perpendicular slits, with a knob over the top of each, to prevent any small pieces of coals or ashes from falling in. The door, or some apertures made in it, being kept open, for the inspection of the cupels, fresh air enters into the muffle, and passes off through these slits: by laying some burning charcoal on an iron plate before the door, the air is heated before its admission; and by removing the charcoal or supplying more, the heat in the cavity of the muffle may be somewhat diminished or increased more speedily than can be effected by suppressing or exciting the fire in the furnace on the outside of the muffle. The renewal of the air is also necessary for promoting the scorification of the lead.

Cupellation.

The cupel being of a full red heat, the lead cast into a smooth bullet, that it may not scratch or injure the surface, is laid lightly in the cavity; it immediately melts; and then the gold or silver to be cupelled is cautiously introduced either by means of a small iron ladle, or by wrapping them in paper, and dropping them on the lead with a pair of tongs. The quantity of lead should be at least three or four times that of the fine metal; but when gold is very impure, it requires 10 or 12 times its quantity of lead for cupellation. It is reckoned that copper requires for its scorification about 10 times its weight of lead: that when copper and gold are mixed in equal quantities, the copper is so much defended by the gold, as not to be separable with less than 20 times its weight of lead; and that when copper is in very small proportion, as a 20th or 30th part of the gold or silver, upwards of 60 parts of lead are necessary for one of the copper. The cupel must always weigh at least half as much as the lead and copper; for otherwise it would not be sufficient for receiving half the scoria; there is little danger, however, of cupels being made too small for the quantity of a gold assay.

The mixture being brought into thin fusion, the heat is to be regulated according to the appearances; and in this consists the principal nicety in the operation. If a various coloured skin rises to the top, which liquefying, runs off to the sides, and is there absorbed by the cupel, visibly staining the parts it enters; if a fresh scoria continually succeeds, and is absorbed nearly as fast as it is formed, only a fine circle of it remaining round the edge of the metal; if the lead appears in gentle motion, and throws up a fume a little way from the surface; the fire is of the proper degree, and the process goes on successfully.

Such a fiery brightness of the cupel as prevents its colour from being distinguished, and the fumes of the lead rising up almost to the arch of the muffle, are marks of too strong a heat; though it must be observed, that the elevation of the fumes is not always in proportion to the degree of heat; for if the heat greatly exceeds the due limits, both the fumes and ebullition will entirely cease. In these circumstances the fire must necessarily be diminished: for while the lead boils and smokes vehemently, its fumes are apt to carry off some part of the gold; the cupel is liable to crack from the hasty absorption of the scoria, and part of the gold and silver is divided into globules, which lying discontinued on the cupel after the process is finished, cannot easily be collected; if there is no ebullition or fumes, the scorification does not appear to go on. Too weak a heat is known by the dull redness of the cupel; by the fume not rising from the surface of the lead; and the scoria like bright drops in languid motion, or accumulated, or growing consistent all over the metal. The form of the surface affords also an useful mark of the degree of heat; the stronger the fire, the more convex is the surface; and the weaker, the more flat: in this point, however, regard must be had to the quantity of metal; a large quantity being always flatter than a small one in an equal fire.

Towards the end of the process, the fire must be increased; for the greatest part of the fusible metal lead being now worked off, the gold and silver will not continue melted in the heat that was sufficient before. As the last remains of the lead are separating, the rainbow colours on the surface become more vivid, and variously intersect one another with quick motions. Soon after, disappearing all at once, a sudden luminous brightness of the button of gold and silver shows the process to be finished. The cupel is then drawn forwards towards the mouth of the muffle; and the button, as soon as grown fully solid, taken out.

CUPELLING FURNACE. See *Cupelling* FURNACE.

CUPID, in Pagan mythology, the god of love. There seems to have been two Cupids; one the son of Jupiter and Venus, whose delight it was to raise sentiments of love and virtue; and the other the son of Mars and the same goddess, who inspired base and impure desires. The first of these, called Eros, or true love, bore golden arrows, which caused real joy, and a virtuous affection; the other, called Anteros, had leaden arrows, that raised a passion founded only on desire, which ended in satiety and disgust. Cupid was always drawn with wings, to represent his inconstancy; and naked, to shew that he has nothing of his own. He was painted blind, to denote that love sees no fault in the object beloved; and with a bow and quiver of arrows, to show his power over the mind. Sometimes he is placed between Hercules and Mercury, to show the prevalence of eloquence and valour in love; and at others is placed near Fortune, to signify that the success of lovers depends on that inconstant goddess. Sometimes he is represented with a helmet on his head and a spear on his shoulder, to signify that love disarms the fiercest men; he rides upon the backs of panthers and lions, and uses their manes for a bridle, to denote that love tames the most savage beasts. He is likewise pictured riding upon a dolphin, to signify that his empire extends over the sea no less than the land.

CUPOLA, in *Architecture*, a spherical vault, or the round top of the dome of a church, in the form of a cup inverted.

CUPPING, in *Surgery*, the operation of applying cupping-glasses for the discharge of blood and other humours by the skin. See SURGERY.

CUPRESSUS, the CYPRESS TREE, a genus of plants belonging to the monœcia class; and in the natural method ranking under the 51st order, *Coniferæ*. See BOTANY *Index*.

The wood of the *sempervirens*, or evergreen cypress, is said to resist worms, moths, and putrefaction, and to last many centuries. The coffins in which the Athenians were wont to bury their heroes, were made, says Thucydides, of this wood; as were likewise the chests containing the Egyptian mummies. The doors of St Peter's church at Rome were originally of the same materials. These, after lasting upwards of 600 years, at the end of which they did not discover the smallest tendency to corruption, were removed by order of Pope Eugenius IV. and gates of brass substituted in their place. The same tree is by many eminent authors recommended as improving and meliorating the air by its balsamic and aromatic exhalations; upon which account many ancient physicians of the eastern countries used to send their patients who were troubled with weak lungs to the island of Candia, where these trees grow in great abundance; and where, from the salubrious air alone, very few failed of a perfect cure. In the same island, says Miller, the cypress-trees were so lucrative a commodity, that the plantations were called *dos filiæ;* the felling of them being reckoned a daughter's portion. Cypress, says Mr Pococke, is the only tree that grows towards the top of Mount Lebanon, and being nipped by the cold, grows like a small oak. Noah's ark is commonly supposed to have been made of this kind of wood.

CUPRUM AMMONIACALE. See CHEMISTRY *Index*. This preparation is recommended in some kinds of spasmodic diseases, given in the dose of one or two grains.

CUPRUM, or *Copper*. See COPPER, CHEMISTRY *Index*.

CURACOA, or CURASSOW, one of the larger Antilles islands, formerly subject to the Dutch; situated in W. Long. 68. 30. N. Lat. 12. 30. This island is little else than a bare rock, about ten leagues long and five broad; lying three leagues off the coast of Venezuela. It has an excellent harbour, but the entrance is difficult. The bason is extremely large, and convenient in every respect; and is defended by a fort skilfully constructed, and always kept in repair. The reason of forming a settlement upon this barren spot, was to carry on a contraband trade with the Spanish colonies on the continent; but after some time the method of managing this trade was changed. Curassow itself became an immense magazine, to which the Spaniards resorted in their boats to exchange gold, silver, vanilla, cocoa, cochineal, bark, skins, and mules, for negroes, linen, silks, India stuffs, spices, laces, ribbands, quicksilver, steel, and iron-ware. These voyages, though continual, did not prevent a number of Dutch sloops from passing from Curassow to the continent. But the modern substitution of register-ships, instead of galleons, has made this communication less frequent; but it will be revived whenever, by the intervention of war, the communication with the Spanish Main shall be cut off. The disputes between the courts of London and Versailles also prove favourable to the trade of Curassow. At these times it furnishes provisions to the southern parts of St Domingo, and takes off all its produce. Even the French privateers, from the windward islands, repair in great numbers to Curassow, notwithstanding the distance. The reason is, that they find there all kinds of necessary stores for their vessels; and frequently Spanish, but always European goods, which are universally used. Every commodity without exception, that is landed at Curassow, pays one per cent. port-duty. Dutch goods are never taxed higher; but those that are shipped from other European ports pay nine per cent. more. Foreign coffee is subject to the same tax, in order to promote the sale of that of Surinam. Every other production of America is subject only to a payment of three per cent. but with an express stipulation, that they are to be conveyed directly to some port belonging to the republic. This island is now in possession of Great Britain.

CURATE, the lowest degree in the church of England; he who represents the incumbent of a church, parson, or vicar, and performs divine service in his stead: and in case of pluralities of livings, or where a clergyman is old and infirm, it is requisite there should be a curate to perform the cure of the church. He is to be licensed, and admitted by the bishop of the diocese, or by an ordinary having episcopal jurisdiction; and when a curate hath the approbation of the bishop, he usually appoints the salary too; and in such case, if he be not paid, the curate hath a proper remedy in the ecclesiastical court, by a sequestration of the profits of the benefice; but if the curate is not licensed by the bishop, he is put to his remedy at common law, where he must prove the agreement, &c. A curate having no fixed estate in his curacy, not being instituted and inducted, may be removed at pleasure by the bishop or incumbent. But there are perpetual curates as well as temporary, who are appointed where the tithes are impropriate, and no vicarage endowed: these are not removeable, and the impropriators are obliged to find them; some whereof have certain portions of the tithes settled on them. Every clergyman that officiates in a church (whether incumbent or substitute) in the liturgy is called a *curate*. Curates must subscribe the declaration according to the act of uniformity, or are liable to imprisonment, &c.

CURATELLA, a genus of plants belonging to the polyandria class; and in the natural method ranking with those of which the order is doubtful. See BOTANY *Index*.

CURATOR, among the Romans, an officer under the emperors, who regulated the price of all kinds of merchandise and vendible commodities in the cities of the empire. They had likewise the superintendence of the customs and tributes; whence also they were called *logistæ*.

CURATOR, among civilians, a trustee or person nominated to take care of the affairs and interests of a person emancipated or interdicted. In countries where the Roman law prevails, between the age of 14 and 24 years, minors have curators assigned them; till 14, they have tutors.

CURATOR of an University, in the United Provinces, is an elective office, to which belongs the direction of the affairs of the university; as, the administration of the revenues, the inspection of the professors, &c. The curators are chosen by the states of each province: The university of Leyden has three; the burghermasters of the city have a fourth.

CURB, in the manege, a chain of iron made fast to the upper part of the branches of the bridle in a hole called the *eye*, and running over the horse's beard. It consists of these three parts; the hook fixed to the eye of the branch; the chain of SS's or links; and the two rings or mailes. Large curbs, provided they be round, are always most gentle; but care is to be taken, that it rest in its proper place, a little above the beard, otherwise the bit-mouth will not have the effect that may be expected from it.

English watering bits have no curbs; the Turkish bits, called *genettes*, have a ring that serves instead of a curb. See GENETTES.

CURB, in *Farriery*, is a hard and callous swelling on the hind part of the hock, attended with stiffness, and sometimes with pain and lameness. See SPAVIN.

CURCAS, a name given in Egypt to an esculent root, approaching to the taste and virtues of the colocasia. It is also a name used in Malabar for a small fruit of the shape and size of a hazel nut. Both these things have the credit of being strong provocatives: and it is very probable that the curcas of the East Indies may be the fruit called *bell* by Avicenna, and said to possess the same virtues. Gracias has been led into a very great error by this similarity of names and virtues; and supposes the curcas of Egypt the same with that of the East Indies.

CURCULIO, a genus of insects belonging to the order of coleoptera. See ENTOMOLOGY *Index*.

CURCUMA, TURMERIC, a genus of plants belonging to the monandria class; and in the natural method ranking under the 8th order, *Scitamineæ*. See BOTANY *Index*.

CURDISTAN, a country of Asia, situated between the Turkish empire and Persia, lying along the eastern coast of the river Tigris, and comprehending great part of the ancient Assyria. Some of the inhabitants live in towns and villages, and others rove from place to place, having tents like the wild Arabs, and are also robbers like them. Their religion is partly Christian, and partly Mahometanism.

CURDLING, the coagulating or fixing any fluid body; particularly milk. See CHEESE, AGRICULTURE *Index*.

Pausanias says, that Aristæus son of Apollo, and Cyrene, daughter of the river Peneus, were the first who found out the secret of curdling milk.

At Florence they curdle their milk for the making of cheese with artichoke flowers, in lieu of the rennet used for the same purpose among us.

The Bisaltæ, a people of Macedonia, Rochfort observes, live wholly upon curded milk, i. e. on curds. He adds, that curds are the whole food of the people of Upper Auvergne in France, and whey their only drink.

CURETES, in antiquity, a sort of priests or people of the isle of Crete, called also *Corybantes*. See CORYBANTES and CRETE. The Curetes are said to have been originally of Mount Ida in Phrygia; for which reason they were also called *Idæi Dactyli*. See DACTYLI.

Lucian and Diodorus Siculus represent them as very expert in casting of darts; though other authors give them no weapons but bucklers and pikes: but all agree in furnishing them with tabors and castanettas: and relate, that they used to dance much to the noise and clashing thereof. By this noise, it is said, they prevented Saturn from hearing the cries of young Jupiter, whereby he was saved from being destroyed.

Some authors, however, give a different account of the Curetes. According to Pezron and others, the Curetes were, in the times of Saturn, &c. and in the countries of Crete and Phrygia, what the druids were afterwards among the Gauls, &c. i. e. they were priests who had the care of what related to religion and the worship of the gods. Hence, as in those days it was supposed there was no communication with the gods but by divinations, auguries, and the operations of magic, the Curetes passed for magicians and enchanters: to these they added the study of the stars, of nature,

ture, and poesy; and so were philosophers, astronomers, &c.

Vossius, *de Idolat.* distinguishes three kinds of Curetes, those of Ætolia, those of Phrygia, and those of Crete, who were originally derived from the Phrygians. The first, he says, took their name from κȣρα, *tonsure;* in regard, from the time of a combat wherein the enemy seized their long hair, they always kept it cut. Those of Phrygia and Crete, he supposes, were so called from κȣρος, *young man*, in regard they were young, or because they nursed Jupiter when he was young.

CURFEU, Curfew, or Courfew, a signal given in cities taken in war, &c. to the inhabitants to go to bed. Pasquin says, it was so called, as being intended to advertise the people to secure themselves from the robberies and debaucheries of the night.

Curfew-Bell in French *couvrefeu*, and in law Latin of the middle ages, *ignitegium*, or *pyritegium*, was a signal for all persons to extinguish their fires. The most eminent curfew in England was that established by William the Conqueror, who appointed, under severe penalties, that, at the ringing of the bell at 8 o'clock in the evening, every one should put out their lights and fires and go to bed; whence to this day a bell rung about this time is called a *curfew-bell.* This law was abolished by Henry I. in 1100.

This practice was highly necessary to prevent accidents in those ages when the fires were placed in a hole in the middle of the floor, under an opening in the roof to allow the escape of the smoke. This hole was covered up when the family went to bed. The same practice still exists in some countries, and particularly in some parts of Scotland. But besides securing houses against accidents by fire, the law which was very generally established in England for extinguishing or covering fires, was probably meant also to check the turbulence which frequently prevailed in the middle ages, by forcing the people to retire to rest, or to keep within doors. From this ancient practice, in the opinion of Beckmann, has arisen a custom in Lower Saxony of saying, when people wish to go home sooner than the company choose, that they hear the *bürgerglocke*, the burgher's bell.

The ringing of the prayer bell, as it is called, which is still practised in some Protestant countries, according to Beckmann, originated in that of the curfeu-bell. Pope John XXIII. dreading that some misfortunes were to befal him, ordered every person on hearing the ignitegium to repeat the *ave Maria* three times, with a view to avert them. When the appearance of a comet, and a dread of the Turks, alarmed all Christendom, Pope Calixtus VIII. increased these periodical times of prayer, by ordering the prayer-bell to be rung also at noon. *Hist. of Invent.* ii. 101.

CURIA, in Roman antiquity, was used for the senate house. There were several curiæ in Rome; as the *curia calabra*, said to be built by Romulus; the *curia hostilia*, by Tullus Hostilius; and the *curia pompeia*, by Pompey the Great.

Curia also denoted the places where the curia used to assemble. Each of the 30 curiæ of old Rome had a temple or chapel assigned to them for the common performance of their sacrifices, and other offices of their religion; so that they were not unlike our parishes. Some remains of these little temples seem to have subsisted many ages after on the Palatine hill, where Romulus first built the city, and afterwards resided.

Curia, among the Romans, also denoted a portion or division of a tribe. In the time of Romulus, a tribe consisted of ten curiæ, or a thousand men; each curia being one hundred. That legislator made the first division of his people into thirty curiæ. Afterwards *curia*, or *domus curialis*, became used for the place where each curia held its assemblies. Hence also curia passed to the senate-house; and it is from hence the moderns came to use the word *curia*, "court," for a place of justice, and for the judges, &c. there assembled.

Varro derives the word from *cura*, "care," *q. d.* an assembly of people charged with the care of public affairs. Others deduce it from the Greeks; maintaining, that at Athens they called κυρια the place where the magistrate held his assizes, and the people used to assemble: κυρια, again, may come from κυρος, *authority*, *power;* because it was here the laws were made.

Curia, in our ancient customs.—It was usual for the kings of England to summon the bishops, peers, and great men of the kingdom to some particular place, at the chief festivals in the year; and this assembly is called by our historians *curia;* because there they consulted about the weighty affairs of the nation; whence it was sometimes also called *solemnis curia*, *generalis curia*, *augustalis*, and *curia publica*, &c. See Witena-*Mot.*

Curia Baronum. See *Court-Baron.*

Curia Claudenda, is a writ that lies against him who should fence and inclose the ground, but refuses or defers to do it.

CURIATII, three brothers of Alba, maintained the interest of their country against the Romans, who had declared war against those of Alba. The two armies being equal, three brothers on each side were chosen to decide the contest; the Curiatii by those of Alba, and the Horatii by the Romans. The three first were wounded, and two of the latter killed; but the third joining policy to valour, ran away; and having thus tired the Curiatii, he took them one after another, and killed them all three.

CURING, a term used for the preserving fish, flesh, and other animal substances, by means of certain additions of things, to prevent putrefaction. One great method of doing this is by exposing the bodies to the smoke of wood, or rubbing them with salt, nitre, &c.

CURIO, the chief and priest of a curia.—Romulus, upon dividing the people into curiæ, gave each division a chief, who was to be priest of that curia, under the title of *curio* and *flamen curialis.* His business was to provide and officiate at the sacrifices of the curia, which were called *curionia;* the curia furnishing him with a sum of money on that consideration, which pension or appointment was called *curionium.* Each division had the election of its curia; but all these particular curios were under the direction of a superior or general, called *curio maximus*, who was the head of the body, and elected by all the curios assembled in the comitia curialis.

All these institutions were introduced by Romulus, and confirmed by Numa, as Halicarnassus relates it.

CURIOSUS, an officer of the Roman empire during the middle age, appointed to take care that no frauds and irregularities were committed; particularly no abuses in what related to the posts, the roads, &c. and to give intelligence to the court of what passed in the provinces. This made the curiosi people of importance, and put them in a condition of doing more harm than they prevented; on which account, Honorius cashiered them, at least in some parts of the empire, anno 415.

The curiosi came pretty near to what we call *controllers*. They had their name from *cura*, " care;" *quod curis agendis et evectionibus cursus publici inspiciendis operam darent.*

CURLEW. See SCOLOPAX, ORNITHOLOGY *Index*.

CURMI, a name given by the ancients to a sort of malt liquor or ale. It was made of barley, and was drunk by the people of many nations instead of wine, according to Dioscorides's account. He accuses it of causing pains in the head, generating bad juices, and disordering the nervous system. He also says, that in the western part of Iberia, and in Britain, such a sort of liquor was in his time prepared from wheat instead of barley. See ALE.

CURNOCK, a measure of corn containing four bushels, or half a quarter.

CURRANS, or CURRANTS, the fruit of a species of grossularia. See GROSSULARIA, BOTANY *Index*.

The white and red sort are mostly used; for the black, and chiefly the leaves, upon first coming out, are in use to flavour English spirits, and counterfeit French brandy. Currants greatly assuage drought, cool and fortify the stomach, and help digestion; and the jelly of black currants is said to be very efficacious in curing inflammations of the throat.

CURRANTS also signify a smaller kind of grapes, brought principally from Zante and Cephalonia. They are gathered off the bushes, and laid to dry in the sun, and so put up in large butts. They are opening and pectoral; but are more used in the kitchen than in medicine.

CURRENT, or CURRANT, a term used to express the present time. Thus the year 1804 is the current year, the 20th current is the 20th day of the month now running.—With regard to commerce, the price current of any merchandise is the known and ordinary price accustomed to be given for it. The term is also used for any thing that has course or is received in commerce; in which sense we say, *current coin*, &c.

CURRENT, in *Navigation*, a certain progressive movement of the water of the sea, by which all bodies floating therein are compelled to alter their course or velocity, or both, and submit to the laws imposed on them by the current.

In the sea, currents are either natural and general, as arising from the diurnal rotation of the earth about its axis; or accidental and particular, caused by the waters being driven against promontories, or into gulfs and straits, where, wanting room to spread, they are driven back, and thus disturb the ordinary flux of the sea. Currents are various, and directed towards different parts of the ocean, of which some are constant, others periodical. The most extraordinary current of the sea is that by which part of the Atlantic or African ocean moves about Guinea from Cape Verd towards the curvature or bay of Africa, which they call *Fernando Poo;* viz. from west to east, contrary to the general motion: and such is the force of the current, that when ships approach too near the shore, it carries them violently towards that bay, and deceives the mariners in their reckoning. There is a great variety of shifting currents, which do not last, but return at certain periods: and these do, most of them, depend upon and follow the anniversary winds or monsoons, which by blowing in one place may cause a current in another. Varenius informs us, that at Java, in the straits of Sunda, when the monsoons blow from the west, viz. in the month of May, the currents set to the eastward, contrary to the general motion. Between the island of Celebes and Madura, when the western monsoons set in, viz. in December, January, and February, or when the winds blow from the north-west, or between the north and west, the currents set to the south-east, or between the south and east. At Ceylon, from the middle of March to October, the currents set to the southward, and in the other parts of the year to the northward: because at this time the southern monsoons blow, and at the other the northern. Between Cochin-China and Malacca, when the western monsoons blow, viz. from April to August, the currents set eastward against the general motion; but the rest of the year they set westward, the monsoon conspiring with the general motion. They run so strongly in these seas, that unexperienced sailors mistake them for waves that beat upon the rocks, known usually by the name of *breakers*. So for some months after the 15th of February, the currents set from the Maldives towards India on the east, against the general motion of the sea. On the shore of China and Cambodia, in the months of October, November, and December, the currents set to the north-west, and from January to the south-west, when they run with such rapidity about the shoals of Parcel, that they seem swifter than an arrow. At Pulo Condore, upon the coast of Cambodia, though the monsoons are shifting, yet the currents set strongly towards the east, even when they blow to a contrary point. Along the coasts of the bay of Bengal, as far as the Cape Romania, at the extreme point of Malacca, the current runs southward in November and December. When the monsoons blow from China to Malacca, the sea runs swiftly from Pulo Cambi to Pulo Condore on the coast of Cambodia. In the bay of Sans Bras, not far from the Cape of Good Hope, there is a current particularly remarkable, where the sea runs from east to west to the landward; and this more vehemently, as it is opposed by winds from a contrary direction. The cause is undoubtedly owing to some adjacent shore which is higher than this. In the straits of Gibraltar the currents almost constantly drive to the eastward, and carry ships into the Mediterranean; they are also found to drive the same way into St George's channel.

The setting or progressive motion of the current may be either quite down to the bottom, or to a certain determinate depth. As the knowledge of the direction and velocity of currents is a very material article

ticle in navigation, it is highly necessary to discover both, in order to ascertain the ship's situation and course with as much accuracy as possible. The most successful method which has been hitherto practised by mariners for this purpose, is as follows: A common iron-pot, which may contain four or five gallons, is suspended by a small rope, fastened to its ear or handles, so as to hang directly upright, as when placed upon the fire. This rope, which may be from 70 to 100 fathoms in length, being prepared for the experiment, is coiled in the boat, which is hoisted out of the ship at a proper opportunity, when there is little or no wind to ruffle the surface of the sea. The pot being then thrown overboard into the water, and immediately sinking, the line is slackened till about 70 or 80 fathoms of the line are run out; after which the line is fastened to the boat's stern, by which she is accordingly restrained and rides at an anchor. The velocity of the current is then easily tried by the log and half-minute glass, the usual method of discovering the rate of a ship's sailing at sea. The course of the stream is next obtained by the compass provided for this operation. Having thus found the setting and drift of the current, it next remains to apply this experiment to the purposes of NAVIGATION; for which see that article.

Under-CURRENTS, are distinct from the upper or apparent, and in different places set or drive a contrary way. Dr Smith makes it highly probable, that in the Downs, in the straits of Gibraltar, &c. there is an under-current, whereby as much water is carried out as is brought in by the upper currents. This he argues from the offing between the North and South Foreland, where it runs tide and half-tide, i. e. it is ebb or flood in that part of the Downs three hours before it is so off at sea: a certain sign, that though the tide of flood runs aloft, yet the tide of ebb runs under-foot, i. e. close by the ground; and so at the tide of ebb it will flow under foot. This he confirms by an experiment in the Baltic sound, communicated to him by an able seaman present at the making of it. Being there then with one of the king's frigates, they went with their pinnace into the mid-stream, and were carried violently by the current. Soon after that, they sunk a basket with a large cannon bullet to a certain depth of water, which gave a check to the boat's motion; and sinking it still lower and lower, the boat was driven a-head to the windward against the upper current, the current aloft not being above four or five fathom deep. He added, that the lower the basket was let down, the stronger the under-current was found.

From this principle, it is easy to account for that continual indraught of water out of the Atlantic into the Mediterranean through the straits of Gibraltar, a passage about 20 miles broad; yet without any sensible rising of the water along the coasts of Barbary, &c. or any overflowing of the land, which there lies very low.—Dr Halley, however, solves the currents setting in at the straits without overflowing the banks, by the great evaporation, without supposing any under current.

CURRICULUS, in our ancient writers, denotes the year or course of a year. *Actum est hoc annorum Dominicæ incarnationis quater quinquagenis et quinquies quinis lustris, et tribus curriculis*, i. e. In the year 1028; for four times fifty make two hundred, and five times two hundred make one thousand; five lustres are twenty-five years, and three curriculi are three years.

CURRIE, JAMES, an eminent Scotch physician. See SUPPLEMENT.

CURRIERS, those who dress and colour leather after it comes from the tan-yard. See TANNING.

CURRODREPANUS, (formed of *currus*, "chariot," and δρεπανον, "scythe" or "sickle"), in antiquity, a kind of chariot armed with scythes. The driver of these chariots was obliged to ride on one of the horses, as there was no other seat for him; the usual place for him being all armed with knives, as was likewise the hinder part of the chariot. There were no scythes pointing down to the earth, either from the beam or axle-tree; but these were fixed at the head of the axle-tree in such a manner as to be moveable by means of a rope, and thereby could be raised or let down, and drawn forward or let fall backward.

CURRYING, the method of preparing leather with oil, tallow, &c. The chief business is to soften cow and calve-skins, which make the upper leather and quarters of shoes, covering of saddles, coaches, and other things which must keep out water. 1. These skins, after coming from the tanner's yard, having many fleshy fibres on them, the currier soaks them some time in common water. 2. He takes them out, and stretches them on a very even wooden horse; then with a paring knife he scrapes off all the superfluous flesh, and puts them in to soak again. 3. He puts them wet on a hurdle, and tramples them with his heels till they begin to grow soft and pliant. 4. He soaks thereon train-oil, which by its unctuous quality is the best liquor for this purpose. 5. He spreads them on large tables, and fastens them at the ends. There, with the help of an instrument called a *pummel*, which is a thick piece of wood, the under side of which is full of furrows crossing each other, he folds, squares, and moves them forwards and backwards several times, under the teeth of this instrument, which breaks their too great stiffness. This is what is properly called *currying*. The order and number of these operations is varied by different curriers, but the material part is always the same. 6. After the skins are curried, there may be occasion to colour them. The colours are black, white, red, yellow, green, &c.: the other colours are given by the skinners, who differ from curriers in this, that they apply their colours on the flesh side; the curriers on the hair side. In order to whiten skins, they are rubbed with lumps of chalk or white lead, and afterwards with pumice-stone. 7. When a skin is to be made black, after having oiled and dried it, he passes over it a puff dipt in water impregnated with iron; and after his first wetting, he gives it another in water prepared with soot, vinegar, and gum-arabic. These different dyes gradually turn the skin black, and the operations are repeated till it be of a shining black. The grain and wrinkles, which contribute to the suppleness of calves and cows leather, are made by the reiterated folds given to the skin in every direction, and by the care taken to scrape off all hard parts on the colour side.

CURSING AND SWEARING, an offence against God and religion, and a sin of all others the most extravagant and unaccountable, as having no benefit or advantage attending it. By the last statute against this crime, 19 George II. which repels all former ones, every labourer, sailor, or soldier, profanely cursing or swearing, shall forfeit 1s.; every other person under the rank of a gentleman, 2s.; and every gentleman or person of superior rank, 5s. to the poor of the parish; and, on a second conviction, double: and, for every subsequent offence, treble the sum first forfeited, with all charges of conviction: and, in default of payment, shall be sent to the house of correction for ten days. Any justice of the peace may convict upon his own hearing, or the testimony of one witness; and any constable or peace officer, upon his own hearing, may secure any offender, and carry him before a justice, and there convict him. If the justice omits his duty, he forfeits 5l. and the constable 40s. And the act is to be read in all parish churches, and public chapels, the Sunday after every quarter day, on pain of 5l. to be levied by warrant from any justice. Besides this punishment for taking God's name in vain in common discourse, it is enacted, by stat. 3 Jac. I. c. 21. that if in any stage-play, interlude, or show, the name of the Holy Trinity, or any of the persons therein, be jestingly or profanely used, the offender shall forfeit 10l. one moiety to the king, and the other to the informer.

CURSITOR, a clerk belonging to the court of chancery, whose business it is to make out original writs. In the statute 18 Edw. III. they are called *clerks of course*, and are 24 in number, making a corporation of themselves. To each of them is allowed a division of certain counties, into which they issue out the original writs required by the subject.

CURTATE DISTANCE, in *Astronomy*, the distance of a planet from the sun to that point, where a perpendicular let fall from the planet meets with the ecliptic.

CURTATION, in *Astronomy*, is the interval between a planet's distance from the sun and the curtate distance.

CURTEYN, (*Curtana*), was the name of Edward the Confessor's sword, which is the first sword carried before the kings of England at their coronation; and it is said the point of it is broken as an emblem of mercy.

CURTIN, CURTAIN, or *Courtin*, in *Fortification*, is that part of the rampart of a place which is betwixt the flanks of two bastions, bordered with a parapet five feet high, behind which the soldiers stand to fire upon the covered way and into the moat.

CURTIUS, MARCUS, a Roman youth, who devoted himself to the gods manes for the safety of his country, about 360 years before the Augustan age. A wide gap had suddenly opened in the forum, and the oracle had said that it never would close before Rome threw into it whatever it had most precious. Curtius immediately perceived that no less than a human sacrifice was required. He armed himself, mounted his horse, and solemnly threw himself into the gulf, which instantly closed over his head.

CURTIUS, *Quintus*, a Latin historian, who wrote the life of Alexander the Great in 10 books, of which the two first are not indeed extant, but were so well supplied by Freinshemius, that the loss is scarcely regretted. Where this writer was born, or even when he lived, are points no one pretends to know. By his style he is supposed to have lived in or near the Augustan age; while some are not wanting, who imagine the work to have been composed in Italy about 300 years ago, and the name of *Quintus Curtius* to be fictitiously added to it. Cardinal du Perron was so great an admirer of this work, as to declare one page of it to be worth 30 of Tacitus; yet, M. le Clerc, at the end of his Art of Criticism, has charged the writer with great ignorance and many contradictions. He has nevertheless many qualities as a writer, which will always make him admired and applauded.

CURVATURE OF A LINE, is the peculiar manner of its bending or flexure, by which it becomes a curve of any form and properties. Thus the nature of the curvature of a circle is such, as that every point in the periphery is equally distant from a point within, called the centre; and so the curvature of the same circle is everywhere the same. But the curvature in all other curves is continually varying.

CURVE, in *Geometry*, a line which running on continually in all directions, may be cut by one right line in more points than one. See CONIC SECTIONS and FLUXIONS.

CURVE of Equable Approach. Leibnitz first proposed to find a curve, down which a body descending by the force of gravity, shall make equal approaches to the horizon in equal portions of time. This curve, as it has been found by Bernoulli and others, is the second cubical parabola placed with its vertex uppermost, and which the descending body must enter with a certain determinate velocity. The question was rendered general by Varignon for any law of gravity, by which a body may approach towards a given point by equal spaces in equal times. Maupertuis also resolved the problem in the case of a body descending in a medium whose resistance is as the square of the velocity.

CURVES, *Algebraical* or *Geometrical*, are those in which the relation of the abscisses to the ordinates can be expressed by a common algebraic equation.

CURVES, *Transcendental*, or *Mechanical*, are those which cannot be defined or expressed by an algebraic equation.

CURVET, or CORVET, in the manege, an air in which the horse's legs are raised higher than in the demi-volt; being a kind of leap up, and a little forwards, wherein the horse raises both his fore-legs at once, equally advanced, (when he is going straight forward, and not in a circle); and as his fore-legs are falling, he immediately raises his hind legs, equally advanced, and not one before the other: so that all his four legs are in the air at once; and as he sets them down, he marks but twice with them.

CURVILINEAR, or CURVILINEAL, is said of figures bounded by curves or crooked lines.

CURVIROSTRA. See LOXIA, ORNITHOLOGY *Index*.

CURULE CHAIR, in Roman antiquity, a chair adorned with ivory, wherein the great magistrates of Rome had a right to sit and be carried.

The curule magistrates were the ædiles, the prætors, censors, and consuls. The chair was fitted in a kind of chariot, whence it had its name. The senators who had borne the offices of ædiles, prætors, &c. were carried to the senate-house in this chair, as were all

all those who triumphed, and such as went to administor justice, &c. See ÆDILE, &c.

CURZOLA, an island in the gulf of Venice, lying on the coast of Dalmatia. It is about 20 miles long, and has a small town of the same name, with a bishop's see. It now belongs to the Austrians. E. Long. 17. 15. N. Lat. 43. 6.

CUSA, NICHOLAS DE, a learned cardinal, born of mean parentage, and named from Cusa, the place of his birth. He was made a cardinal in 1448; and being appointed governor of Rome by Pope Pius II. during his absence at Mantua, he was the chief concerter and manager of the war against the Turks. He founded a church, and a noble library of Greek and Latin authors, at Cusa; and left many excellent works behind him, which were collected and published in three volumes at Basil in 1565. In these he has made no scruple to detect the lying traditions and sophistries of the Roman church.

CUSCO, a large and handsome town of South America in Peru, formerly the residence of the Incas. It is seated at the foot of a mountain, and is built in a square form, in the middle of which there is the best market in all America. Four large streets terminate in this square, which are all as straight as a line, and regard the four quarters of the world. The Spaniards tell us wonderful things of the richness of the Inca's palace, and of the temple of the sun; but more sober travellers, judging from what remains, think most of them to be fabulous. At present it contains eight large parishes, and five religious houses, the best of which belongs to the Jesuits; and the number of the inhabitants may be about 20,000, of which three-fourths are the original natives, Americans. From this town there is a very long road, which runs along the Cordilleras; and, at certain distances, there are small houses for resting places, some parts of which are so artificially wrought, that it is surprising how a people who had no iron tools could perform such workmanship. There are streams of water run through the town, which are a great convenience in so hot a country where it never rains. It is 375 miles east of Lima. W. Long. 71. 47. S. Lat. 13. 40.

CUSCUTA, DODDER; a genus of plants belonging to the tetrandria class; and in the natural method ranking under those of which the order is doubtful. See BOTANY *Index*.

CUSH, the eldest son of Ham, and father of Nimrod; the other sons of Cush were Seba, Havilah, Sabtah, Raamah, and Sabtecha, Gen. x. 6—8. Though we know of no other person in Scripture that is called by this name, yet there are several countries that are called by it; whether the same man may have dwelt in them all at different times, or that there were some other men of this name, we are ignorant.

The Vulgate, Septuagint, and other interpreters, both ancient and modern, generally translate Cush, *Ethiopia:* but there are many passages wherein this translation cannot take place.

CUSH is the name of the country watered by the Araxes. They who, in translating the situation of Eden, have made *Cush* Ethiopia, gave rise to that unwarrantable opinion which Josephus and several others have entertained of the river Gihon's being the Nile. In this place (Gen. ii. 13.) the LXX translation renders the word *Cush* by the name of Ethiopia; and, in this mistake, is not only here followed by our English version, but in the same particular in several other places.

Cuth is the same as Cush. The Chaldees generally put the *tau* where the Hebrews use the *schin:* they say *cuth* instead of *cush*. See CUTH.

But Ethiopia is frequently in the Hebrew called *Cush;* and Josephus says, that they called themselves by this name, and that the same name was given them by all Asia. St Jerome tells us that the Hebrews call the Ethiopians by the same name, and the Septuagint give them no other. Jeremiah (xiii. 23.) says, "Can the Cushæan, or Ethiopian, change his colour?" In Ezekiel (xxxix. 10.) the Lord threatens to reduce "Egypt to a desert, from the tower of Syene even unto the border of Cush, or Ethiopia;" and in Isaiah, (xi. 11.) he says, "he will recover the remnant of his people, which shall be left, from Assyria, and from Egypt, and Pathros, and from Cush." All these marks agree with Ethiopia properly so called, which lies to the south of Egypt.

Bochart has shown very clearly that there was a country called the "land of *Cush*" in Arabia Petræa, bordering upon Egypt; that this country extended itself principally upon the eastern shore of the Red sea, and at its extremity to the point of the sea, inclining towards Egypt and Palestine.

Thus there are three countries of the name of Cush, described in Scripture, and all confounded by interpreters under the general name of Ethiopia.

CUSHION, in engraving, is a bag of leather filled with sand, commonly about nine inches square, and three or four thick, used for supporting the plate to be engraved.

CUSHION, in gilding, is made of leather, fastened to a square board, from 14 inches square to 10, with a handle. The vacuity between the leather and board is stuffed with fine tow or wool, so that the outer surface may be flat and even. It is used for receiving the leaves of gold from the paper, in order to its being cut into proper sizes and figures.

CUSI, in *Natural History*, a name given by the people of the Philippine islands to a very small and very beautiful species of parrot.

CUSP (*cuspis*), properly denotes the point of a spear or sword: but is used in astronomy to express the points or horns of the moon, or any other luminary.

CUSP, in *Astrology*, is used for the first point of each of the 12 houses, in a figure or scheme of the heavens. See HOUSE.

CUSPIDATED, in *Botany*, are such plants whose leaves are pointed like a spear.

CUSPINIAN, JOHN, a German, was born at Sweinfurt in 1473, and died at Vienna in 1529. He was first physician to the emperor Maximilian I. and employed by that prince in several delicate negotiations. We have of his in Latin, 1. A history of the Roman emperors from Julius Cæsar to the death of Maximilian I. Degory Wheare, in his *Methodus Legendæ Historiæ*, calls this "*luculentum sane opus, et omnium lectione dignissimum.*" 2. A history of Austria; being a kind of continuation of the preceding. 2. A history of the origin of the Turks, and of their cruelties towards Christians. Gerard Vossius calls Cuspinian *magnum suo ævo historiæ lumen.*

CUSSO, the name given by the natives to a tree which is indigenous to the high country of Abyssinia. It is particularly described by Mr Bruce; but as this celebrated traveller was totally unacquainted with the language of botany, it is impossible to discover to what class, order, or genus, it belongs. It grows nearly to the height of 20 feet, and the seed is employed by the Abyssinians as a vermifuge. From the figure which Mr Bruce has given of this plant, it would appear to be most nearly allied to the palms.

CUSTOM, a very comprehensive term, denoting the manners, ceremonies, and fashions of a people, which having turned into a habit, and passed into use, obtain the force of laws; in which sense it implies such usages, as, though voluntary at first, are yet by practice become necessary.

Custom is hence, both by lawyers and civilians, defined *lex non scripta*, "a law or right not written," established by long usage, and the consent of our ancestors: in which sense it stands opposed to the *lex scripta*, or "the written law." See LAW *Index*.

CUSTOM and Habit, in the human economy. The former is often confounded with the latter. By *custom* we mean a frequent reiteration of the same act; and by *habit*, the effect that custom has on the mind or body. This curious subject falls to be considered first in a moral, and secondly in a physical, light.

I. *Influence of Custom and Habit on the Mind*, &c. Custom hath such influence upon many of our feelings, by warping and varying them, that its operations demand the attention of all those who would be acquainted with human nature. The subject, however, is intricate. Some pleasures are fortified by custom: and yet custom begets familiarity, and consequently indifference:

Kames's Elements of Criticism.

If all the year were playing holidays,
To sport would be as tedious as to work:
But when they seldom come, they wish'd-for come,
And nothing pleaseth but rare accidents.

SHAKESPEARE.

In many instances, satiety and disgust are the consequences of reiteration: again, though custom blunts the edge of distress and of pain; yet the want of any thing to which we have been long accustomed is a sort of torture. A clue to guide us through all the intricacies of this labyrinth, would be an acceptable present.

Whatever be the cause, it is certain that we are much influenced by custom: it hath an effect upon our pleasures, upon our actions, and even upon our thoughts and sentiments. Habit makes no figure during the vivacity of youth: in middle age it gains ground; and in old age governs without controul. In that period of life, generally speaking, we eat at a certain hour, take exercise at a certain hour, go to rest at a certain hour, all by the direction of Habit; nay, a particular seat, table, bed, comes to be essential; and a habit in any of these cannot be controuled without uneasiness.

Any slight or moderate pleasure, frequently reiterated for a long time, forms a peculiar connexion between us and the thing that causes the pleasure. This connexion, termed *habit*, has the effect to awaken our desire or appetite for that thing when it returns not as usual. During the course of enjoyment, the pleasure rises insensibly higher and higher till a habit be established; at which time the pleasure is at its height. It continues not, however, stationary: the same customary reiteration which carried it to its height, brings it down again by insensible degrees, even lower than it was at first; but of that circumstance afterwards. What at present we have in view, is to prove by experiments, that those things which at first are but moderately agreeable, are the aptest to become habitual. Spirituous liquors, at first scarce agreeable, readily produce a habitual appetite; and custom prevails so far, as even to make us fond of things originally disagreeable, such as coffee, assafœtida, and tobacco.

A walk upon the quarter-deck, though intolerably confined, becomes however so agreeable by custom, that a sailor in his walk on shore confines himself commonly within the same bounds. The author knew a man who had relinquished the sea for a country life: in the corner of his garden, he reared an artificial mount with a level summit, resembling most accurately a quarter-deck, not only in shape but in size; and here he generally walked. In Minorca Governor Kane made an excellent road the whole length of the island: and yet the inhabitants adhere to the old road, though not only longer, but extremely bad. Play or gaming, at first barely amusing, by the occupation it affords, become in time extremely agreeable; and is frequently prosecuted with avidity, as if it were the chief business of life. The same observation is applicable to the pleasures of the internal senses, those of knowledge and virtue in particular: children have scarce any sense of these pleasures; and men very little who are in the state of nature without culture: our taste for virtue and knowledge improves slowly; but is capable of growing stronger than any other appetite in human nature.

To introduce an active habit, frequency of acts is not sufficient without length of time: the quickest succession of acts in a short time is not sufficient; nor a slow succession in the longest time. The effect must be produced by a moderate soft action, and a long series of easy touches, removed from each other by short intervals. Nor are these sufficient without regularity in the time, place, and other circumstances of the action; the more uniform any operation is, the sooner it becomes habitual. And this holds equally in a passive habit; variety, in any remarkable degree, prevents the effect; thus any particular food will scarce ever become habitual where the manner of dressing is varied. The circumstances then requisite to augment a moderate pleasure, and at the long-run to form a habit, are weak uniform acts, reiterated during a long course of time, without any considerable interruption: every agreeable cause that operates in this manner will grow habitual.

Affection and aversion, as distinguished from passion on the one hand, and on the other from original disposition, are in reality habits respecting particular objects, acquired in the manner above set forth. The pleasure of social intercourse with any person must originally be faint, and frequently reiterated, in order to establish the habit of affection. Affection thus generated,

nerated, whether it be friendship or love, seldom swell into any tumultuous or vigorous passion; but it is however the strongest cement that can bind together two individuals of the human species. In like manner, a slight degree of disgust often reiterated with regularity, grows into the habit of aversion, which commonly subsists for life.

Objects of taste that are delicious, far from tending to become habitual, are apt by indulgence to produce satiety and disgust: no man contracts a habit of using sugar, honey, or sweetmeats, as he does tobacco.

> These violent delights have violent ends,
> And in their triumphs die. The sweetest honey
> Is loathsome in its own deliciousness,
> And in the taste confounds the appetite;
> Therefore love mod'rately, long love doth so;
> Too swift arrives as tardy as too slow.
>
> *Romeo and Juliet*, Act ii. sc. 6.

The same observation holds with respect to all objects which being extremely agreeable raise violent passions: such passions are incompatible with a habit of any kind: and in particular they never produce affection or aversion: a man who at first sight falls violently in love, has a strong desire of enjoyment, but no affection for the woman (A): a man who is surprised with an unexpected favour, burns for an opportunity to exert his gratitude, without having any affection for his benefactor: neither does desire of vengeance for an atrocious injury involve aversion.

It is perhaps not easy to say why moderate pleasures gather strength by custom: but two causes concur to prevent that effect in the more intense pleasures. These, by an original law in our nature, increase quickly to their full growth, and decay with no less precipitation: and custom is too slow in its operation to overcome that law. The other cause is not less powerful: exquisite pleasure is extremely fatiguing; occasioning, as a naturalist would say, great expence of animal spirits; and of such the mind cannot bear so frequent gratification, as to superinduce a habit: if the thing that raises the pleasure return before the mind have recovered its tone and relish, disgust ensues instead of pleasure.

A habit never fails to admonish us of the wonted time of gratification, by raising a pain for want of the object, and a desire to have it. The pain of want is always first felt; the desire naturally follows; and upon presenting the object, both vanish instantaneously. Thus a man accustomed to tobacco, feels, at the end of the usual interval, a confused pain of want; which at first points at nothing in particular, though it soon settles upon its accustomed object: and the same may be observed in persons addicted to drinking, who are often in an uneasy restless state before they think of the bottle. In pleasures indulged regularly, and at equal intervals, the appetite, remarkably obsequious to custom, returns regularly with the usual time of gratification; not sooner, even though the object be presented. This pain of want arising from habit, seems directly opposite to that of satiety; and it must appear singular, that frequency of gratification should produce effects so opposite, as are the pains of excess and of want.

The appetites that respect the preservation and propagation of our species, are attended with a pain of want similar to that occasioned by habit: hunger and thirst are uneasy sensations of want, which always precede the desire of eating and drinking; and a pain for want of carnal enjoyment precedes the desire of an object. The pain being thus felt independent of an object, cannot be cured but by gratification. Very different is an ordinary passion, in which desire precedes the pain of want: such a passion cannot exist but while the object is in view: and therefore, by removing the object out of thought, it vanisheth with its desire and pain of want.

The natural appetites above mentioned, differ from habit in the following particular: they have an undetermined direction toward all objects of gratification in general; whereas an habitual appetite is directed to a particular object: the attachment we have by habit to a particular woman, differs widely from the natural passion which comprehends the whole sex; and the

---

(A) Violent love, without affection, is finely exemplified in the following story. When Constantinople was taken by the Turks, Irene, a young Greek of an illustrious family, fell into the hands of Mahomet II. who was at that time in the prime of youth and glory. His savage heart being subdued by her charms, he shut himself up with her, denying access even to his ministers. Love obtained such ascendant as to make him frequently abandon the army, and fly to his Irene. War relaxed, for victory was no longer the monarch's favourite passion. The soldiers, accustomed to booty, began to murmur, and the infection spread even among the commanders. The Basha Mustapha, consulting the fidelity he owed his master, was the first who durst acquaint him of the discourses held publicly to the prejudice of his glory. The sultan, after a gloomy silence, formed his resolution. He ordered Mustapha to assemble the troops next morning; and then with precipitation retired to Irene's apartment. Never before did that princess appear so charming; never before did the prince bestow so many warm caresses. To give a new lustre to her beauty, he exhorted her women next morning to bestow their utmost art and care on her dress. He took her by the hand, led her into the middle of the army, and pulling off her veil, demanded of the bashas with a fierce look, whether they had ever beheld such a beauty? After an awful pause, Mahomet with one hand laying hold of the young Greek by her beautiful locks, and with the other pulling out his scimitar, severed the head from the body at one stroke. Then turning to his grandees, with eyes wild and furious, "This sword (says he), when it is my will, knows to cut the bands of love." However strange it may appear, we learn from experience, that desire of enjoyment may consist with the most brutal aversion, directed both to the same woman. Of this we have a noted example in the first book of Sully's Memoirs; to which we refer the reader.

the habitual relish for a particular dish, is far from being the same with a vague appetite for food. That difference notwithstanding, it is still remarkable, that nature hath enforced the gratification of certain natural appetites essential to the species, by a pain of the same sort with that which habit produceth.

The pain of habit is less under our power than any other pain that arises from want of gratification: hunger and thirst are more easily endured, especially at first, than an unusual intermission of any habitual pleasure: persons are often heard declaring, they would forego sleep or food, rather than tobacco. We must not, however, conclude, that the gratification of an habitual appetite affords the same delight with the gratification of one that is natural: far from it; the pain of want only is greater.

The slow and reiterated acts that produce a habit, strengthen the mind to enjoy the habitual pleasure in greater quantity and more frequency than originally; and by that means a habit of intemperate gratification is often formed: after unbounded acts of intemperance, the habitual relish is soon restored, and the pain for want of enjoyment returns with fresh vigour.

The causes of the present emotions hitherto in view, are either an individual, such as a companion, a certain dwelling-place, a certain amusement; or a particular species, such as coffee, mutton, or any other food. But habit is not confined to such. A constant train of trifling diversions may form such a habit in the mind, that it cannot be easy a moment without amusement: a variety in the objects prevents a habit as to any one in particular: but as the train is uniform with respect to amusement, the habit is formed accordingly; and that sort of habit may be denominated *a generic habit*, in opposition to the former, which is *a specific habit*. A habit of a town-life, of country-sports, of solitude, of reading, or of business, where sufficiently varied, are instances of generic habits. Every specific habit hath a mixture of the generic; for the habit of any one sort of food makes the taste agreeable, and we are fond of that taste wherever found. Thus a man deprived of an habitual object, takes up with what most resembles it; deprived of tobacco, any bitter herb will do rather than want; a habit of punch makes wine a good resource: accustomed to the sweet society and comforts of matrimony, the man unhappily deprived of his beloved object, inclines the sooner to a second. In general, when we are deprived of a habitual object, we are fond of its qualities in any other object.

The reasons are assigned above, why the causes of intense pleasure become not readily habitual: but now we discover, that these reasons conclude only against specific habits. In the case of a weak pleasure, a habit is formed by frequency and uniformity of reiteration, which, in the case of an intense pleasure, produceth satiety and disgust. But it is remarkable, that satiety and disgust have no effect, except as to that thing singly which occasions them; a surfeit of honey produceth not a loathing of sugar; and intemperance with one woman produceth no disrelish of the same pleasure with others. Hence it is easy to account for a generic habit in any intense pleasure; the delight we had in the gratification of the appetite, inflames the imagination, and makes us search, with avidity, for the same gratification in whatever other object it can be found. And thus uniform frequency in gratifying the same passion upon different objects, produceth at length a generic habit. In this manner one acquires an habitual delight in high and poignant sauces, rich dress, fine equipages, crowds of company, and in whatever is commonly termed *pleasure*. There concurs, at the same time, to introduce this habit, a peculiarity observed above, that reiteration of acts enlarges the capacity of the mind to admit a more plentiful gratification than originally, with regard to frequency, as well as quantity.

Hence it appears, that though a specific habit cannot be formed but upon a moderate pleasure, a generic habit may be formed upon any sort of pleasure, moderate or immoderate, that hath variety of objects. The only difference is, that a weak pleasure runs naturally into a specific habit; whereas an intense pleasure is altogether averse to such a habit. In a word, it is only in singular cases that a moderate pleasure produces a generic habit; but an intense pleasure cannot produce any other habit.

The appetites that respect the preservation and propagation of the species, are formed into a habit in a peculiar manner; the time as well as measure of their gratification is much under the power of custom; which, introducing a change upon the body, occasions a proportional change in the appetites. Thus, if the body be gradually formed to a certain quantity of food at stated times, the appetite is regulated accordingly; and the appetite is again changed, when a different habit of body is introduced by a different practice. Here it would seem, that the change is not made upon the mind, which is commonly the case in passive habits, but upon the body.

When rich food is brought down by ingredients of a plainer taste, the composition is susceptible of a specific habit. Thus the sweet taste of sugar, rendered less poignant in a mixture, may, in course of time, produce a specific habit for such mixture. As moderate pleasures, by becoming more intense, tend to generic habits; so intense pleasures, by becoming more moderate, tend to specific habits.

The beauty of the human figure, by a special recommendation of nature, appears to us supreme, amid the great variety of beauteous forms bestowed upon animals. The various degrees in which individuals enjoy that property, render it an object sometimes of a moderate, sometimes of an intense, passion. The moderate passion, admitting frequent reiteration without diminution, and occupying the mind without exhausting it, turns gradually stronger till it become a habit. Nay, instances are not wanting, of a face at first disagreeable, afterwards rendered indifferent by familiarity, and at length agreeable by custom. On the other hand, consummate beauty, at the very first glance, fills the mind so as to admit no increase. Enjoyment lessens the pleasure; and if often repeated, ends commonly in satiety and disgust. The impressions made by consummate beauty, in a gradual succession from lively to faint, constitute a series opposite to that of faint impressions waxing gradually more lively, till they produce a specific habit. But the mind when accustomed to beauty contracts a relish for it in general, though often repelled from particular objects by by the pain of satiety; and thus a generic habit is formed, of which inconstancy in love is the necessary consequence; for a generic habit, comprehending every beautiful object, is an invincible obstruction to a specific habit, which is confined to one.

But a matter which is of great importance to the youth of both sexes, deserves more than a cursory view. Though the pleasant emotion of beauty differs widely from the corporeal appetite, yet when both are directed to the same object, they produce a very strong complex passion; enjoyment in that case must be exquisite; and therefore more apt to produce satiety than in any other case whatever. This is a never-failing effect, where consummate beauty in the one party, meets with a warm imagination and great sensibility in the other. What we are here explaining, is true without exaggeration; and they must be insensible upon whom it makes no impression: it deserves well to be pondered by the young and the amorous, who, in forming the matrimonial society, are too often blindly impelled by the animal pleasure merely, inflamed by beauty. It may indeed happen, after the pleasure is gone, and go it must with a swift pace, that a new connexion is formed upon more dignified and more lasting principles: but this is a dangerous experiment; for even supposing good sense, good temper, and internal merit of every sort, yet a new connexion upon such qualifications is rarely formed: it commonly, or rather always happens, that such qualifications, the only solid foundation of an indissoluble connexion, are rendered altogether invisible by satiety of enjoyment creating disgust.

One effect of custom, different from any that have been explained, must not be omitted, because it makes a great figure in human nature: though custom augments moderate pleasures, and lessens those that are intense, it has a different effect with respect to pain; for it blunts the edge of every sort of pain and distress, faint or acute. Uninterrupted misery, therefore, is attended with one good effect: if its torments be incessant, custom hardens us to bear them.

The changes made in forming habits are curious. Moderate pleasures are augmented gradually by reiteration, till they become habitual: and then are at their height: but they are not long stationary: for from that point they gradually decay, till they vanish altogether. The pain occasioned by want of gratification runs a different course: it increases uniformly; and at last becomes extreme, when the pleasure of gratification is reduced to nothing.

——————— It so falls out,
That what we have we prize not to the worth,
While we enjoy it; but being lack'd and lost,
Why then we rack the value; then we find
The virtue that possession would not show us
Whilst it was ours.
Much ado about Nothing, Act iv. sc. 2.

The effect of custom with relation to a specific habit is displayed through all its varieties in the use of tobacco. The taste of that plant is at first extremely unpleasant: our disgust lessens gradually till it vanish altogether; at which period the taste is neither agreeable nor disagreeable: continuing the use of the plant, we begin to relish it; and our relish improves by use, till it arrive at perfection: from that period it gradually decays, while the habit is in a state of increment, and consequently the pain of want. The result is, that when the habit has acquired its greatest vigour, the relish is gone; and accordingly we often smoke and take snuff habitually, without so much as being conscious of the operation. We must expect gratification after the pain of want; the pleasure of which gratification is the greatest when the habit is the most vigorous: it is of the same kind with the pleasure one feels upon being delivered from the rack. This pleasure, however, is but occasionally the effect of habit; and, however exquisite, is avoided as much as possible because of the pain that precedes it.

With regard to the pain of want, we can discover no difference between a generic and specific habit; but these habits differ widely with respect to the positive pleasure. We have had occasion to observe, that the pleasure of a specific habit decays gradually till it turn imperceptible: the pleasure of a generic habit, on the contrary, being supported by variety of gratification, suffers little or no decay after it comes to its height. However it may be with other generic habits, the observation certainly holds with respect to the pleasures of virtue and knowledge: the pleasure of doing good has an unbounded scope, and may be so variously gratified that it can never decay: science is equally unbounded; our appetite for knowledge having an ample range of gratification where discoveries are recommended by novelty, by variety, by utility, or by all of them.

In this intricate inquiry, we have endeavoured, but without success, to discover by what particular means it is that custom hath influence upon us: and now nothing seems left, but to hold our nature to be so framed as to be susceptible of such influence. And supposing it purposely so framed, it will not be difficult to find out several important final causes. That the power of custom is a happy contrivance for our good, cannot have escaped any one who reflects, that business is our province, and pleasure our relaxation only. Now satiety is necessary to check exquisite pleasures, which otherwise would engross the mind, and unqualify us for business. On the other hand, as business is sometimes painful, and is never pleasant beyond moderation, the habitual increase of moderate pleasure, and the conversion of pain into pleasure, are admirably contrived for disappointing the malice of fortune, and for reconciling us to whatever course of life may be our lot:

How use doth breed a habit in a man!
This shadowy desert, unfrequented woods,
I better brook than flourishing peopled towns.
Here I can sit alone, unseen of any,
And to the nightingale's complaining notes
Tune my distresses, and record my woes.
Two Gentlemen of Verona, Act v. sc. 4.

As the foregoing distinctions between intense and moderate, hold in pleasure only, every degree of pain being softened by time, custom is a catholicon for pain and distress of every sort; and of that regulation the final cause requires no illustration.

Another final cause of custom will be highly relished by every person of humanity, and yet has in a great

Custom and Habit.

measure been overlooked; which is, that custom hath a greater influence than any other known cause, to put the rich and the poor upon a level; weak pleasures, the share of the latter, become fortunately stronger by custom; while voluptuous pleasures, the share of the former, are continually losing ground by satiety. Men of fortune, who possess palaces, sumptuous gardens, rich fields, enjoy them less than passengers do. The goods of Fortune are not unequally distributed; the opulent possess what others enjoy.

And indeed, if it be the effect of habit, to produce the pain of want in a high degree while there is little pleasure in enjoyment, a voluptuous life is of all the least to be envied. Those who are habituated to high feeding, easy vehicles, rich furniture, a crowd of valets, much deference and flattery, enjoy but a small share of happiness, while they are exposed to manifold distresses. To such a man, enslaved by ease and luxury, even the petty inconveniences in travelling, of a rough road, bad weather, or homely fare, are serious evils: he loses his tone of mind, turns peevish, and would wreak his resentment even upon the common accidents of life. Better far to use the goods of Fortune with moderation; a man who by temperance and activity hath acquired a hardy constitution, is on the one hand, guarded against external accidents; and, on the other, is provided with great variety of enjoyment ever at command.

We shall close this branch of the subject with an article more delicate than abstruse, viz. what authority custom ought to have over our taste in the fine arts. One particular is certain, that we cheerfully abandon to the authority of custom things that nature hath left indifferent. It is custom, not nature, that hath established a difference between the right hand and the left, so as to make it awkward and disagreeable to use the left where the right is commonly used. The various colours, though they affect us differently, are all of them agreeable in their purity: but custom has regulated that matter in another manner; a black skin upon a human being, is to us disagreeable; and a white skin probably not less so to a negro. Thus things, originally indifferent, become agreeable or disagreeable by the force of custom. Nor will this be surprising after the discovery made above, that the original agreeableness or disagreeableness of an object is, by the influence of custom, often converted into the opposite quality.

Proceeding to matters of taste, where there is naturally a preference of one thing before another; it is certain, in the first place, that our faint and more delicate feelings are readily susceptible of a bias from custom; and therefore that it is no proof of a defective taste, to find these in some measure influenced by custom; dress and the modes of external behaviour are regulated by custom in every country; the deep red or vermilion with which the ladies in France cover their cheeks, appears to them beautiful in spite of nature; and strangers cannot altogether be justified in condemning that practice, considering the lawful authority of custom, or of the fashion, as it is called: it is told of the people who inhabit the skirts of the Alps facing the north, that the swelling they universally have in the neck is to them agreeable. So far has custom power to change the nature of things, and to make an object originally disagreeable take on an opposite appearance.

Custom and Habit.

But as to every particular that can be denominated proper or improper, right or wrong, custom has little authority, and ought to have none. The principle of duty takes naturally place of every other; and it argues a shameful weakness or degeneracy of mind, to find it in any case so far subdued as to submit to custom.

II. *Effects of Custom and Habit in the Animal Economy.* These may be reduced to five heads: 1. On the simple solids. 2. On the organs of sense. 3. On the moving power. 4. On the whole nervous power. 5. On the system of blood-vessels.

1. *Effects on the Simple Solids.* Custom determines the degree of flexibility of which they are capable. By frequently repeated flexion, the several particles of which these solids consist are rendered more supple and moveable on each other. A piece of catgut, e. g. when on the stretch, and having a weight appended to its middle, will be bended thereby perhaps half an inch; afterwards, by frequent repetitions of the same weight, or by increasing the weight, the flexibility will be rendered double. The degree of flexibility has a great effect in determining the degree of oscillation, provided that elasticity is not affected; if it go beyond this, it produces flaccidity. Again, custom determines the degree of tension; for the same elastic chord that now oscillates in a certain degree of tension, will, by frequent repetition of these oscillations, be so far relaxed, that the extension must be renewed in order to produce the same tension, and consequently the same vibrations, as at first. This appears in many instances in the animal economy, as when different muscles concur to give a fixed point or tension to each other; and thus a weakly child totters as it walks; but by giving it a weight to carry, and by thus increasing the tension of the system, it walks more steadily. In like manner, the fullness of the system gives strength, by distending the vessels everywhere, and so giving tension: hence a man, by good nourishment, from being weak, acquires a great increase of strength in a few days: and, on the other hand, evacuations weaken by taking off the tension.

2. *Effects on the Organs of Sense.* Repetition gives a greater degree of sensibility, in so far only as it renders perception more accurate. Repetition alone gives lasting impression, and thus lays the foundation of memory; for single impressions are but retained for a short time, and are soon forgot. Thus a person, who at present has little knowledge of cloths, will by frequently handling them, acquire a skill of discerning them, which to others seems almost impossible. Many are apt to mistake this for a nicer sensibility, but they are much mistaken; for it is an universal law, that the repetition of impression renders us less acute. This is well illustrated by the operation of medicines; for all medicines which act on the organs of sense must, after some time, be increased in their dose to produce the same effects as at first. This affords a rule in practice with regard to these medicines; it becoming necessary, after a certain time, to change one medicine even for a weaker of the same nature. Thus medicines which even have no great apparent force, are found, by long use, to destroy the sensibility of the system to

other

other impressions. But to this general rule, that, by repetition, the force of impressions is more and more diminished, there are some exceptions. Thus persons, by a strong emetic, have had their stomachs rendered so irritable, that one-20th of the first dose was sufficient to produce the same effect. This, however, oftener takes place when the vomit is repeated every day; for if the same vomit be given at pretty considerable intervals, the general rule is observed to hold good. Thus two contrary effects of habit are to be noted; and it is proper to observe, that the greater irritability is more readily produced when the first impression is great, as in the case first given of the strong emetic. This may be further illustrated by the effect of fear, which is commonly observed to be diminished on repetition; which can only be attributed to custom; while, on the other hand, there are instances of persons, who, having once got a great fright, have for ever after continued slaves to fears excited by impressions of the like kind, however slight; which must be imputed entirely to excess of the first impression, as has been already observed. To this head also belongs the association of ideas, which is the foundation of memory and all our intellectual faculties, and is entirely the effect of custom: with regard to the body also, these associations often take place. And sometimes, in producing effects on the body, associations seemingly opposite are formed, which, through custom, become absolutely necessary; e. g. a person long accustomed to sleep in the neighbourhood of a great noise, is so far from being incommoded on that account, that afterwards such noise becomes necessary to produce sleep. It will be of use to attend to this in medical practice; for we ought to allow for, however opposite it may seem at the time, whatever usually attended the purpose we design to effect. Thus, in the instance of sleep, we must not exclude noise when we want to procure rest, or any cause which may seem opposite to such an effect, provided custom has rendered them necessary.

3. *Effects on the Moving Fibres.* A certain degree of tension is necessary to motion, which is to be determined by custom; e. g. a fencer, accustomed to one foil, cannot have the same steadiness or activity with one heavier or lighter. It is necessary also that every motion should be performed in the same situation, or posture of the body, as the person has been accustomed to employ in that motion. Thus, in any chirurgical operation, a certain posture is recommended; but if the operator has been accustomed to another, such a one, however awkward, becomes necessary afterwards to his right performance of that operation.

Custom also determines the degree of oscillation of which the moving fibres are capable. A person accustomed to strong muscular exertions is quite incapable of the more delicate. Thus writing is performed by small muscular contractions; but if a person has been accustomed to stronger motions with these muscles, he will write with much less steadiness.

This subject of tension, formerly attributed to the *simple fibres*, is probably more strictly applicable to the moving: for besides a tension from flexion, there is also a tension from irritation and sympathy; e. g. the tension of the stomach from food, gives tension to the whole body. Wine and spirituous liquors give tension: e. g. a person that is so affected with tremor as scarcely to hold a glass of any of these liquors to his head, has no sooner swallowed it, than his whole body becomes steady; and after the system has been accustomed to such stimuli, if they are not applied at the usual time, the whole body becomes flaccid, and of consequence unsteady in its motions.

Again, custom gives facility of motion. This seems to proceed from the distension which the nervous power gives to the moving fibres themselves. But in whatever manner it is occasioned, the effect is obvious; for any new or unusual motion is performed with great difficulty.

It is supposed that sensation depends on a communication with the sensorium commune, by means of organs sufficiently distended with nervous influence. We have found, that sensibility is diminished by repetition. And we have now to observe, that in some cases it may be increased by repetition, owing to the nervous power itself flowing more easily into the part on account of custom. Attention to a particular object may also determine a greater influx into any particular part, and thus the sensibility and irritability of that particular part may be increased.

But with regard to facility of motion, the nervous power, no doubt, flows most easily into those parts to which it has been accustomed: yet facility of motion does not entirely depend on this, but in part also on the concurrence of the action of a great many muscles; e. g. Winslow has observed, that in performing any motion, a number of muscles concur to give a fixed point to those intended chiefly to act, as well as to others that are to vary and modify their action. This, however, is assisted by repetition and the freer influx; as by experience we know the proper attitude for giving a fixed point in order to perform any action with facility and steadiness.

Custom gives a spontaneous motion also, which seems to recur at stated periods, even when the exciting causes are removed. Thus, if the stomach has been accustomed to vomit from a particular medicine, it will require a much smaller dose than at first, nay, even the very sight or remembrance of it will be sufficient to produce the effect: and there are not wanting instances of habitual vomiting, from the injudicious administration of emetics. It is on this account that all spasmodic affections so easily become habitual, and are so difficult of cure; as we must not only avoid all the exciting causes, even in the smallest degree, but also their associations.

Custom also gives strength of motion; strength depends on strong oscillations, a free and copious influx of the nervous power, and on dense solids. But in what manner all these circumstances have been brought about by repetition, has been already explained. The effect of custom in producing strength, may be thus illustrated: a man that begins with lifting a calf, by continuing the same practice every day, will be able to lift it when grown to the full size of a bull.

All this is of considerable importance in the practice of physic, though but too little regarded; for the recovery of weak people, in a great measure, depends on the use of exercise suited to their strength, or rather within it, frequently repeated and gradually increased. Farther, it is necessary to observe, that custom regulates

lates the particular celerity with which each motion is to be performed: for a person accustomed, for a considerable time to one degree of celerity, becomes incapable of a greater; e. g. a man accustomed to slow walking will be out of breath before he can run 20 paces. The train or order in which our motions are to be performed is also established by custom; for if a man hath repeated motions, for a certain time, in any particular order, he cannot afterwards perform them in any other. Custom also very frequently associates motions and sensations: thus, if a person has been in use of associating certain ideas with the ordinary stimulus which in health excites urine, without these ideas the usual inclination will scarce excite that excretion; and, when these occur, will require it even in the absence of the primary exciting cause: e. g. it is very ordinary for a person to make urine when going to bed; and if he has been for any length of time accustomed to do so, he will ever afterwards make urine at that time, though otherwise he would often have no such inclination: by this means some secretions become in a manner subject to the will. The same may be said of going to stool; and this affords us a good rule in the case of costiveness; for by endeavouring to fix a stated time for this evacuation, it will afterwards, at such a time, more readily return. It is farther remarkable, that motions are inseparably associated with other motions: this perhaps, very often proceeds from the necessary degree of tension; but it also often depends merely on custom, an instance of which we have in the uniform motions of our eyes.

4. *Effects on the whole Nervous Power.* We have found, that, by custom, the nervous influence may be determined more easily into one part than another; and therefore, as all the parts of the system are strongly connected, the sensibility, irritability, and strength of any particular part may be thus increased. Custom also has the power of altering the natural temperament, and of inducing a new one. It is also in the power of custom to render motions periodical, and periodically spontaneous. An instance of this we have in sleep, which is commonly said to be owing to the nervous power being exhausted, the necessary consequence of which is sleep, e. g. a rest of the voluntary motions to favour the recruit of that power; but if this were the case, the return of sleep should be at different times, according as the causes which diminish the nervous influence operate more or less powerfully; whereas the case is quite otherwise, these returns of sleep being quite regular. This is no less remarkable in the appetites, that return at particular periods independent of every cause but custom. Hunger, e. g. is an extremely uneasy sensation; but goes off of itself, if the person did not take food at the usual time. The excretions are farther proofs of this, e. g. going to stool, which, if it depended on any particular irritation, should be at longer or shorter intervals, according to the nature of the aliment. There are many other instances of this disposition of the nervous influence to periodical motions, as the story of the idiot of Stafford, recorded by Dr Plot (Spectator, N° 447.), who, being accustomed to tell the hours of the church clock as it struck, told them as exactly when it did not strike by its being out of order. Montaigne tells us of some oxen that were employed in a machine for drawing water, who, after making 300 turns, which was the usual number, could be stimulated by no whip or goad to proceed farther. Infants also cry for and expect the breast at those times in which the nurse has been accustomed to give it.

Hence it would appear, that the human economy is subject to periodical revolutions, and that these happen not oftener may be imputed to variety; and this seems to be the reason why they happen oftener in the body than mind, because that is subject to greater variety. We see frequent instances of this in diseases, and in their crises; intermitting fevers, epilepsies, asthmas, &c. are examples of periodical affections; and that critical days are not so strongly marked in this country as in Greece, and some others, may be imputed to the variety and instability of our climate; but perhaps still more to the less sensibility and irritability of our system; for the exhibition of medicine has little effect in disturbing the crises, though it be commonly assigned as a cause.

We are likewise subject to many habits independent of ourselves, as from the revolutions of the celestial bodies, particularly the sun, which determines the body, perhaps, to other daily revolutions besides sleeping and waking. There are also certain habits depending on the seasons. Our connections, likewise, with respect to mankind, are means of inducing habits. Thus regularity from associating in business induces regular habits both of mind and body.

There are many diseases which, though they arose at first from particular causes, at last continue merely through custom or habit. These are chiefly of the nervous system. We should therefore study to counteract such habits; and accordingly Hippocrates, among other things for the cure of epilepsy, orders an entire change of the manner of life. We likewise imitate this in the chincough; which often resists all remedies, till the air, diet, and ordinary train of life, are changed.

5. *Effects on the Blood-vessels.* From what has been said on the nervous power, the distribution of the fluids must necessarily be variously affected by custom, and with that the distribution of the different excretions; for though we make an estimate of the proportion of the excretions to one another, according to the climate and seasons, they must certainly be very much varied by custom.

On this head we may observe, that blood-letting has a manifest tendency to increase the quantity of the blood; and if this evacuation be repeated at stated times, such symptoms of repletion, and such motions, are excited at the returning periods, as render the operation necessary. The same has been observed in some spontaneous hemorrhagies. These, indeed, at first, may have some exciting causes, but afterwards they seem to depend chiefly on custom. The best proof of this is with regard to the menstrual evacuation. There is certainly something originally in females, that determines that evacuation to the monthly periods. Constant repetition of this comes to fix it, independent of strong causes, either favouring or preventing repletion; e. g. blood-letting will not impede it, nor filling the body induce it; and, indeed, so much is this evacuation connected with periodical motions, that it is little in our power to produce any effect by medicines but at

Custom and Habit, Customs.

at those particular times. Thus if we would relax the uterine system, and bring back this evacuation when suppressed, our attempts would be vain and fruitless, unless given at that time when the menses should have naturally returned.

CUSTOMS, in political economy, or the duties, toll, tribute, or tariff, payable to the king upon merchandise exported and imported, form a branch of the perpetual taxes. See Tax.

The considerations upon which this revenue (or the more ancient part of it, which arose only from exports) was invested in the king, were said to be two: 1. Because he gave the subject leave to depart the kingdom, and to carry his goods along with him. 2. Because the king was bound of common right to maintain and keep up the port and havens, and to protect the merchant from pirates. Some have imagined they are called with us *customs*, because they were the inheritance of the king by immemorial usage and the common law, and not granted him by any statute: but Sir Edward Coke hath clearly shown, that the king's first claim to them was by grant of parliament 3 Edw. I. though the record thereof is not now extant. And indeed this is in express words confessed by statute 25 Edw. I. c. 7. wherein the king promises to take no customs from merchants, without the common assent of the realm, "saving to us and our heirs the customs on wool, skins, and leather, formerly granted to us by the commonalty aforesaid." These were formerly called *hereditary customs* of the crown; and were due on the exportation only of the said three commodities, and of none other: which were styled the *staple* commodities of the kingdom, because they were obliged to be brought to those ports where the king's staple was established, in order to be there first rated, and then exported. They were denominated in the barbarous Latin of our ancient records, *custuma* (an appellation which seems to be derived from the French word *coustum* or *coutum*, which signifies toll or tribute, and owes its own etymology to the word *coust*, which signifies price, charge, or as we have adopted it in English, *cost*); not *consuetudines*, which is the language of our law whenever it means merely usages. The duties on wool, sheep-skins or woolfells, and leather exported, were called *custuma antiqua sive magna*, and were payable by every merchant, as well native as stranger: with this difference, that merchant-strangers paid an additional toll, viz. half as much again as was paid by natives. The *custuma parva et nova* were an impost of 3d. in the pound, due from merchant-strangers only, for all commodities as well imported as exported; which was usually called the *aliens* duty, and was first granted in 31 Edw. I. But these ancient hereditary customs, especially those on wool and woolfells, came to be of little account, when the nation became sensible of the advantages of a home manufacture, and prohibited the exportation of wool by statute 11 Edw. III. c. 1.

Other customs payable upon exports and imports were distinguished into subsidies, tonnage, poundage, and other imposts. Subsidies were such as were imposed by parliament upon any of the staple commodities before mentioned, over and above the *custuma antiqua et magna*: tonnage was a duty upon all wines imported, over and above the prisage and butlerage aforesaid: poundage was a duty imposed *ad valorem*, at the rate of 12d. in the pound, on all other merchandise whatsoever: and the other imposts were such as were occasionally laid on by parliament, as circumstances and times required. These distinctions are now in a manner forgotten, except by the officers immediately concerned in this department; their produce being in effect all blended together, under the one denomination of the *customs*.

Customs.

Blackst. Comment.

By these we understand, at present, a duty or subsidy paid by the merchants at the quay upon all imported as well as exported commodities, by authority of parliament; unless where, for particular national reasons, certain rewards, bounties or drawbacks, are allowed for particular exports or imports. The customs thus imposed by parliament are chiefly contained in two books of rates, set forth by parliamentary authority; one signed by Sir Harbottle Grimeston, speaker of the house of commons in Charles II.'s time; and the other an additional one, signed by Sir Spencer Compton, speaker in the reign of George I. to which also subsequent additions have been made. Aliens pay a larger proportion than natural subjects, which is what is now generally understood by the aliens duty; to be exempted from which is one principal cause of the frequent applications to parliament for acts of naturalization.

These customs are then, we see, a tax immediately paid by the merchant, although ultimately by the consumer. And yet these are the duties felt least by the people: and if prudently managed, the people hardly consider that they pay them at all. For the merchant is easy, being sensible he does not pay them for himself; and the consumer, who really pays them, confounds them with the price of the commodity; in the same manner as Tacitus observes, that the emperor Nero gained the reputation of abolishing the tax of the sale of slaves, though he only transferred it from the buyer to the seller: so that it was, as he expresses it, *remissum magis specie, quam vi: quia cum venditor pendere juberetur, in partem pretii emptoribus accrescebat.* But this inconvenience attends it on the other hand, that these imposts, if too heavy, are a check and cramp upon trade; and especially when the value of the commodity bears little or no proportion to the quantity of the duty imposed. This in consequence gives rise also to smuggling, which then becomes a very lucrative employment: and its natural and most reasonable punishment, viz. confiscation of the commodity, is in such cases quite ineffectual; the intrinsic value of the goods, which is all that the smuggler has paid, and therefore all that he can lose, being very inconsiderable when compared with his prospect of advantage in evading the duty. Recourse must therefore be had to extraordinary punishments to prevent it; perhaps even to capital ones: which destroys all proportion of punishment, and puts murderers upon an equal footing with such as are really guilty of no natural, but merely a positive offence.

There is also another ill consequence attending high imposts on merchandise, not frequently considered, but indisputably certain; that the earlier any tax is laid on a commodity, the heavier it falls upon the consumer in the end; for every trader, through whose

whose hands it passes, must have a profit, not only upon the raw materials and his own labour and time in preparing it, but also upon the very tax itself, which he advances to the government; otherwise he loses the use and interest of the money which he so advances. To instance in the article for foreign paper. The merchant pays a duty upon importation, which he does not receive again till he sells the commodity, perhaps at the end of three months. He is therefore equally entitled to a profit upon that duty which he pays at the customhouse, as to a profit upon the original price which he pays to the manufacturer abroad; and considers it accordingly in the price he demands of the stationer. When the stationer sells it again, he requires a profit of the printer or bookseller upon the whole sum advanced by him to the merchants: and the bookseller does not fail to charge the full proportion to the student or ultimate consumer; who therefore does not only pay the original duty, but the profits of these three intermediate traders who have successively advanced it for him. This might be carried much farther in any mechanical, or more complicated, branch of trade.

Custom-House, an office established by the king's authority in the maritime cities, or port towns, for the receipt and management of the customs and duties of importation and exportation, imposed on merchandises, and regulated by books of rates.

CUSTOS BREVIUM, the principal clerk belonging to the court of common pleas, whose business it is to receive and keep all the writs made returnable in that court, filing every return by itself; and, at the end of each term, to receive of the prothonotaries all the records of the nisi prius, called the *posteas*.

Custos Rotulorum, an officer who has the custody of the rolls and records of the session of peace, and also of the commission of the peace itself.

He usually is some person of quality, and always a justice of the peace, of the quorum, in the county where he is appointed.

Custos Spiritualium, he that exercises the spiritual jurisdiction of a diocese, during the vacancy of any see, which by the canon law, belongs to the dean and chapter; but at present, in England, to the archbishop of the province by prescription.

Custos Temporalium, was the person to whom a vacant see or abbey was given by the king, as supreme lord. His office was, as steward of the goods and profits, to give an account to the escheator, who did the like to the exchequer.

CUT-FEATHER, in the sea-language. If a ship has too broad a bow, it is common to say, *she will not cut a feather;* that is, she will not pass through the water so swift as to make it foam or froth.

Cut-Purse, in *Law;* if any person *clam et secretè*, and without the knowledge of another, cut his purse or pick his pocket, and steal from thence above the value of twelve pence, it is felony excluded clergy.

Cut-purses, or *saccularii*, were more severely punished than common thieves by the Roman and Athenian laws.

Cut-Water, the sharp part of the head of a ship below the beak. It is so called, because it cuts or divides the water before it comes to the bow, that it may not come too suddenly to the breadth of the ship, which would retard it.

CUTANEOUS, in general, an appellation given to whatever belongs to the cutis or skin. Thus, we say, *cutaneous* eruptions: the itch is a *cutaneous* disease.

CUTH, or CUTHAH, in *Ancient Geography*, a province of Assyria, which, as some say, lies upon the Araxes, and is the same with Cush; but others take it to be the same with the country which the Greeks call *Susiana*, and which to this very day, says Dr Wells, is by the inhabitants called *Chusestan*. F. Calmet is of opinion that Cuthah and Scythia are the same place, and that the Cuthites who were removed into Samaria by Salmaneser (2 Kings xvii. 24.) came from Cush or Cuth, mentioned in Gen. ii. 23. See the article CUSH. The Cuthites worshipped the idol Nergal, Id. ibid. 30. These people were transplanted into Samaria in the room of the Israelites, who before inhabited it. Calmet is of opinion, they came from the land of Cush, or Cuthah upon the Araxes; and that their first settlement was in the cities of the Medes, subdued by Salmaneser and the kings of Assyria his predecessors. The Scripture observes, that the Cuthites, upon their arrival in this new country, continued to worship the gods formerly adored by them beyond the Euphrates. Esarhaddon king of Assyria, who succeeded Sennacherib, appointed an Israelitish priest to go thither, and instruct them in the religion of the Hebrews. But these people thought they might reconcile their old superstition with the worship of the true God. They therefore framed particular gods for themselves, which they placed in the several cities where they dwelt. The Cuthites then worshipped both the Lord and their false gods together, and chose the lowest of the people to make priests of them in the high places; and they continued this practice for a long time. But afterwards they forsook the worship of idols, and adhered only to the law of Moses, as the Samaritans, who are descended from the Cuthites, do at this day.

CUTICLE, the SCARF SKIN. See ANATOMY *Index*.

CUTICULAR, the same with CUTANEOUS.

CUTIS, the SKIN. See ANATOMY *Index*.

CUTLERY, a general term which includes all cutting tools. See SUPPLEMENT.

CUTTER, a small vessel, commonly navigated in the channel of England. It is furnished with one mast, and rigged as a sloop. Many of these vessels are used in an illicit trade, and others are employed by government to take them; the latter of which are either under the direction of the admiralty or custom-house.

CUTTER, is also a small boat used by ships of war.

Cutter of the Tallies, an officer of the exchequer, whose business is to provide wood for the tallies, to cut or notch the sum paid upon them; and then to cast them into court, to be written upon. See TALLY.

CUTTING, a term used in various senses and various arts; in the general it implies a division or separation.

CUTTING is particularly used in heraldry, where the shield is divided into two equal parts, from right to left, parallel to the horizon, or in the fesse-way.

The word also is applied to the honourable ordinaries, and even to animals and moveables, when they are divided equally the same way; so, however, as that one moiety is colour, the other metal. The ordinaries are said to be cut, couped, when they do not come full to the extremities of the shield.

CUTTING, in *Surgery*, denotes the operation of extracting the stone out of the bladder by section. See LITHOTOMY, SURGERY *Index*.

CUTTING, in coinage. When the laminæ or plates of the metal, be it gold, silver, or copper, are brought to the thickness of the species to be coined, pieces are cut out, of the thickness, and nearly of the weight, of the intended coin ; which are now called *planchets*, till the king's image hath been stamped on them. The instrument wherewith they cut, consists of two pieces of steel, very sharp, and placed over one another ; the lower a little hollow, representing a mortar, the other a pestle. The metal put between the two, is cut out in the manner described under COINAGE.

Note. Medallions, where the relievo is to be great, are not cut, but cast or moulded.

CUTTING, in the manege, is when the horse's feet interfere ; or when with the shoe of one foot he beats off the skin from the pastern joint of another foot. This is more frequent in the hind feet than the fore : the causes are either weariness, weakness in the reins, not knowing how to go, or ill shoeing.

CUTTING, in painting, the laying one strong lively colour over another, without any shade or softening. The cutting of colours has always a disagreeable effect.

CUTTING in wood, a particular kind of sculpture or engraving ; denominated from the matter wherein it is employed.

It is used for various purposes ; as for figured letters ; head and tail pieces of books ; and even for schemes and other figures, to save the expences of engraving on copper ; and the prints and stamps for paper, callicoes, linens, &c.

The invention of cutting in wood, as well as that in copper, is ascribed to a goldsmith of Florence ; but it is to Albert Durer and Lucas they are both indebted for their perfection. See ENGRAVING and PRINTING.

One Hugo de Carpi invented a manner of cutting in wood, by means whereof the prints appeared as if painted in clair-obscure. In order to this, he made three kinds of stamps for the same design ; which were drawn one after another through the press for the same print : they were so conducted, as that one served for the grand lights, a second for the demi-teints, and a third for the outlines and the deep shadows.

The art of cutting in wood was certainly carried to a very great pitch above two hundred years ago ; and might even vie, for beauty and justness, with that of engraving in copper. At present it is in a low condition, as having been long neglected, and the application of artists wholly employed on copper, as the more easy and promising province ; not but that wooden cuts have the advantage of those in copper on many accounts ; chiefly for figures and devices in books ; as being printed at the same time and in the same press as the letters ; whereas for the other there is required a particular impression. In the representation of plants and flowers, and in designs for paper-hangings, where the outline only is wanted to be printed in a bold full manner, this method will be found cheaper and more effectual than the use of copperplates.

The cutters in wood begin with preparing a plank or block of the size and thickness required, and very even and smooth on the side to be cut : for this, they usually take beech, pear-tree, or box ; though the latter is the best, as being the closest, and least liable to be worm-eaten. The wood being cut into a proper form and size, should be planed as even and truly as possible : it is then fit to receive the drawing or chalking of the design to be engraved. But the effect may be made more apparent, and the ink, if any be used in drawing, be prevented from running, by spreading thinly on the surface of the wood white lead tempered with water, by grinding with a brush pencil, and afterwards rubbing it well with a fine linen rag whilst it is wet : and when it is dry, brushing off any loose or powdery part with a soft pencil.

On this block they draw their design with a pen or pencil, just as they would have it printed. Those who cannot draw their own design, as there are many who cannot, make use of a design furnished them by another ; fastening it upon the block with paste made of flour and water, with a little vinegar or gum tragacanth ; the strokes or lines turned towards the wood.

When the paper is dry, they wash it gently over with a sponge dipped in water ; which done, they take off the paper by little and little, still rubbing it a little first with the tip of the finger ; till at length there be nothing left on the block but the strokes of ink that form the design, which mark out so much of the block as is to be spared or left standing. Figures are sometimes cut out of prints, by taking away all the white part or blank paper, and cemented with gum-water to the surface of the wood. The rest they cut off, and take away very curiously with the points of very sharp knives, or little chisels or gravers, according to the bigness or delicacy of the work : for they need no other instruments.

It differs from engraving in copper, because in the former the impression comes from the prominent parts or strokes left uncut ; whereas in the latter, it comes from the channels cut in the metal.

The manner of printing with wooden prints is much more expeditious and easy than that of copper-plate : because they require only to be dipt in the printing-ink, and impressed on the object in the same manner and with the same apparatus as the letter-printing is managed : and for purposes that do not require great correctness, the impression is made by the hand only, a proper handle being fixed to the middle of the print, by which it is first dipped in the ink, spread by means of a brush on a block of proportionable size covered with leather ; and then lifted up instantly, and dropped with some little force on the paper which is to receive the impression.

Most of our readers are probably not ignorant that the art of engraving on wood has been revived of late years, and has been carried to great perfection by Messrs Bewick of Newcastle, and other ingenious artists. Of this number we may mention Messrs Nesbit and Anderson of London. The Natural History of Quadrupeds, in one volume 8vo, and the Natural

History of British Birds, in two volumes, published with engravings cut in wood by Messrs Bewick, are excellent specimens of the degree of perfection at which this art has arrived.

Cuttings, or slips, in *Gardening*, the branches or sprigs of trees or plants, cut or slipped off to set again; which is done in any moist fine earth.

The best season is from August to April; but care is to be taken, when it is done, the sap be not too much in the top, lest the cut die before that part in the earth have root enough to support it: nor yet must it be too dry or scanty; the sap in the branches assisting it to take root.

In providing the cuttings, such branches as have joints, knots, or burrs, are to be cut off two or three inches beneath them, and the leaves to be stripped off so far as they are set in the earth. Small top branches, of two or three years growth, are fittest for this operation.

CUTTLE-fish. See Sepia. The bone of the cuttle-fish is hard on one side, but soft and yielding on the other; so as readily to receive pretty neat impressions from medals, &c. and afterwards to serve as a mould for casting metals, which thus take the figure of the original; the bone is likewise frequently employed for cleaning or polishing silver. This fish contains in a certain distinct vessel a fluid as black as ink; which it is said to emit when pursued, and thus to conceal itself by discolouring the water. The particular qualities of this liquor are not yet determined. Dr Leigh says, he saw a letter which had been written with it ten years before, and which still continued. Some report that the ancients made their ink from it; and others, that it is the basis of China or Indian ink; but both these accounts appear to have little foundation. Pliny, speaking of the inks made use of in his time, after observing that the cuttle-fish is in this respect of a wonderful nature, adds expressly, that ink was not made from it.

CUTTS, John Lord, a soldier of most hardy bravery in King William's wars, was son of Richard Cutts, Esq. of Matching in Essex; where the family were settled about the time of Henry VI. and had a great estate. He entered early into the service of the duke of Monmouth, was aid-de-camp to the duke of Lorrain in Hungary, and signalized himself in a very extraordinary manner at the taking of Buda by the Imperialists in 1686; which important place had been for near a century and a half in the hands of the Turks. Mr Addison, in a Latin poem worthy of the Augustan age, plainly hints at Mr Cutts's distinguished bravery at that siege. Returning to England at the revolution, he had a regiment of foot; was created baron of Gowran in Ireland, Dec. 6. 1690; appointed governor of the isle of Wight, April 14. 1693; was made a major-general; and, when the assassination project was discovered, in 1695-6, was captain of the king's guard. In 1698 he was complimented by Mr John Hopkins, as one to whom "a double crown was due," as a hero and a poet. He was colonel of the Coldstream, or second regiment of guards, in 1701; when Mr Steele, who was indebted to his interest for a military commission, inscribed to him his first work, "The Christian Hero." On the accession of Queen Anne, he was made a lieutenant-general of the forces in Holland; commander in chief of the forces in Ireland, under the duke of Ormond, March 23. 1704-5; and afterwards one of the lords justices of that kingdom, to keep him out of the way of action; a circumstance which broke his heart. He died at Dublin, Jan. 26. 1706-7, and is buried there in the cathedral of Christ church. He wrote a poem on the death of Queen Mary; and published, in 1687, "Poetical Exercises, written upon several occasions, and dedicated to her Royal highness Mary princess of Orange." It contains, besides the dedication signed J. Cutts, verses to that princess; a poem on Wisdom; another to Mr Waller on his commending it; seven more copies of verses (one of them called *La Muse Cavalier*, which had been ascribed to Lord Peterborough, and as such mentioned by Mr Walpole in the list of that nobleman's writings), and 11 songs; the whole composing but a very thin volume. A specimen of his poetry is here added:

> Only tell her that I love,
>   Leave the rest to her and fate;
> Some kind planet from above
> May perhaps her pity move;
>   Lovers on their stars must wait;
> Only tell her that I love.
> Why, oh, why should I despair?
>   Mercy's pictur'd in her eye;
> If she once vouchsafe to hear,
> Welcome hope, and welcome fear.
>   She's too good to let me die;
> Why, oh, why should I despair?

CUVETTE, or Cunette, in *Fortification*, is a ditch within a ditch, being a pretty deep trench, about four fathoms broad, sunk, and running along the middle of the great dry ditch, to hold water; serving both to keep off the enemy, and prevent him from mining.

CYANITE, a species of mineral. See Mineralogy *Index*.

CYANOMETER, an instrument for measuring the intensity of the blue colour of the sky. See Supplement.

CYATHUS, κυαθος (from the verb χυειν, *to pour out*), was a common measure among the Greeks and Romans, both of the liquid and dry kind. It was equal to an ounce, or the twelfth part of a pint. The cyathus was made with a handle like our punch ladle. The Roman topers used to drink as many *cyathi* as there were muses, i. e. nine; also as many as there were letters in the patron's name. Thus, they had modes of drinking similar to the modern health-drinking or toasting. The cyathus of the Greeks weighed 10 drachms; but Galen says that a cyathus contains 12 drachms of oil, 13 drachms and one scruple of wine, water, or vinegar, and 18 drachms of honey; and he adds that among the Veterinarii the cyathus contained two ounces.

CYAXARES, son of Phraortes, was king of Media and Persia. He bravely defended his kingdom, which the Scythians had invaded. He made war against Alyattes king of Lydia; and subjected to his power all Asia beyond the river Halys. He died after a reign of 40 years, in the year of Rome 160.

Cyaxares II. is supposed by some to be the same as Darius the Mede. He was son of Astyages king of Media. He added seven provinces to his father's dominions,

dominions, and made war against the Assyrians, whom Cyrus favoured.

CYBEBE, a name of Cybele, from κυβηβειν, because in the celebration of her festivals men were driven to madness.

CYBELE, in Pagan mythology, the daughter of Cœlus and Terra, and wife of Saturn. She is supposed to be the same as Ceres, Rhea, Ops, Vesta, Bona Mater, Magna Mater, Berecynthia, Dindymene, &c. According to Diodorus, she was the daughter of a Lydian prince, and as soon as she was born she was exposed on a mountain. She was preserved by sucking some of the wild beasts of the forest, and received the name of Cybele from the mountain where her life had been preserved. When she returned to her father's court, she had an intrigue with Atys, a beautiful youth, whom her father mutilated, &c. All the mythologists are unanimous in mentioning the amours of Atys and Cybele. In Phrygia the festivals of Cybele were observed with the greatest solemnity. Her priests, called *Corybantes*, *Galli*, &c. were not admitted in the service of the goddess without a previous mutilation. In the celebration of the festivals, they imitated the manners of madmen, and filled the air with shrieks and howlings mixed with the confused noise of drums, tabrets, bucklers, and spears. This was in commemoration of the sorrow of Cybele for the loss of her favourite Atys. Cybele was generally represented as a robust woman far advanced in her pregnancy, to intimate the fecundity of the earth. She held keys in her hand, and her head was crowned with rising turrets, and sometimes with the leaves of an oak. She sometimes appears riding in a chariot drawn by two tame lions: Atys follows by her side, carrying a ball in his hand, and supporting himself upon a fir-tree which is sacred to the goddess. Sometimes she is represented with a sceptre in her hand, with her head covered with a tower. She is also seen with many breasts, to show that the earth gives aliments to all living creatures; and she generally carries two lions under her arms. From Phrygia the worship of Cybele passed into Greece, and was solemnly established at Eleusis under the name of the *Eleusinian mysteries of Ceres*. The Romans, by order of the Sibylline books, brought the statue of the goddess from Pessinus into Italy; and when the ship which carried it had run on a shallow bank of the Tiber, the virtue and innocence of Claudia were vindicated in removing it with her girdle. It is supposed that the mysteries of Cybele were first known about 257 years before the Trojan war, or 1580 years before the Augustan age. The Romans were particularly superstitious in washing every year, on the 6th of the kalends of April, the shrine of this goddess in the waters of the river Almon. There prevailed many obscenities in the observation of the festivals; and the priests themselves were the most eager to use indecent expressions, and to show their unbounded licentiousness by the impurity of their actions.

CYBELLICUM MARMOR, a name given by the ancients to a species of marble dug in a mountain of that name in Phrygia. It was of an extremely bright white, with broad veins of bluish black.

CYCAS, in *Botany*, a genus of plants belonging to the natural order, *Palmæ*. See BOTANY *Index*.

This is a valuable tree to the inhabitants of India, as it not only furnishes a considerable part of their constant bread, but also supplies them with a large article of trade. The pith consists of a farinaceous substance, which is extracted from it and made into bread in this manner: they saw the body into small pieces, and after beating them in a mortar, pour water upon the mass; this is left for some hours to settle. When fit, it is strained through a cloth, and the finer particles of the mealy substance running through with the water, the gross ones are left behind and thrown away. After the farinaceous part is sufficiently subsided, the water is poured off, and the meal being properly dried, is occasionally made into cakes and baked. These cakes are said to eat nearly as well as wheaten bread, and are the support of the inhabitants for three or four months in the year.

The same meal more finely pulverized, and reduced into granules, is what is called *sago*, which is sent into all parts of Europe, and sold in the shops as a great strengthener and restorative.

There is a sort of sago made in the West Indies, and sent to Europe in the same manner as that from the East; but the West India sago is far inferior in quality to the other. It is supposed to be made from the pith of the areca oleracea. See ARECA.

The *brood boom* (or bread-tree) of the Hottentots, a plant discovered by Professor Thunberg, is described as a new species of this genus, by the name of *cycas Caffra*, in the *Nova Acta Reg. Soc. Scient. Ups.* vol. ii. p. 283. Table V. The pith, or *medulla*, which abounds in the trunk of this little palm, Mr Sparrman informs us, is collected and tied up in dressed calf or sheep-skins, and then buried in the earth for the space of several weeks, till it becomes sufficiently mellow and tender to be kneaded up with water into a paste, of which they afterwards make small loaves or cakes, and bake them under the ashes. Other Hottentots, not quite so nice, nor endued with patience enough to wait this tedious method of preparing it, are said to dry and roast the pith or marrow, and afterwards make a kind of frumenty of it.

CYCEON, from κυκαειν, "to mix;" a name given by the ancient poets and physicians to a mixture of meal and water, and sometimes of other ingredients. These constituted the two kinds of cyceon; the coarser being of water and meal alone; the richer and more delicate composed of wine, honey, flour, water, and cheese. Homer, in the 11th Iliad, talks of cyceon made with cheese and the meal of barley mixed with wine, but without any mention either of honey or water; and Ovid, describing the draught of cyceon given by the old woman of Athens to Ceres, mentions only flower and water. Dioscorides understood the word in both these senses; but extolled it most in the coarse and simple kind: he says, when prepared with water alone, it refrigerates and nourishes greatly.

CYCINNIS, a Grecian dance, so called from the name of its inventor, one of the satyrs belonging to Bacchus. It consisted of a combination of grave and gay movements.

CYCLADES INSULÆ: islands anciently so called, as Pliny informs us, from the cyclus or orb in which they lie; beginning from the promontory Geræstum of Eubœa, and lying round the island Delos, (Pliny).

Where they are, and what their number, is not so generally agreed. Strabo says, they were at first reckoned 12, but that many others were added: yet most of them lie to the south of Delos, and but few to the north; so that the middle or centre, ascribed to Delos, is to be taken in a loose, not a geometrical, sense. Strabo recites them after Artemidorus, as follows: Helena, Ceos, Cynthus, Seriphus, Melus, Siphus, Cimolus, Prepesinthus, Olearus, Naxus, Parus, Syrus, Myconus, Tenus, Andrus, Gyarus; but he excludes from the number Prepesinthus, Olearus, and Gyarus.

CYCLAMEN, Sowbread; a genus of plants, belonging to the pentandria class; and in the natural method ranking under the 21st order, *Preciæ*. See Botany *Index*.

CYCLE, in *Chronology*, a certain period or series of numbers, which regularly proceed from the first to the last, and then return again to the first, and so circulate perpetually. See Chronology, N° 26.

Cycle of Indiction, is a series of 15 years, returning constantly around, like the other cycles, and commenced from the third year before Christ; whence it happens, that if 3 be added to any given year of Christ, and the sum be divided by 15, what remains is the year of the indiction.

Cycle of Indiction, a period of 15 years, in use among the Romans. It has no connection with the celestial motion, but was instituted, according to Baronius, by Constantine; who having reduced the time which the Romans were obliged to serve to 15 years, he was consequently obliged every 15 years to impose, or *indicere* according to the Latin expression, an extraordinary tax for the payment of those who were discharged; and hence arose this cycle, which, from the Latin word *indicere*, was styled *indiction*.

Cycle of the Moon, called also the *golden number*, and the *Metonic* cycle, from its inventor Meton the Athenian, is a period of 19 years, which when they are completed, the new moons and full moons return on the same days of the month, so that on whatever days the new and full moons fall this year, 19 years hence they will happen on the very same days of the month, though not at the same hour, as Meton and the fathers of the primitive church thought; and therefore, at the time of the council of Nice, when the method of finding the time for observing the feast of Easter was established, the numbers of the lunar cycle were inserted in the kalendar, which, upon the account of their excellent use, were set in golden letters, and the year of the cycle called the *golden number* of that year.

Cycle of the Sun, a revolution of 28 years, which being elapsed, the dominical or Sunday letters return to their former place, and proceed in the same order as before, according to the Julian kalendar.

CYCLISUS, in *Surgery*, an instrument in the form of a half moon, used in scraping the skull, in case of fractures on that part.

CYCLOID, a curve on which the doctrine of pendulums, and time-measuring instruments, in a great measure depends. Mr Huygens demonstrated, that from whatever point or height, a heavy body, oscillating on a fixed centre, begins to descend, while it continues to move in a cycloid, the time of its falls or oscillations will be equal to each other. It is likewise demonstrable, that it is the curve of quickest descent, i. e. a body falling in it, from any given point above, to another not exactly under it, will come to this point in a less time than in any other curve passing through those two points. This curve is thus generated: suppose a wheel or circle to roll along a straight line till it has completed just one revolution; a nail or point in that part of the circumference of the circle, which at the beginning of the motion touches the straight line, will, at the end of the revolution, have described a cycloid on a vertical plane.

CYCLOPÆDIA, or Encyclopædia, denotes the circle or compass of arts and sciences. A cyclopædia, say the authors of the French Encyclopédie, ought to explain as much as possible the order and connexion of human knowledge. See Encyclopædia.

CYCLOPS, in fabulous history, the sons of Neptune and Amphitrite; the principal of whom were Brontes, Steropes, and Peracmon; but their whole number amounted to above a hundred. Jupiter threw them into Tartarus as soon as they were born; but they were delivered at the intercession of Tellus, and became the assistants of Vulcan. They were of prodigious stature, and had each only one eye, which was placed in the middle of their foreheads.

Some mythologists say, that the Cyclops signify the vapours raised in the air, which occasion thunder and lightning: on which account they are represented as forging the thunderbolts of Jupiter. Others represent them as the first inhabitants of Sicily, who were cruel, of a gigantic form, and dwelt round Mount Ætna.

CYCLOPTERUS, the Sucker, a genus of fishes belonging to the order of amphibia nantes. See Ichthyology *Index*.

CYDER, or Cider, an excellent drink made of the juice of apples, especially of the more curious table kinds; the juice of these being esteemed more cordial and pleasant than that of the wild or harsh kinds. In making this drink, it hath long been thought necessary, in every part of England, to lay the harder cyder-fruits in heaps for some time before breaking their pulps; but the Devonshire people have much improved this practice. In other countries, the method is to make these heaps of apples in a house, or under some covering inclosed on every side. This method hath been found defective, because, by excluding the free air, the heat soon became too violent, and a great perspiration ensued, by which in a short time the loss of juice was so great, as to reduce the fruit to half their former weight, attended with a general rottenness, rancid smell, and disagreeable taste. In the South-hams, a middle way has been pursued, to avoid the inconveniences and loss attending the above. They make their heaps of apples in an open part of an orchard, where, by the means of a free air and less perspiration, the desired maturity is brought about, with an inconsiderable waste of the juices and decay of the fruit entirely free of rankness; and though some apples rot even in this manner, they are very few, and are still fit for use; all continue plump and full of juices, and very much heighten the colour of cyders, without ill taste or smell.

In pursuing the Devonshire method it is to be observed, 1. That all the promiscuous kinds of apples that have dropped from the trees, from time to time, are to be gathered up and laid in a heap by themselves, and to be made into cyder after having so lain about ten days. 2. Such apples as are gathered from the trees, having already acquired some degree of maturity, are likewise to be laid in a heap by themselves for about a fortnight. 3. The later hard fruit, which are to be left on the trees till the approach of frost is apprehended, are to be laid in a separate heap, where they are to remain a month or six weeks, by which, notwithstanding frost, rain, &c. their juices will receive such a maturation, as will prepare them for a kindly fermentation, and which they could not have attained on the trees by means of the coldness of the season.

It is observable, that the riper and mellower the fruits are at the time of collecting them into heaps, the shorter should be their continuance there; and on the contrary, the harsher, immaturer, and harder they are, the longer they should rest.

These heaps should be made in an even and open part of an orchard, without any regard to covering from rain, dew, or what else may happen during the apples staying there; and whether they be carried in and broke in wet or dry weather, the thing is all the same. If it may be objected, that during their having lain together in the heap, they may have imbibed great humidity, as well from the air as from the ground, rain, dews, &c. which are mixed with their juices; the answer is, this will have no other effect than a kindly diluting, natural to the fruit, by which means a speedier fermentation ensues, and all heterogeneous humid particles are thrown off.

The apples are then ground, and the pummice is received in a large open-mouthed vessel, capable of containing as much thereof as is sufficient for one making, or one cheese. Though it has been a custom to let the pummice remain some hours in the vessel appropriated to contain it, yet this practice is by no means commendable; for if the fruits did not come ripe from the trees, or otherwise matured, the pummice remaining in the vat too long will acquire such sharpness and coarseness from the skins as is never to be got rid of; and if the pummice is of well ripened fruit, the continuing too long there will occasion it to contract a sharpness that very often is followed with want of spirit and pricking: nay, sometimes it even becomes vinegar, or always continues of a wheyish colour; all which proceeds from the heat of fermentation that it almost instantly falls into on lying together; the pummice therefore should remain no longer in the vat than until there may be enough broke from one pressing, or that all be made into cheese, and pressed the same day it is broken. See farther on this subject AGRICULTURE *Index*.

In Plate CLXVIII. is a perspective view of the cyder press and apple-mill. A, B, the bottom or lower-beam; C, D, the upper beam; 5, 6, 7, 8, 9, the rights; 4, 4, *e*, *e*, spurs; Z, 2, 12, braces, or cross-pieces; *a*, *b*, capitals; X, blocks; *g*, the screw; E, the back or receiver; F, the cheese or cake of pummice, placed on the stage or bason; G, the stage or bason; 10, 10, beams that support the pieces of which the bason is composed; 11, perpendicular pieces for supporting these beams; H, the buckler; R, S, Q, a circular trough of the apple-mill; T, L, V, compartments or divisions, for different sorts of apples; M, the mill-stone; L, M, axis of the mill-stone; N, the spring-tree bar.

CYDER-Spirit, a spirituous liquor drawn from cyder by distillation, in the same manner as brandy from wine. The particular flavour of this spirit is not the most agreeable, but it may with care be divested wholly of it, and rendered a perfectly pure and insipid spirit upon rectification. The traders in spirituous liquors are well enough acquainted with the value of such a spirit as this: they can give it the flavour of some other kinds, and sell it under their names, or mix it in large proportion with the foreign brandy, rum and arrack, in the sale, without any danger of a discovery of the cheat.

CYDER-Wine. See AGRICULTURE *Index*.

CYDERKIN. See AGRICULTURE *Index*.

CYDIAS, a painter who made a painting of the Argonauts in the 11th Olympiad. This celebrated piece was bought by the orator Hortensius for 164 talents.

CYDNUS, in *Ancient Geography*, a river of Cilicia; rising in Mount Taurus, to the north of Tarsus, through whose middle it ran, in a very clear and cold stream, which had almost proved fatal to Alexander on bathing in it; falling into the sea at a place called Rhegma, a breach, the sea breaking in there, and affording the people of Tarsus a station or port for their ships. The water of the Cydnus is commended by Strabo, as of service in nervous disorders and the gout.

CYDONIA, in *Ancient Geography*, one of the three most illustrious cities of Crete, situated in the north-west of the island, with a locked port, or walled round. The circumstances of the founding of Cydon are uncertain. Stephen of Byzantium says, that it was at first named Apollonia from Cydon the son of Apollo. Pausanias ascribes the founding of it to Cydon the son of Tegetus, who travelled into Crete. Herodotus affirms, that it was founded by the Samians, and that its temples were erected by them. Alexander, in the first book of the Cretans, informs us, that it received its name from Cydon the son of Mercury. Cydon was the largest city in the island; and was enabled to hold the balance between her contending neighbours. She sustained some famous sieges. Phaleucus, general of the Phocians, making an expedition into Crete with a fleet and a numerous army, invested Canea both by sea and land, but lost his army and his life before its walls. In succeeding times when Metellus subdued the island, he assailed Cydon with all his forces; and after combating an obstinate resistance, subjected it to the power of Rome. Cydon occupied the present situation of Canea; only extending half a league farther towards St Odero; where on the sea-shore the remains are still to be seen of some ancient walls which appear to have been of a very solid construction. See CANEA.

CYDONIA, the QUINCE; so called from Cydon, a town of Crete, famous for its abounding with this fruit. Linnæus has joined this genus to the apple and pear; but as there is such a remarkable difference between the fruits, Mr Miller treats the quince as a genus by itself. The species are, 1. The oblonga, with an oblong fruit, lengthened at the base. 2. The maliforma, with oval leaves, wholly on the upper side, with some other varieties. The Portugal quince is the most valuable; its pulp turns to a fine purple when stewed or baked, and becomes much softer and less austere than the others; so is much fitter for making marmalade. The trees are also easily propagated, either by layers, suckers, or cuttings; which must be planted in a moist soil. Those raised from suckers are seldom so well rooted as those which are obtained from cuttings or layers, and are subject to produce suckers again in greater plenty; which is not so proper for fruit-bearing trees. These trees require very little pruning: the chief thing to be observed is, to keep their stems clear from suckers, and cut off such branches as cross each other; likewise all upright luxuriant shoots from the middle of the tree should be taken off, that the head may not be too much crowded with wood, which is of ill consequence to all fruit trees. These sorts may also be propagated by building or grafting upon stocks raised by cuttings; so that the best sorts may be cultivated this way in greater plenty than by any other method. These are also in great esteem to bud or graft pears upon; which for summer or autumn fruits are a great improvement to them, especially those designed for walls and espaliers; for the trees, upon these stocks do not shoot so vigorously as those upon free-stocks, and therefore may be kept in less compass, and sooner produce fruit: but hard winter fruits do not succeed so well upon these stocks, their fruit being subject to crack, and are commonly stony, especially all the breaking pears: therefore these stocks are only fit for melting pears and a moist soil.

CYGNUS, the SWAN. See ANAS, ORNITHOLOGY *Index*.

CYGNUS, the *Swan*, in *Astronomy*, a constellation of the northern hemisphere, between Lyra and Cepheus. The stars in the constellation Cygnus, in Ptolemy's catalogue, are 19; in Tycho's 18; in Hevelius's 47; in the Britannic catalogue 81.

CYLINDER, in *Geometry*, a solid body supposed to be generated by the rotation of a parallelogram.

Rolling or *Loaded* CYLINDER, a cylinder which rolls up an inclined plane; the phenomena of which are explained under MECHANICS.

CYLINDROID, in *Geometry*, a solid body approaching to the figure of a cylinder, but differing from it in some respects, as having the bases elliptical, but parallel and equal.

CYLINDRUS, in *Natural History*, the name of a genus of shell-fish, of which there are many elegant and precious species.

CYMA, in *Botany*, the tender stalks which herbs send forth in the beginning of spring, particularly those of the cabbage kind.

CYMA, or CYMATIUM, in *Architecture*, a member or moulding of the corniche, the profile of which is waved, that is, concave at top, and convex at bottom.

CYMBAL, (κυμβαλον), a musical instrument in use among the ancients. The cymbal was made of brass, like our kettle-drums, and, as some think, in their form, but smaller, and of different use. Ovid gives cymbals the epithet of *genialia*, because they were used at weddings and other diversions.

Cassiodorus and Isidore call this instrument *acetabulum*, the name of a cup or cavity of a bone wherein another is articulated; and Xenophon compares it to a horse's hoof; whence it must have been hollow; which appears, too, from the figure of several other things denominated from it; as a basin, caldron, goblet, cask, and even a shoe, such as those of Empedocles, which were of brass.

In reality, the ancient cymbals appear to have been very different from our kettle-drums, and their use of another kind: to their exterior cavity was fastened a handle; whence Pliny compares them to the upper part of the thigh, and Rabanus to phials.

They were struck against one another in cadence, and made a very acute sound. Their invention was attributed to Cybele; whence their use in feasts and sacrifices: setting aside this occasion, they were seldom used but by dissolute and effeminate people. M. Lampe, who has written expressly on the subject, attributes the invention to the Curetes, or inhabitants of Mount Ida in Crete; it is certain these, as well as the Corybantes or guards of the kings of Crete, and those of Rhodes and Samothracia, were reputed to excel in the music of the cymbal.

The Jews had their cymbals, or at least instruments which translators render cymbals; but as to their matter and form, critics are still in the dark. The modern cymbal is a mean instrument, chiefly in use among vagrants, gypsies, &c. It consists of steel wire in a triangular form, whereupon are passed five rings, which are touched and shifted along the triangle with an iron rod held in the left hand, while it is supported in the right by a ring, to give it the freer motion. Durandus says, that the monks used the word *cymbal* for the cloister-bell, used to call them to the refectory.

CYME, in *Ancient Geography*, a city built by Pelops on his return to Greece. Cyme the Amazon gave it name, on expelling the inhabitants, according to Mela. Latin authors, as Nepos, Livy, Mela, Pliny, Tacitus, retain the appellation *Cyme*, after the Greek manner. It stood in Æolia, between Myrina and Phocæa (Ptolemy); and long after, in Peutinger's map, is set down nine miles distant from Myrina.—From this place was the Sibylla Cumæa, called *Erythræa*, from *Erythra*, " a neighbouring place." It was the country of Ephorus. Hesiod was a Cumean originally (Stephanus); his father coming to settle at Ascra in Bœotia.

CYMENE, in *Botany*, a name given by the ancient Greeks to a plant with which they used to dye woollen stuffs yellow, and with which the women of those times used also to tinge the hair yellow, which was then the favourite colour. The *cymene* of the Greeks is evidently the same plant with the *lutea herba* of the Latins; or what is now called *dyers weed*. See RESEDA, BOTANY *Index*.

CYNÆGIRUS, an Athenian, celebrated for his extraordinary courage. He was brother to the poet Æschylus. After the battle of Marathon he pursued the flying Persians to their ships, and seized one of their vessels with his right hand, which was immediately severed by the enemy. Upon this he seized the

the vessel with his left hand, and when he had lost that also, he still kept his hold with his teeth.

CYNANCHE, in *Medicine*, a disease, in which the throat is inflamed and swelled to such a degree as sometimes to threaten suffocation. See MEDICINE *Index*.

CYNANCHUM, BASTARD DOGSBANE; a genus of plants, belonging to the pentandria class; and in the natural method ranking under the 30th order, *Contortæ*. See BOTANY *Index*.

CYNARA, the ARTICHOKE; a genus of plants belonging to the syngenesia class. See BOTANY *Index*.

The varieties of the artichoke are propagated by slips or suckers, arising annually from the stool or root of the old plants in spring, which are to be taken from good plants of any present plantation in March or the beginning of April, and planted in the open quarter of the kitchen garden, in rows five feet asunder: and they will produce artichokes the same year in autumn. It should, however, be remarked, that though artichokes are of many years duration, the annual produce of their fruit will gradually lessen in the size of the eatable parts after the third or fourth year, so that a fresh plantation should be made every three or four years. The cardoon is a very hardy plant, and prospers in the open quarters of the kitchen-garden. It is propagated by seed sown annually in the full ground in March; either in a bed for transplantation, or in the place where they are designed to remain. The plants are very large, so must stand at considerable distances from one another. By this means you may have some small temporary crops between the rows, as of lettuce, spinach, endive, cabbage, savoy, or brocoli plants. In the latter end of September, or in October, the cardoons will be grown very large, and their footstalks have acquired a thick substance; you must then tie up the leaves of each plant, to admit of earthing them closely all round for blanching, which will take up six or eight weeks; and thus the plants will come in for use in November and December, and continue all winter.

CYNEUS, of Thessaly, the scholar of Demosthenes, flourished 275 years before Christ. Pyrrhus had so high an esteem for him, that he sent him to Rome to solicit a peace; and so vast was his memory, that the day after his arrival he saluted all the senators and knights by name. Pyrrhus and he wrote a Treatise of War, quoted by Tully.

CYNICS, a sect of ancient philosophers, who valued themselves upon their contempt of riches and state, arts and sciences, and every thing, in short, except virtue or morality.

The Cynic philosophers owe their origin and institution to Antisthenes of Athens, a disciple of Socrates; who being asked of what use his philosophy had been to him, replied, "It enables me to live with myself." Diogenes was the most famous of his disciples, in whose life the system of this philosophy appears in its greatest perfection. He led a most wretched life, a tub having served him for a lodging, which he rolled before him wherever he went. Yet he was nevertheless not the more humble on account of his ragged cloak, bag, and tub; for one day entering Plato's house, at a time when there was a splendid entertainment there for several persons of distinction, he jumped upon a very rich couch in all his dirt, saying, "I trample on the pride of Plato." "Yes (replied Plato), but with great pride, Diogenes." He had the utmost contempt for all the human race; for he walked the streets of Athens at noon-day with a lighted lanthorn in his hand, telling the people, "He was in search of a man." Among many excellent maxims of morality, he held some very pernicious opinions: for he used to say that the uninterrupted good fortune of Harpalus, who generally passed for a thief and a robber, was a testimony against the gods. He regarded chastity and modesty as weaknesses. Hence Laertius observes of him, that he did every thing openly, whether it belonged to Ceres or Venus; though he adds, that Diogenes only ran to an excess of impudence to put others out of conceit of it. But impudence was the characteristic of these philosophers; who argued, that what was right to be done, might be done at all times, and in all places. The chief principle of this sect in common with the Stoics, was, that we should follow nature. But they differed from the Stoics in their explanation of that maxim; the Cynics being of opinion, that a man followed nature that gratified his natural motions and appetites; while the Stoics understood right reason by the word nature.

CYNIC-Spasm, a kind of convulsion, wherein the patient imitates the howlings of dogs.

CYNIPS, a genus of insects belonging to the hymenoptera order. See ENTOMOLOGY *Index*.

CYNOCEPHALUS, in *Zoology*, the trivial name of a species of SIMIA. See MAMMALIA *Index*.

CYNOGLOSSUM, HOUND'S TONGUE; a genus of plants belonging to the pentandria class, and in the natural method ranking under the 41st order, *Asperifoliæ*. See BOTANY *Index*.

CYNOMETRY, in *Botany*, a genus of plants belonging to the decandria class, and in the natural method ranking with those of which the order is doubtful. See BOTANY *Index*.

CYNOMORIUM, in *Botany*, a genus of plants belonging to the monœcia class, and in the natural method ranking under the 50th order, *Amentaceæ*. See BOTANY *Index*.

CYNOPHONTIS, in antiquity, a festival observed in the dog days at Argos, and so called *απο της κυνας φονειν*, i. e. from killing dogs: because it was usual on this day to kill all the dogs they met with.

CYNOREXY, an immoderate appetite, to the degree of a disease, called also *fames canina* and *bulimy*.

CYNOSARGES, a place in the suburbs of Athens, named from a white or swift dog, who snatched away part of the sacrifice offering to Hercules. It had a gymnasium, in which strangers or those of the half-blood performed their exercises; the case of Hercules, to whom the place was consecrated. It had also a court of judicature to try illegitimacy, and to examine whether persons were Athenians of the whole or half blood. Here Antisthenes set up a new sect of philosophers called *Cynics*, either from the place, or from the snarling or the impudent disposition of that sect.

CYNOSCEPHALÆ, in *Ancient Geography*, a place in Thessaly near Scotussa; where the Romans, under Q. Flaminius, gained a great victory over Philip, son of Demetrius king of Macedon. These Cynoscephalæ

phalæ are small tops of several equal eminences; named from their resemblance to dogs heads, according to Plutarch.

CYNOSSEMA, the tomb of Hecuba, on the promontory Mastusia, over against Dardanus, in the south of the Chersonesus Thracica; named either from the figure of a dog, to which she was changed, or from her sad reverse of fortune (Pliny, Mela).

CYNOSURA, in *Astronomy*, a denomination given by the Greeks to *ursa minor*, "the little bear," by which sailors steer their course. The word is formed of κυνοσȣρα, q. d. the dog's tail. This is the constellation next our pole, consisting of seven stars; four whereof are disposed like the four wheels of a chariot, and three lengthwise representing the beam; whence some give it the name of the *chariot*, or *Charles's wain*.

Cynosura, *Cynosuræ*, or *Cynosuris*, in *Ancient Geography*, a place in Laconia; but whether maritime or inland, uncertain. Here Æsculapius, being thunderstruck, was buried (Cicero).

Cynosura was also the name of the promontory of Marathon in Attica, opposite to Eubœa.

Cynosura, in *Mythology*, a nymph of Ida in Crete. She nursed Jupiter, who changed her into a star which bears the same name. It is the same as the ursa minor.

CYNOSURUS, in *Botany*, a genus of plants belonging to the triandria class, and in the natural method ranking under the 4th order, *Gramineæ*. See Botany *Index*.

CYNTHIUS and Cynthia, in *Mythology*, surnames of Apollo and Diana, derived from *Cynthia*, the name of a mountain in the middle of the island of Delos.

CYNTHUS, in *Ancient Geography*, a mountain of the island Delos, so high as to overshadow the whole island. On this mountain Latona brought forth Apollo and Diana: hence the epithet *Cynthius* (Virgil), and *Cynthia* (Lucan, Statius).

CYNURIA, or Cynurius *Ager*, in *Ancient Geography*, a district of Laconia, on the confines of Argolis. A territory that proved a perpetual bone of contention between the Argives and Spartans (Thucydides). For the manner of deciding the dispute, see Thyrea.

CYPERUS, in *Botany*, a genus of plants belonging to the triandria class, and in the natural method ranking under the 3d order, *Calamariæ*. See Botany *Index*.

CYPHON, in antiquity, a kind of punishment used by the Athenians. It was a collar made of wood; so called because it constrained the criminal who had this punishment inflicted on him to bow down his head.

CYPHONISM (*Cyphonismus*), from κυφων, which has various significations; derived from κυφος, *crooked*; a kind of torture or punishment in use among the ancients.

The learned are at a loss to determine what it was. Some will have it to be that mentioned by Jerome in his Life of Paul the Hermit, chap. 2. which consisted in smearing the body over with honey, and thus exposing the person, with his hands tied, to the warm sun, to invite the flies and other vermin to persecute him.

CYPRÆA, or Cowrie, a genus of shells belonging to the order of vermes testacea. See Conchology *Index*.

This genus is called *cypræa* and *venerea* from its being peculiarly dedicated to Venus, who is said to have endowed a shell of this genus with the powers of a *remora*, so as to impede the course of the ship which was sent by Periander tyrant of Corinth, with orders to emasculate the young nobility of Corcyra.

CYPRESS. See Cupressus, Botany *Index*.

CYPRIANUS, Thascius-Cæcilius, a principal father of the Christian church, was born at Carthage in Africa, at the latter end of the second or beginning of the third century. We know nothing more of his parents than that they were Heathens; and he himself continued such till the last 12 years of his life. He applied himself early to the study of oratory; and some of the ancients, particularly Lactantius, inform us, that he taught rhetoric in Carthage with the highest applause. Cyprian's conversion is fixed by Pearson to the year 246; and was at Carthage, where, as St Jerome observes, he had often employed his rhetoric in the defence of paganism. It was brought about by one Cæcilius, a priest of the church of Carthage, whose name Cyprian afterwards took; and between whom there ever after subsisted so close a friendship, that Cæcilius at his death committed to Cyprian the care of his family. Cyprian was also a married man himself; but as soon as he was converted to the faith, he resolved upon a state of continence, which was thought a high degree of piety, as not being yet become general. Being now a Christian, he was to give the usual proof of the sincerity of his conversion; and that was by writing against Paganism and in defence of Christianity. With this view he composed his piece *De Gratia Dei*, or "concerning the grace of God," which he addressed to Donatus. It is a work of the same nature with the Apologetic of Tertullian, and the Octavius of Minutius Felix. He next composed a piece *De Idolorum Vanitate*, or "upon the vanity of idols." Cyprian's behaviour, both before and after his baptism, was so highly pleasing to the bishop of Carthage, that he ordained him a priest a few months after. It was rather irregular to ordain a man thus in his very noviciate; but Cyprian was so extraordinary a person, and thought capable of doing such singular service to the church, that it seemed allowable in this case to dispense a little with the form and discipline of it. For besides his known talents as a secular man, he had acquired a high reputation of sanctity since his conversion; having not only separated himself from his wife, as we have observed before, which in those days was thought an extraordinary act of piety, but also consigned over all his goods to the poor, and given himself up entirely to the things of God. It was on this account no doubt, too, that when the bishop of Carthage died the year after, that is, in the year 248, none was judged so proper to succeed him as Cyprian. The quiet and repose which the Christians had enjoyed during the last 40 years, had, it seems, greatly corrupted their manners; and therefore Cyprian's first care, after his advancement to the bishopric, was to correct disorders and reform abuses. Luxury was prevalent among them; and many of their women were not so strict as as they should be, especially in the article of dress. This occasioned him to draw up his piece *De habitu virginum*, "concerning the dress of young women;" in which, besides what he says on that particular head, he inculcates many lessons of modesty and sobriety. In the year 249, the emperor Decius began to issue out very severe edicts against the Christians, which particularly affected those upon the coast of Africa: and in the beginning of 250, the Heathens in the circus and amphitheatre of Carthage, insisted loudly upon Cyprian's being thrown to the lions: a common method of destroying the primitive Christians. Cyprian upon this withdrew from the church at Carthage, and fled into retirement, to avoid the fury of the persecutions. He wrote, in the place of his retreat, pious and instructive letters to those who had been his hearers; and also to the *libellatici*, a name by which those pusillanimous Christians were called, who procured certificates of the Heathen magistrates, to show that they had complied with the emperor's orders in sacrificing to idols. At his return to Carthage, he held several councils on the repentance of those who had fallen during this persecution, and other points of discipline; he opposed the schemes of Novatus and Novatianus; and contended for the rebaptizing of those who had been baptized by heretics. At last he died a martyr in the persecution of Valerian and Gallienus, in 258. Cyprian wrote 81 letters, and several treatises. The best edition of his works are those of Pamelius in 1568; of Rigaltius in 1648; and of Oxford in 1682. His works have all been translated into English by Dr Marshal.

CYPRINUS, a genus of fishes, belonging to the order of abdominales. See ICHTHYOLOGY *Index*.

CYPRIPEDIUM, the LADY'S SLIPPER; a genus of plants belonging to the gynandria class, and in the natural method ranking under the 7th order, *Orchideæ*. See BOTANY *Index*.

CYPRUS, an island situated in the Levant, or most easterly part of the Mediterranean sea, between 33 and 36 degrees of east longitude, and 35 and 36 of north latitude. In ancient times this island was known by the names of Acamis, Cerastis, Aspalia, Amathus, Macaria, Cryptos, Colinia, Sphecia, Paphia, Salaminia, Ærosa, and Cyprus. The etymologies of these names are neither very easily found, nor are they of much importance. The name by which it was most generally known is that of *Cyprus*, said to be derived from *cypros*, the name of a shrub or tree with which the island abounds; supposed to be the cypress.

Cyprus, according to Eratosthenes, was first discovered by the Phœnicians, two or three generations before the days of Asterius and Minos, kings of Crete; that is, according to Sir Isaac Newton's computation, 2006 years before the Christian era. It was at that time so full of wood that it could not be tilled, and the Phœnicians first cut down that wood for melting copper, with which the island abounded; and afterwards, when they began to sail without fear on the Mediterranean, that is, after the Trojan war, they built great navies of the wood produced on this island. Josephus, however, informs us, that the descendants of *Cittim*, the son of Javan, and grandson of Japhet, were the original inhabitants of Cyprus. According to his account, Cittim, seeing his brother Tarshish settled in Cilicia, where he built the city of Tarsus, settled with his followers in this opposite island; and either he or his descendants laid the foundation of the city of Cittim, which, according to Ptolemy, was the most ancient in the island. As Cyprus was too narrow to contain the great numbers who attended him, he left here as many as might serve to people the country, and with the rest passed over to Macedon.

The island of Cyprus was divided among several petty kings till the time of Cyrus the Great. He subdued them all; but left each in possession of his kingdom, obliging them only to pay him an annual tribute, and to send supplies of men, money, and ships when required. The Cyprian princes lived thus subject to the Persians till the reign of Darius Hystaspes, when they attempted to shake off the yoke, but with bad success; their forces being entirely defeated, and themselves again obliged to submit. They made another more successful attempt about the year before Christ 357; but, however, could never totally free themselves from their subjection. It is very probable that they submitted to Alexander the Great, though historians are silent as to that event. On the death of the Macedonian conqueror, the dominion of Cyprus was disputed by Antigonus and Ptolemy the son of Lagus. At last Antigonus prevailed, and the whole island submitted to him about 304 years before Christ. He and his son Demetrius kept possession of it for 11 years, when it was recovered by Ptolemy, and quietly possessed by him and his descendants till 58 years before Christ, when it was most unjustly seized by the Romans. In the time of Augustus, it began to be ranked among the proconsular provinces, and to be governed by magistrates sent thither by the senate. In the year 648 it was conquered by the Saracens; but recovered by the Romans in 957. They held it, however, but for a very short time, and the barbarians kept possession of it till the time of the croisades. It was then reduced by the croisaders; and Richard I. of England gave it to the princes of the Lusignan family, who held it till the year 1570. They divided it into 12 provinces, in each of which was a capital city, from which the province was denominated. So considerable was the island at this time, that besides the cities above mentioned, and others of less note, it contained 800 villages. In 1570 it was taken by the Turks, and though it hath ever since continued under their tyrannical yoke, is still so considerable as to be governed by a beglerbeg, and seven sangiacs under him.

The air in this island is for the most part very unwholesome, on account of the many fens and marshes with which the country abounds. The soil is an excellent fertile clay; and would produce all the necessaries of life in abundance, if properly cultivated. There are but few springs or rivers in this island; so that when the rains do not fall plentifully at the usual seasons, the inhabitants are much distressed by the scarcity of water. By reason of the uncultivated state of the country, they are also greatly infested with poisonous reptiles of various kinds. The people are extremely ignorant and lascivious, as indeed they are remarked to have been from the remotest antiquity. Anciently the worship of Venus was established in this island, whence her title among the poets of the *Cyprian queen*; and such an inclination had the inhabitants to become the votaries of this goddess, both in theory and practice, that the young women used to prostitute themselves in her temple in order to raise themselves portions. The exports of the island are silks, oil, cotton, wine, salt, and turpentine: the imports are French and Venetian broad cloths; and sometimes a few bales of English manufacture, cutlery wares, sugar, tin, lead, &c. The number of inhabitants at present is believed not to exceed 60,000.

Knights of CYPRUS, an order instituted by Guy de Lusignan, titular king of Jerusalem, to whom Richard I. of England, after conquering this island, made over his right.

CYRANO, BERGERAC, a French author, born in Gascony, about the year 1620. He first entered into the army, where his natural courage engaged him frequently in duels in the quality of a second; which, with other rash actions, procured him the title of the *Intrepid*. But the little prospect he saw of preferment made him renounce the trade of war for the exercise of wit. His comic histories of the states and empires in the sun and moon, show him well acquainted with the Cartesian philosophy, and to have a lively imagination. Our Lord Orrery classes him with Swift for his turn of humour, which he says the latter adopted and pursued.

CYRENAICA, an ancient kingdom of Africa, corresponding to the present kingdom and desert of Barca and Tripoli. It was originally inhabited by a number of barbarous nations, differing little from great gangs of robbers. Afterwards some colonies from Greece settled here, and Cyrenaica became so powerful a state, that it waged war with Egypt and Carthage, often with success. In the time of Darius Hystaspes, Arcesilaus, the reigning prince in Cyrenaica, was driven from the throne: on which his mother Pheretima applied for assistance to the king of Cyprus. Her son afterwards returning to Barca, the chief city of Cyrene, was there assassinated, together with his father-in-law. Pheretima finding herself disappointed by the king of Cyprus, applied to Darius Hystaspes, and by the assistance of the Persians reduced Barca. Here she behaved with the utmost cruelty, causing all those who had been concerned in her son's death to be impaled, and the breasts of their wives to be cut off and affixed near them. She is said to have been afterwards devoured by worms; which was looked upon as a divine judgment for her excessive cruelty. The prisoners in the mean time were sent to Darius, who settled him in a district of Bactria, from them called *Barca*. Cyrenaica, however, seems to have remained free till the time of Alexander the Great, who conquered it along with Egypt. Soon after his death the inhabitants recovered their liberty; but were in a short time reduced by Ptolemy king of Egypt. Under these kings it remained till Ptolemy Physcon made it over to his bastard son Apian, who in the 658th year of Rome left it by will to the Romans. The senate permitted all the cities to be governed by their own laws; and this immediately filled the country with tyrants, those who were most potent in every city or district endeavouring to assume the sovereignty of it. Thus the kingdom was thrown into great confusion; but Lucullus in a good measure restored the public tranquillity on his coming thither during the first Mithridatic war. It was found impossible, however, totally to suppress these disturbances till the country was reduced to the form of a Roman province, which happened about 20 years after the death of Apian, and 76 before Christ. Upon a revolt, the city of Cyrene was ruined by the Romans; but they afterwards rebuilt it. In process of time it fell to the Arabs; and then to the Turks, who are still the nominal masters of it.

CYRENAICS, a sect of ancient philosophers, so called from their founder Aristippus of Cyrene, a disciple of Socrates.

The great principle of their doctrine was, that the supreme good of man in this life is pleasure; whereby they not only meant a privation of pain, and a tranquillity of mind, but an assemblage of all mental and sensual pleasures, particularly the last.

Cicero makes frequent mention of Aristippus's school, and speaks of it as yielding debauchees. Three disciples of Aristippus, after his death, divided the sect into three branches; under which division it languished and sunk: the first called the *Hegesiac* school; the second the *Annicerian*; and the third the *Theodoran*; from the names of their authors.

CYRENE, in *Ancient Geography*, the capital of Cyrenaica, and one of the cities called *Pentapolis*, distant from Apollonia, its sea-port, 10 miles, situated on a plain, of the form of a table, according to Strabo: A colony of the Thereans. Though they were descendants of the Lacedæmonians, yet they differed from them in their turn of mind or disposition, applying themselves to philosophy; and hence arose the Cyrenaic sect, at the head of which was Aristippus, who placed all happiness in pleasure. The Cyreneans were a people much given to aurigation, or the use of the chariot, from their excellent breed of horses, (Pindar, Ephorus, Strabo).

CYRIL, St, bishop of Jerusalem, succeeded Maximus in 350. He was afterwards deposed for the crime of exposing to sale the treasures of the church, and applying the money to the support of the poor during a great famine. Under Julian he was restored to his see, and was firmly established in all his old honours and dignities under Theodosius; in which he continued unmolested to his death in 386. The remains of this father consist only of 23 catecheses, and one letter to the emperor Constantius.

CYRIL, *St*, patriarch of Alexandria, succeeded Theophilus, his uncle, in 412. Scarce was he installed, when he began to exert his authority with great rigour; he drove the Novatians and Jews from Alexandria, permitting their wealth and synagogues to be taken from them. This proceeding highly displeased Orestes, the governor of the city, who saw that if the bishop's authority was not soon suppressed, it might grow too strong for that of the magistrate. Upon which a kind of civil war broke out between Orestes and the bishop; many tumults were raised, and some battles fought in the very streets of Alexandria. St Cyril also distinguished himself by his zeal against Nestorius bishop of Constantinople, who in some of his homilies, had asserted that the Virgin Mary ought not to be called the mother of God. The dispute at first proved unfavourable to Cyril, whose opinion was not only condemned, but himself deprived of his bishopric and thrown into prison. But he was soon after released, and

Cyril, Cyrus.

and gained a complete victory over Nestorius, who in 431 was deposed from his see of Constantinople. Cyril returned to his see at Constantinople, where he died in 444. St Cyril also wrote against Theodorus of Mopsuesta, Diodorus of Tarsus, and Julian the apostate. He composed commentaries on St John's gospel, and wrote several other books. His works were published in Greek and Latin in 1638, in six volumes folio.

CYRUS, the son of Cambyses the Persian, by Mandane, the daughter of Astyages king of the Medes. The two chief historians, who have written the life of Cyrus, are Herodotus and Xenophon; but their accounts of him are different, in as much as the latter makes his father a king of Persia, and the former a meaner man. The account of Herodotus, as Dr Prideaux observes, indeed contains narratives that are much more strange and surprising, and consequently more diverting and agreeable to the reader: and for this reason more have chosen to follow him than Xenophon.

Herodotus informs us, that Astyages king of the Medes dreamed that a vine sprung from the womb of his daughter Mandane, the branches whereof overshadowed all Asia; whereupon having consulted the soothsayers, he was told that his dream portended the future power and greatness of a child who should be born of his daughter: and further that the same child should deprive him of his kingdom. Astyages, to prevent the accomplishment of this prediction, instead of marrying his daughter to some powerful prince, gave her to Cambyses, a Persian of mean condition, and one who had no great capacity for forming any important design, nor for supporting the ambition of his son by his own riches and authority. Nor did Astyages stop here: the apprehensions he was under lest Mandane's son might perhaps find that assistance in his own courage, or some lucky circumstance which his family was not able to supply him with, induced him to take a resolution of despatching the child, if there should be any. As soon, therefore, as he understood his daughter was with child, he commanded one of his officers, whose name was Harpagus, to destroy the infant as soon as it came into the world. Harpagus, fearing the resentment of Mandane, put the child into the hands of one who was the king's shepherd, in order to expose him. The shepherd's wife was so extremely touched with the beauty of Cyrus, that she desired her husband rather to expose her own son, who was born some time before, and preserve the young prince. After this manner Cyrus was preserved, and brought up among the king's shepherds.

One day, as the neighbouring children were at play together, Cyrus was chosen king; and having punished one of his little playfellows with some severity, for disobeying his commands, the child's parent complained of Cyrus to Astyages. This prince sent for young Cyrus, and observing something great in his air, his manner and behaviour, together with a great resemblance of his daughter Mandane, he made particular inquiry into the matter, and discovered that, in reality, Cyrus was no other than his grandson. Harpagus, who was the instrument of preserving him, was punished with the death of his own son: however, Astyages believing that the royalty which the soothsayers had promised to the young prince, was only that which he had lately exercised among the shepherd's children, troubled himself no more about it. Cyrus being grown up, Harpagus disclosed the whole secret of his birth to him, together with the manner wherein he had delivered him from the cruel resolution of his grandfather. He encouraged him to come into Media, and promised to furnish him with forces, in order to make him master of the country, and depose Astyages. Cyrus hearkened to these propositions, engaged the Persians to take up arms against the Medes, marched at the head of them to meet Astyages, defeated him, and possessed himself of Media. He carried on many other wars; and at length sat down before Babylon, which after a long siege he took.

Cyrus.

The relation of Cyrus's life from Xenophon is as follows: Astyages king of Media married his daughter Mandane to Cambyses king of Persia, son to Achæmenes king of the same nation. Cyrus was born at his father's court, and was educated with all the care his birth required. When he was about the age of 12 years, his grandfather Astyages sent for him to Media, together with his mother Mandane. Some time after, the king of Assyria's son having invaded Media, Astyages, with his son Cyaxares and his grandson Cyrus, marched against him. Cyrus distinguished himself in this war, and defeated the Assyrians. Cambyses afterwards recalled him, that he might have him near his own person; and Astyages dying, his son Cyaxares, uncle by the mother's side to Cyrus, succeeded him in the kingdom of Media.

Cyrus, at the age of 30 years, was, by his father Cambyses, made general of the Persian troops; and sent at the head of 30,000 men to the assistance of his uncle Cyaxares, whom the king of Babylon, with his allies the Cappadocians, Carians, Phrygians, Cilicians, and Paphlagonians were preparing to attack. Cyaxares and Cyrus prevented them, by falling upon them and dispersing them. Cyrus advanced as far as Babylon, and spread terror throughout the country. From this expedition he retired to his uncle, towards the frontiers of Armenia and Assyria, and was received by Cyaxares in the tent of the Assyrian king whom he had defeated.

After this Cyrus carried the war into the countries beyond the river Halys, entered Cappadocia, and subdued it entirely. From thence he marched against Crœsus king of Lydia, beat him in the first battle; then besieged him in Sardis his capital; and after a siege of fourteen days obliged him to surrender. See Croesus. After this, Cyrus having reduced almost all Asia, repassed the Euphrates, and made war upon the Assyrians. He marched directly to Babylon, took it, and there prepared a palace for his uncle Cyaxares, whither he might retire, if at any time he had an inclination to come to Babylon; for he was not then in the army. After all these expeditions, Cyrus returned to his father and mother into Persia, where they were still living: and going some time after to his uncle Cyaxares into Media, he married his cousin the only daughter and heiress of all Cyaxares's dominions, and went with her to Babylon, from whence he sent men of the first rank and quality to govern all the several nations which he had conquered. He engaged again in several wars, and subdued all the nations which lie between Syria and the Red sea. He died at the age of 70 years, after a reign of 30: but authors differ very much concerning the manner of his death. Herodotus, Justin, and Valerius Maximus relate, that he died in the war against the Scythians; and that falling into an ambush which Queen Tomyris had laid for him, she ordered his head to be cut off, and cast into a vessel full of blood, saying, "Thou hast always thirsted after human blood, now glut thyself with it." Diodorus the Sicilian says, that he was taken in an engagement and hanged. Ctesias assures us, that he died of a wound which he received in his thigh: but by Xenophon's account he died peaceably in his bed, amidst his friends and his servants; and certain it is, that in Alexander's time his monument was shown at Pasagarda in Persia.

From all this it is easy to conclude, that we are but imperfectly acquainted with the history of this great prince, the founder of the Persian, and destroyer of the Chaldean empire. We learn fewer particulars of it from Scripture, but then they are more certain than any that we have produced. Daniel (viii. 3—20.) in the famous vision wherein God showed him the ruin of several great emperors, which were to precede the birth of the Messiah, represents Cyrus to us under the idea of "a ram, which had two horns; and the two horns were high, but the one was higher than the other, and the higher came up last. This ram pushed westward, and northward, and southward, so that no beasts might stand before him; neither was there any that could deliver out of his hand, but he did according to his will, and became great." The ram's two horns signify the two empires which Cyrus reunited in his person; that of the Medes, and that of the Persians. The last was greater and more powerful than the empire of the Medes; or otherwise, these two horns signify the two branches of Cyrus's successors. His son Cambyses dying, the empire was transferred to Darius the son of Hystaspes, and was continued down to Darius Codomannus, who, as Calmet thinks, is the great horn which the he-goat, that denotes Alexander, run against. In chap. vii. 5. Daniel compares Cyrus to a bear, with three ribs in the mouth of it, to which it was said, "Arise, devour much flesh." Cyrus succeeded his father Cambyses in the kingdom of Persia, and Darius the Mede, by Xenophon called Cyaxares, and Astyages in the apocryphal chapter (xiii. 1.) of Daniel, in the kingdom of the Medes and empire of Babylon. He was monarch of all the east; or as he speaks (2 Chr. xxxvi. 22, 23. and Ezr. i. 1, 2.) "of all the earth," when he permitted the Jews to return to their own country, in the year of the world 3466, before Jesus Christ 538. The enemies of the Hebrews, making use of this prince's affection to his own religion, prevailed with him to put a stop by his orders to the building of the temple at Jerusalem; (Ezra iv. 5.). The prophets frequently foretold the coming of Cyrus; and Isaiah (xliv. 28.) has been so particular as to declare his name 200 years before he was born. Josephus (Antiq. lib. ii. c. 2.) says, that the Jews of Babylon showed this passage of the prophet to Cyrus; and that this prince, in the edict which he granted them for their return, acknowledged that he received the empire of the world from the God of Israel; and that the same God had described him by name in the writings of the prophets, and foretold that he should build a temple to him at Jerusalem. Cyrus is pointed out in Scripture under the name of the righteous man and the shepherd of Israel, (Isaiah xli. 2. 10. xliv. 28.) and xlvi. 11. Notwithstanding this, God says of him (Isaiah xlv. 5.) "I girded thee, though thou hast not known me." And Jeremiah calls Cyrus and his people who overthrew the Babylonish empire, thieves and robbers. The taking of Babylon by Cyrus is clearly set down by the prophets, and may be seen under the articles BABYLON and BELSHAZZAR. Archbishop Usher fixes the birth of Cyrus to the year of the world 3405; his first year at Babylon to 3466, and his death to 3475. The eastern people will have it, that Cyrus by his mother's side was descended from some of the Hebrew prophets: as also that his wife was a Jew, which is the reason (say they) that this prince so attached himself to the Jews, to whom he was so nearly allied.

CYRUS II. was the younger son of Darius Nothus, and the brother of Artaxerxes. He was sent by his father at the age of 16 to assist the Lacedæmonians against Athens. Artaxerxes succeeded to the throne at the death of Nothus; and Cyrus, who was of an aspiring soul, attempted to assassinate him. He was discovered, and had been punished with death, had not his mother Parysatis saved him from the hands of the executioner by her tears and entreaties. This circumstance did not in the least check the ambition of Cyrus; he was appointed over Lydia and the sea-coasts, where he secretly fomented rebellion and levied troops under various pretences. At last he took the field with an army of 100,000 barbarians, and 13,000 Greeks under the command of Clearchus. Artaxerxes met him with 900,000 men near Cunaxa. The battle was long and bloody; and Cyrus might have perhaps obtained the victory, had not his uncommon rashness proved his ruin. It is said that the two royal brothers met in person, and their engagement ended in the death of Cyrus, 401 years before the Augustan age. Artaxerxes was so anxious of its being universally reported that his brother had fallen by his hand, that he put to death two of his subjects for boasting that they had killed Cyrus. The Greeks, who were engaged in the expedition, obtained much glory in the battle; and after the death of Cyrus they remained victorious in the field without a commander. They were not discouraged though at the distance of above 600 leagues from their country, and surrounded on every side by a powerful enemy. They unanimously united in the election of commanders, and traversed all Asia, in spite of the continual attacks of the Persians; and nothing is more truly celebrated in ancient history than the bold retreat of the ten thousand. The journey that they made from the time of their first embarkation till their return, has been calculated at 1155 leagues, performed in the space of 15 months, including all the time which was devoted to take rest and refreshment. This retreat has been celebrated by Xenophon, who was one of their leaders, and among the friends and supporters of Cyrus.

CYST, the bag or tunic including all encysted tumors, as the scirrhus, atheroma, steatoma, meliceres, &c.

CYSTIC, in *Anatomy*, a name given to two arteries and two veins.

Cystic Duct. See ANATOMY *Index*.

CYTHERA, *-orum*, in *Ancient Geography*, an island opposite to Mallea, a promontory, and to Boiæ a town of Laconia. The island was sacred to Venus, with a very ancient temple of that goddess exhibited in armour at Cythera, as in Cyprus. It is now called Cerigo, and forms one of the seven Ionian islands. See IONIAN ISLANDS, SUPPLEMENT.

CYTHEREA, in *Mythology*, the surname of Venus, so called from Cythera an island, where she had a temple esteemed the most ancient in Greece, and on the shores of which she was believed to be borne by the Zephyrs, surrounded by the Loves, the Tritons, and Nereides, reclining in a languishing posture in a seashell. They give the name of Cytheriades to the Graces which attended her on the shore without quitting her, except on those occasions when she rather chose to be waited upon by the Pleasures.

CYTINUS, a genus of plants belonging to the gynandria class; and in the natural method ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

CYTISUS, TREE TREFOIL, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, *Papilionaceæ*. See BOTANY *Index*.

CYZICENS, CYZICENA, among the ancient Greeks, were a sort of magnificent banqueting houses, always looking toward the north, and usually opening upon gardens.

They had their name from Cyzicus, a city very considerable for the grandeur of its buildings; situated in an island of Mysia, bearing the same name.

CYZICUM, or CYZICUS, in *Ancient Geography*, one of the noblest cities of the hither Asia; situated in a cognominal island of the Propontis, on the coast of Mysia; joined to the continent by two bridges (Strabo); the first by Alexander; the city, a colony of the Milesians (Pliny). Rendered famous by the siege of Mithridates, which was raised by Lucullus.—The inhabitants were made a free people by the Romans, but forfeited their freedom under Tiberius. It was adorned with a citadel and walls round it; had a port and marble towers; and three magazines, one for arms, another for warlike engines, and a third for corn. Cyziceni, the people; noted by the ancients for their timidity and effeminacy: hence the proverb in Zenodotus and others, *Tinctura Cyzenica*, applied to persons guilty of an indecency through fear; but *Stateres Cyziceni, nummi Cyziceni*, denote things executed to perfection.

CZACKTHURN, a strong town of Germany, in Austria, and near the frontiers of Hungary. It is seated between the rivers Drave and Muhir, in E. Long. 17. 19. N. Lat. 46. 24.

CZAR, a title of honour, assumed by the grand dukes, or, as they are now styled, emperors of Russia.

The natives pronounce it *tzar*, or *zaar*; and this, by corruption (it has been fancied), from *Cæsar*, "emperor," from some imagined relation to the Roman emperors. But this etymology does not seem correct. When the czar Peter formerly required of the European courts an acknowledgement of his imperial titles, and that the appellation of *Emperor* should never be omitted, there was great difficulty made about it, especially at the court of Vienna; which occasioned him to produce the famous letter, written in the German tongue, from Maximilian I. emperor of Germany, to Vassili Ivanovitch, confirming a treaty of alliance offensive and defensive against Sigismund king of Poland. In this dispatch, which is dated August the 4th, 1514, and is ratified with the seal of the golden bull, Maximilian addresses Vassili by calling him *Kayser* and *Herrscher aller Russen*, "emperor and ruler of all the Russias." But independently of this document, there could be no doubt that the foreign courts, in their intercourse with that of Moscow, styled the sovereigns indiscriminately *Great Duke*, *Czar*, and *Emperor*. With respect to England in particular, it is certain that in Chancellor's Account of Russia, so early as the middle of the 16th century, Ivan Vassilievitch II. is called *Lord and Emperor of all Russia*; and in the English dispatches, from the reign of Elizabeth to that of Anne, he is generally addressed under the same appellation. When the European powers, however, styled the czar *Emperor of Muscovy*, they by no means intended to give him a title similar to that which was peculiar to the emperor of Germany; but they bestowed upon him that appellation as upon an Asiatic sovereign, in the same manner as we now say the emperors of China and Japan. When Peter, therefore, determined to assume the title of emperor, he found no difficulty in proving that it had been conferred upon his predecessors by most of the European powers; yet when he was desirous of affixing to the term the European sense, it was considered as an innovation, and was productive of more negotiations than would have been requisite for the termination of the most important state affair. At the same time it occasioned a curious controversy among the learned, concerning the rise and progress of the titles by which the monarchs of this country have been distinguished. From their researches it appeared, that the early sovereigns of Russia were called great dukes, and that Vassili Ivanovitch was probably the first who styled himself *tzar*, an expression which in the Sclavonian language signifies *king*; and that his successors continued to bear within their own dominions that title as the most honourable appellation, until Peter the Great first took that of *Povelitel*, or emperor. After many delays and objections, the principal courts of Europe consented, about the year 1722, to address the sovereign of Russia with the title of Emperor; without prejudice, nevertheless, to the other crowned heads of Europe.

CZASLAU, a town of Bohemia, and capital of a circle of the same name. The principal church has the highest tower in Bohemia; and near this place the king of Prussia gained a victory over the Austrians in 1742. It is seated on the river Crudenka, in E. Long. 15. 33. N. Lat. 49. 50.

CZENSTOKOW, a town of Russian Poland in the palatinate of Cracovia, with a fort, in which they keep a rich treasure called "the treasure of the Virgin Mary." The pilgrims flock hither so much for the sake of a convent near it, that it is called the *Loretto* of Poland. The town is situated on the river Warte. E. Long. 19. 15. N. Lat. 50. 48.

CZERNIC, a town of Carniola, in Austria, situated in E. Long. 15. 0. N. Lat. 46. 12. It is remarkable for its lake; for a particular description of which see the article CIRCHNITZER.

CZERNIKOU, a considerable town of Muscovy, and capital of a duchy of the same name, with a castle. It is seated on the river Dezna, in E. Long. 32. 13. N. Lat. 51. 20.

CZONGRODT, a town of Upper Hungary, and capital of a territory of the same name, at the confluence of the rivers Teisse and Keres. E. Long. 20. 57. N. Lat. 46. 50.

D

D, THE fourth letter of the alphabet, and the third consonant.

Grammarians generally reckon D among the lingual letters, as supposing the tongue to have the principal share in the pronunciation thereof; though the Abbot de Dangeau seems to have reason in making it a palate letter. The letter D is the fourth in the Hebrew, Chaldee, Samaritan, Syriac, Greek, and Latin alphabets; in the five first of which languages it has the same name, though somewhat differently spoke, e. g. in Hebrew, Samaritan, and Chaldee, *Daleth*, in Syriac *Doleth*, and in Greek *Delta*.

The form of our D is the same with that of the Latins, as appears from all the ancient medals and inscriptions, and the Latin D is no other than the Greek Δ, rounded a little, by making it quicker and at two strokes. The Δ of the Greeks, again, is borrowed from the ancient character of the Hebrew *Daleth*: which form it still retains, as is shown by the Jesuit Souciet, in his dissertation on the Samaritan Medals.

D is also a numerical letter, signifying *five hundred*, which arises hence, that in the Gothic characters, the D is half the M, which signifies a *thousand*, hence the verse,

Litera D *velut* A *quingentos significabit.*

A dash added a-top D̄, denotes it to stand for *five thousand.*

Used as an abbreviation, it has various significations: thus D stands for Doctor; as, M. D. for Doctor of Medicine; D. T. Doctor of Theology; D. D. implies Doctor of Divinity, or "dono dedit;" D. D. D. is used for "dat, dicat, dedicat; and D. D. D. D. for "dignum Deo donum dedit."

DAB, the English name of a species of PLEURONECTES. See ICHTHYOLOGY *Index*.

DABUL, a town of Asia, in the East Indies, on the coast of Malabar, and to the south of the gulf of Cambaye, on a navigable river. It was formerly very flourishing, but is now much decayed. It belongs to the Mahrattas, and its trade consists principally in pepper and salt. E. Long. 72. 50. N. Lat. 17. 30.

DACCA, a town of Asia, in the kingdom of Bengal in the East Indies, situated in E. Long. 90. 10. N. Lat. 23. 45.—The advantages of the situation of this place, and the fertility of the soil round it, long since made it the centre of an extensive commerce. The courts of Delhi and Muxadavad were furnished from thence with the cottons wanted for their own consumption; and it was formerly the custom of each to maintain an agent on the spot to superintend the manufacture, who had an authority, independent of the magistrate, over the brokers, weavers, embroiderers, and all of the workmen whose business had any relation to the object of his commission. These unhappy people are forbidden, under pecuniary and corporeal penalties, to sell, to any person whatever, a piece exceeding the value of three guineas. Dacca was for eighty years the capital of Bengal.

In this, as in all the other markets, the Europeans treat with the Moorish brokers settled upon the spot, and appointed by the government. They likewise lend their name to the individuals of their own nation, as well as to Indians and Armenians living in their settlements, who, without this precaution, would infallibly be plundered. The Moors themselves, in their private transactions, sometimes avail themselves of the same pretence, that they may pay only two, instead of five per cent. A distinction is observed, in their contracts, between the cottons that are bespoke and those which the weaver ventures, in some places, to manufacture on his own account. The length, the number of threads, and the price, of the former are fixed: nothing further than the commission for the latter is stipulated, because it is impossible to enter into the same detail. These nations that make a point of having fine goods, take proper measures that they may be enabled to advance money to their workmen at the beginning of the year. The weavers, who in general have but little employment at that time, perform their work with less hurry than in the months of October, November, and December, when the demand is pressing.

Some of the cottons are delivered unbleached, and others half bleached. It were to be wished that this custom might be altered. It is very common to see cottons that look very beautiful go off in the bleaching. Perhaps the manufacturers and brokers foresee how they will turn out; but the Europeans have not so exquisite a touch, nor such an experienced eye, to discern this. It is a circumstance peculiar to India, that cottons, of what kind soever they are, can never be well bleached and prepared but in the place where they are manufactured. If they have the misfortune to get damage before they are shipped for Europe, they must be sent back to the places from whence they came.

DACE, a species of CYPRINUS. See ICHTHYOLOGY *Index*.

This fish is extremely common in our rivers, and gives the expert angler great diversion. The dace will bite at any fly; but he is more than ordinarily fond of the stone caddis, or May fly, which is plentiful in the latter end of April and the whole month of May. Great quantities of these may be gathered among the reeds or sedges by the water-side, and on the hawthorn bushes near the waters. These are a large and handsome bait; but as they only last a small part of the year in season, recourse is to be had to the ant-fly. Of these the black ones found in large mole-hills or ant-hills are the best. These may be kept alive a long time in a bottle, with a little of the earth of the hill, and some roots of grass; and they are in season throughout the months of June, July, August, and September. The best season of all is when they swarm, which is in the end of July or beginning of August; and they may be kept many months in a vessel washed out with a solution of honey and water, even longer than with the earth and grass-roots in the vial; though that is the most convenient method with a small parcel taken for one day's fishing. In warm weather this fish very seldom refuses a fly at the top of the water; but at other times he must have the bait sunk to within three inches of the bottom. The winter fishing for dace requires a very different bait: this is a white maggot with a reddish head, which is the produce of the eggs of the beetle, and is turned up with the plough in great abundance. A parcel of these put in any vessel, with the earth they were taken in, will keep many months, and are an excellent bait. Small dace may be put into a glass jar with fresh water; and there preserved alive for a long time, if the water is properly changed. They have been observed to eat nothing but the animalcula of the water. They will grow very tame by degrees.

DACHAW, a town of Bavaria in Germany. It is pretty large, well built, and seated on a mountain, near the river Amber, 10 miles N. W. of Munich. Here the elector has a palace and fine gardens. E. Long. 11. 30. N. Lat. 48. 20.

DACIA, in *Ancient Geography*, a country which Trajan, who reduced it to a province, joined to Mœsia by an admirable bridge. This country lies extended between the Danube and Carpathian mountains, from the river Tibiscus, quite to the north bend of the Danube; so as to extend thence in a direct line to the mouth of the Danbe and to the Euxine; on the north side, next the Carpates, terminated by the river Hierasus, now the Pruth; on the west by the Tibiscus or Teiss; comprising a part of Upper Hungary, all Transylvania and Wallachia, and a part of Moldavia. *Daci*, the people; a name which Strabo takes to be the same with the *Davi* of comedies; neighbours, on the west, to the *Getæ*, an appellation common also in comedies. Josephus mentions a set of religious men among the Daci, whom he calls *Plisti*, and compares with the Esseni: of these Plisti no other author makes any mention. *Dacicus*, the epithet assumed by some emperors (Juvenal). There was a Dacia Aureliana, a part of Illyricum, which was divided into the eastern and western; Sirmium being the capital of the latter, and Sardica of the former. But this belongs to the lower age.

DACIER, ANDREW, born at Castres in Upper Languedoc, 1651, had a great genius and inclination for learning, and studied at Saumur under Tannegui le Fevre, then engaged in the instruction of his daughter, who proved afterwards an honour to her sex. This gave rise to that mutual tenderness which a marriage of 40 years could never weaken in them. The duke of Montausier hearing of his merit, put him in the list of commentators for the use of the Dauphin, and engaged him in an edition of Pompeius Festus, which he published in 1681. His edition of Horace, printed at Paris in 10 vols. 12mo, and his other works, raised him a great reputation. He was made a member of the academy of inscriptions in 1695. When the history of Louis XIV. by medals was finished, he was chosen to present it to his majesty; who being informed of the pains which he had taken in it, settled upon him a pension of 2000 livres, and appointed him keeper of the books of the king's closet in the Louvre. When that post was united to that of library-keeper to the king, he was not only continued in the privilege of his place during life, but the survivance was granted to his wife; a favour of which there had been no instance before. But the death of Madame Dacier in 1720, rendered this grant, which was so honourable to her, ineffectual. He died September 18. 1722, of an ulcer in the throat. In his manners, sentiments, and the whole of his conduct, he was a complete model of that ancient philosophy of which he was so great an admirer, and which he improved by the rules and principles of Christianity.

DACIER, *Anne*, daughter of Tannegui le Fevre, professor of Greek at Saumur in France. She early showed a fine genius, which her father cultivated with great care and satisfaction. After her father's death she went to Paris, whither her fame had already reached; she was then preparing an edition of Callimachus, which she published in 1674. Having shown some sheets of it to Mr Huet, preceptor to the dauphin, and to several other men of learning at the court, the work was so highly admired, that the duke of Montausier made a proposal to her of publishing several Latin authors for the use of the dauphin. She rejected this proposal at first, as a task to which she was not equal.—But the duke insisted upon it; so that at last he gained her consent; upon which she undertook an edition of Florus, published in 1674. Her reputation being now spread over all Europe, Christina, queen of Sweden, ordered Count Konigsmark to make her a compliment in her name: upon which Mademoiselle le Fevre sent the queen a Latin letter with her edition of Florus; to which her majesty wrote an obliging answer, and not long after sent her another letter, to persuade her to abandon the Protestant religion, and made her considerable offers to settle at her court. In 1683 she married Mr Dacier; and soon after declared her design to the duke of Montausier and the bishop of Meaux of reconciling herself to the church of Rome, which she had entertained for some time: but as Mr Dacier was not yet convinced of the reasonableness of such a change, they retired to Castres in 1684, where they had a small estate, in order to examine the points of controversy between the Protestants and the Roman Catholics. They at last determined in favour of the latter, and made the public abjuration in 1685. After this, the king gave both husband and wife marks of of his favour. In 1693, she applied herself to the education of her son and daughter, who made a prodigious progress: the son died in 1694, and the daughter became a nun in the abbey of Longchamp. She had another daughter, who had united in her all the virtues and accomplishments that could adorn the sex; but she died at 18. Her mother has immortalized her memory in the preface to her translation of the Iliad. Madame Dacier was in a very infirm state of health the two last years of her life; and died, after a very painful sickness, August 17. 1720, aged 69. She was remarkable for her firmness, generosity, equality of temper, and piety.

DACTYL, (*dactylus*), a foot in the Latin and Greek poetry, consisting of a long syllable, followed by two short ones; as *cārmĭnĕ*.

Some say it is derived from δακτυλος, "a finger," because it is divided into three joints, the first of which is longer than the other two.

The dactyl is said to have been the invention of Dionysius or Bacchus, who delivered oracles in this measure at Delphos, before Apollo. The Greeks call it πολιτικος. The dactyl and spondee are the most considerable of the poetical feet; as being the measures used in heroic verse by Homer, Virgil, &c. These two are of equal time, but not equal motion. The spondee has an even, strong, and steady pace, like a trot: the dactyl resembles the nimbler strokes of a gallop.

DACTYLI IDÆI; the *Fingers of Mount Ida*. Concerning these, Pagan theology and fable give very different accounts. The Cretans paid divine worship to them, as those who had nursed and brought up the god Jupiter; whence it appears that they were the same as the Corybantes and Curetes. Nevertheless Strabo makes them different; and says, that the tradition in Phrygia was, that "the Curetes and Corybantes were descended from the Dactyli Idæi: that there were originally an hundred men in the island, who were called *Dactyli Idæi*; from whom sprang nine Curetes, and each of these nine produced ten men, as many as the fingers of a man's two hands; and that this gave the name to the ancestors of the Dactyli Idæi." He relates another opinion, which is, that there were but five Dactyli Idæi; who, according to Sophocles, were the inventors of iron: that these five brothers had five sisters, and that from this number they took the name of *Fingers of Mount Ida*, because they were in number ten: and that they worked at the foot of this mountain. Diodorus Siculus reports the matter a little differently. He says, "the first inhabitants of the island of Crete were the Dactyli Idæi, who had their residence on Mount Ida: that some said they were an hundred; others only five in number, equal to the fingers of a man's hand, whence they had the name of *Dactyli*: that they were magicians, and addicted to mystical ceremonies: that Orpheus was their disciple, and carried their mysteries into Greece: that the Dactyli invented the use of iron and fire, and that they had been recompensed with divine honours."

Diomedes the grammarian says, the Dactyli Idæi were priests of the goddess Cybele: called *Idæi*, because that goddess was chiefly worshipped on Mount Ida in Phrygia; and *Dactyli*, because that, to prevent Saturn from hearing the cries of infant Jupiter, whom Cybele had committed to their custody, they used to sing certain verses of their own invention, in the Dactylic measure. See CURETES and CORYBANTES.

DACTYLIC, something that has a relation to dactyls.

Anciently there were dactylic as well as spondaic flutes, *tibiæ dactylicæ*. The dactylic flutes consisted of unequal intervals; as the dactylic foot does of unequal measures.

DACTYLIC Verses are hexameter verses, ending in a dactyl instead of a spondee; as spondaic verses are those which have a spondee in the fifth foot instead of a dactyl.

An instance of a dactylic verse we have in Virgil;

> *Bis patriæ cecidere manus; quin protinus omnia*
> *Perlegerent oculis.*——ÆN. vi. 33.

DACTYLIOMANCY, (*Dactyliomantia*), a sort of divination performed by means of a ring. The word is composed of the Greek δακτυλιος, "ring," of δακτυλος, "a finger," and μαντεια, "divination."

Dactyliomancy consisted principally in holding a ring, suspended by a fine thread, over a round table, on the edge whereof were made divers marks with the twenty-four letters of the alphabet. The ring in shaking, or vibrating over the table, stopped over certain of the letters, which, being joined together, composed the answer required. But the operation was preceded and accompanied by several superstitious ceremonies: for first the ring was to be consecrated with a great deal of mystery; the person who held it was to be clad in linen garments to the very shoes; his head was to be shaved all round; and in his hand he was to hold vervain. And before he proceeded, the gods were first to be appeased by a formulary of prayers, &c. Ammianus Marcellinus gives the process at large in his 29th book.

DACTYLIS, COCK'S-FOOT GRASS, a genus of plants belonging to the triandria class; and in the natural method ranking under the 4th order, *Gramina*. See BOTANY *Index*.

DACTYLS, the fruit of the palm-tree, more usually called *dates*.

DACTYLUS, a sort of dance among the ancient Greeks, chiefly performed, Hesychius observes, by the athletæ.

DACTYLUS, a name given by Pliny to a species of PHOLAS. See PHOLAS, CONCHOLOGY *Index*.

DADUCHI, in antiquity, priests of Ceres. That goddess having lost her daughter Proserpine, say mythologists, began to make search for her at the beginning of the night. In order to do this in the dark, she lighted a torch and thus set forth on her travels throughout the world: for which reason it is that she is always seen represented with a lighted torch in her hand. On this account, and in commemoration of this pretended exploit, it became a custom for the priests, at the feasts and sacrifices of this goddess, to run about in the temple, with torches after this manner; one of them took a lighted torch from off the altar, and holding it with his hand, ran with it to a certain part of the temple where he gave it to another, saying to him, *Tibi trado*: this second ran after the like manner to another part of the temple, and gave it to the third, and so of the rest. From this ceremony the priests became denominated *daduchi*, δαδουχοι, *q. d.*

q. d. "torch-bearers;" from δας, "an unctuous resinous wood, as pine, fir," &c. whereof the ancients made torches; and εχω, "I have, I hold."—The Athenians also gave the name *daduchus* to the high-priest of Hercules.

DÆDALA, a mountain and city of Lycia, where Dædalus was buried, according to Pliny.—Also two festivals in Bœotia, so called; one of them observed at Alalcomenos by the Platæans in a large grove, where they exposed in the open air pieces of boiled flesh, and carefully observed whither the crows that came to prey upon them directed their flight. All the trees upon which any of these birds alighted were immediately cut down, and with them statues were made, called *Dædala*, in honour of Dædalus. The other festival was of a more solemn kind. It was celebrated every 60 years by all the cities of Bœotia, as a compensation for the intermission of the smaller festivals, for that number of years, during the exile of the Platæans. Fourteen of the statues called *Dædala* were distributed by lot smong the Platæans, Lebadæans, Coroneans, Orchomenians, Thespians, Thebans, Tanagræans, and Chæroneans, because they had effected a reconciliation among the Platæans, and caused them to be recalled from exile about the time that Thebes was restored by Cassander the son of Antipater. During this festival a woman in the habit of a bridemaid accompanied a statue which was dressed in female garments, on the banks of the Eurotas. This procession was attended to the top of Mount Cithæron by many of the Bœotians, who had places assigned them by lot. Here an altar of square pieces of wood cemented together like stones was erected, and upon it were thrown large quantities of combustible materials. Afterwards a bull was sacrificed to Jupiter, and an ox or heifer to Juno, by every one of the cities of Bœotia, and by the most opulent that attended. The poorer citizens offered small cattle; and all these oblations, together with the Dædala, were thrown into the common heap and set on fire, and totally reduced to ashes. They originated in this: When Juno, after a quarrel with Jupiter, had retired to Eubœa, and refused to return to his bed, the god, anxious for her return, went to consult Cithæron king of Platæa, to find some effectual measure to break her obstinacy. Cithæron advised him to dress a statue in women's apparel, and carry it in a chariot, and publicly to report it was Platæa the daughter of Asopus, whom he was going to marry. The advice was followed; and Juno, informed of her husband's future marriage, repaired in haste to meet the chariot, and was easily united to him, when she discovered the artful measures he made use of to effect a reconciliation.

DÆDALUS, an Athenian, son of Eupalamus, descended from Erichtheus king of Athens. He was the most ingenious artist of his age; and to him we are indebted for the invention of the wedge and many other mechanical instruments, and the sails of ships. He made statues which moved of themselves, and seemed to be endowed with life. Talus his sister's son promised to be as great as himself by the ingenuity of his inventions; and therefore from envy he threw him down from a window and killed him. After the murder of this youth, Dædalus, with his son Icarus, fled from Athens to Crete, where Minos king of the country gave him a cordial reception. Dædalus made a famous labyrinth for Minos, and assisted Pasiphaë the queen to gratify her unnatural passion for a bull. For this action Dædalus incurred the displeasure of Minos, who ordered him to be confined in the labyrinth which he had constructed. Here he made himself wings with feathers and wax, and carefully fitted them to his body and that of his son, who was the companion of his confinement. They took their flight in the air from Crete: but the heat of the sun melted the wax on the wings of Icarus, whose flight was too high, and he fell into that part of the ocean which from him has been called the *Icarian sea*. The father, by a proper management of his wings, alighted at Cumæ, where he built a temple to Apollo, and thence directed his course to Sicily, where he was kindly received by Cocalus, who reigned over part of the country. He left many monuments of his ingenuity in Sicily, which still existed in the age of Diodorus Siculus. He was despatched by Cocalus, who was afraid of the power of Minos, who had declared war against him because he had given an asylum to Dædalus. The flight of Dædalus from Crete with wings is explained by observing that he was the inventor of sails, which in his age might pass at a distance for wings. He lived 1400 years before the Christian era. There were two statuaries of the same name; one of Sicyon, son of Patroclus; the other a native of Bithynia.

DÆMON, (Δαιμων,) a name given by the ancients to certain spirits or genii, which they say appeared to men, either to do them service or to hurt them.

The Greek word δαιμων is derived (according to Plato, in his Cratylus, p. 398, *ed. Serrani*, vol. i.) from δαημων, "knowing or intelligent;" but according to others from δαιομαι, "to distribute," (see the Scholiast on Homer, Il. I. ver. 222.). Either of these derivations agrees with the office ascribed to dæmons by the ancient heathens, as the spirit intrusted with the inspection and government of mankind. For, according to the philosophers, dæmons held a middle rank between the celestial gods, and men on earth, and carried on all intercourse between them; conveying the addresses of men to the gods, and the divine benefits to men. It was the opinion of many, that the celestial divinities did not themselves interpose in human affairs, but committed the entire administration of the government of this lower world to these subaltern deities: *Neque enim pro majestate deum cœlestium fuerit, hæc curare;* (Apuleius *de deo Socratis*, p. 677.). *Cuncta cœlestium voluntate, numine, et authoritate, sed dæmonum obsequio, et opera et ministerio fieri arbitrandum est;* (*Id.* p. 675.). Hence they became the objects of divine worship. "If idols are nothing," says Celsus (*apud Origen. cont. Cels.* lib. viii. p. 393.) "what harm can there be to join in the public festivals? If they are dæmons, then it is certain that they are gods, in whom we are to confide, and to whom we should offer sacrifices and prayers to render them propitious."

Several of the heathen philosophers held that there were different kinds of dæmons; that some of them were spiritual substances of a more noble origin than the human race, and that others had once been men.

But those dæmons who were the more immediate objects of the established worship among the ancient nations

Dæmon. nations were human spirits, such as were believed to become dæmons or deities after their departure from their bodies. Plutarch teaches (*Vit. Romul.* p. 36. *ed. Paris*), "that according to a divine nature and justice, the souls of virtuous men are advanced to the rank of dæmons; and that from dæmons, if they are properly purified, they are exalted into gods, not by any political institution, but according to right reason." The same author says in another place (*de Is. et Osir.* p. 361.), "that Isis and Osiris were, for their virtue, changed from good dæmons into gods, as were Hercules and Bacchus afterwards, receiving the united honours both of gods and dæmons." Hesiod and other poets, who have recorded the ancient history or traditions on which the public faith and worship were founded, assert, that the men of the golden age, who were supposed to be very good, became dæmons after death, and dispensers of good things to mankind.

Though *dæmon* is often used in a general sense as equivalent to a *deity*, and is accordingly applied to *fate* or *fortune*, or whatever else was regarded as a god; yet those dæmons who were the more immediate objects of divine worship amongst the heathens, were human spirits; as is shown in Farmer on Miracles, chap. iii. sect. 2.

The word *dæmon* is used indifferently in a good and a bad sense. In the former sense, it was very commonly used among the ancient heathens. "We must not (says Menander) think any dæmon to be evil, hurtful to a good life, but every god to be good." Nevertheless, those are certainly mistaken who affirm, that *dæmon* never signifies an evil being till after the times of Christ. Pythagoras held dæmons who sent diseases to men and cattle (*Diog. Laert. Vit. Pithagor.* p. 514. *ed. Amstel.*) Zaleucus, in his preface to his Laws (*apud Stobæum*, Serm. 42.) supposes that an evil dæmon might be present with a man, to influence him to injustice. The dæmons of Empedocles were evil spirits, and exiles from heaven; (Plutarch Περι τȣ μηδειν δανειζεσθαι). And in this life of Dion (p. 958.), he says, "It was the opinion of the ancients that evil and mischievous dæmons, out of envy and hatred to good men, oppose whatever they do." Scarce did any opinion more generally prevail in ancient times than this, viz. that as the departed souls of good men became good dæmons, so the departed souls of bad men became evil dæmons.

It has been generally thought, that by *dæmons* we are to understand *devils*, in the Septuagint version of the Old Testament. Others think the word is in that version certainly applied to the ghosts of such dead men as the heathens deified, in Deut. xxxii. 17. Ps. cvi. 37. That *dæmon* often bears the same meaning in the New Testament, and particularly in Acts xvii. 18. 1 Cor. x. 21. 1 Tim. iv. 1. Rev. ix. 13. is shown at large by Mr Joseph Mede (Works, p. 623, *et seq.*). That the word is applied *always* to human spirits in the New Testament, Mr Farmer has attempted to show in his Essay on dæmoniacs, p. 208, *et seq.* As to the meaning of the word *dæmon* in the fathers of the Christian church, it is used by them in the same sense as it was by the heathen philosophers, especially the latter Platonists; that is, sometimes for departed human spirits, and at other times for such spirits as had never inhabited human bodies. In the fathers, indeed, the word is more commonly taken in an evil sense, than in the ancient philosophers. Besides the two forementioned kinds of dæmons, the fathers, as well as the ancient philosophers, held a third, viz. such as sprang from the congress of superior beings with the daughters of men. In the theology of the fathers, these were the worst kind of dæmons.

Dæmon, Dæmoniac.

Different orders of dæmons had different stations and employments assigned them by the ancients. Good dæmons were considered as the authors of good to mankind; evil dæmons brought innumerable evils both upon men and beasts. Amongst evil dæmons there was a great distinction with respect to the offices assigned them; some compelled men to wickedness, others stimulated them to madness. See DÆMONIAC.

Much has been said concerning the dæmon of Socrates. He pretended to his friends and disciples, and even declared to the world, that a friendly spirit, whom he called his *dæmon*, directed him how to act on every important occasion in his life, and restrained him from imprudence of conduct.

In contemplating the character of this great philosopher, while we admire him as the noblest pattern of virtue and moral wisdom that appeared in the heathen world, we are naturally led to inquire, whether what he gave out concerning his dæmon were a trick of imposture, or the reverie of a heated imagination, or a sober and true account of a favour which heaven deigned to confer on so extraordinary a man.

To ascertain in this case the object of our inquiries, is by no means so easy as the superficial thinker may be apt to imagine. When we consider the dignity of sentiment and simplicity of manners which Socrates displayed through the general tenor of his life, we cannot readily bring ourselves to think that he could be capable of such a trick of imposture. Nothing of the wildness of an enthusiast appears in his character; the modesty of his pretensions, and the respect which in his conversation and conduct he uniformly testified for the ordinary duties of social life, sufficiently prove that he was free from the influence of blind enthusiasm: we cannot infer, therefore, that, like the astronomer in Raselas, he was deceived with respect to his dæmon by an overheated imagination. It is no less difficult to believe, that God would distinguish a heathen in so eminent a manner, and yet leave him uninstructed in the principles of true religion. Surely, if ever scepticism be reasonable, it must be in such matters as the present.

Yet, if it be still insisted, that some one of these three notions concerning the dæmon of Socrates must be more probable than the others; we would rather esteem Socrates an enthusiast in this instance, than degrade him to the base character of an impostor, or suppose that a spiritual being actually revealed himself to the philosopher, and condescended to become his constant attendant and counsellor. People are often under the influence of an overheated imagination with regard to some one thing, and cool and sober as to every thing else.

DÆMONIAC (from *dæmon*), a human being whose volition and other mental faculties are overpowered and restrained, and his body possessed and actuated by some created spiritual being of superior power. 1 Definition.

Such seems to be the determinate sense of the word;
but

but it is disputed whether any of mankind ever were in this unfortunate condition.

2 Dispute concerning dæmoniacs.

It is generally agreed, that neither good nor evil spirits are known to exert such authority at present over the human race: but in the ancient heathen world, and among the Jews, particularly in the days of our Saviour, evil spirits at least are thought by many to have been more troublesome.

3 Notions of the Greeks and Romans concerning possession.

The Greeks and Romans imagined that their deities, to reveal future events, frequently entered into the prophet or prophetess who was consulted, overpowered their faculties, and uttered responses with their organs of speech. Apollo was believed to enter into the Pythoness, and to dictate the prophetic answers received by those who consulted her. Other oracles besides that of Delphi were supposed to unfold futurity by the same machinery. And in various other cases either malignant dæmons or benevolent deities were thought to enter into and to actuate human affairs. The *Lymphatici*, the *Cerriti*, the *Larvati*, of the Romans, were all of this description; and the Greeks, by the use of the word δαιμονιζομενοι, show that they referred to this cause the origin of madness. Among the ancient heathens, therefore, it appears to have been a generally received opinion, that superior beings entered occasionally into men, overpowered the faculties of their minds, and actuated their bodily organs. They might imagine that this happened in instances in which the effects were owing to the operation of different causes; but an opinion so generally prevalent had surely some plausible foundation.

4 Of the Jews.

The Jews, too, if we may trust the sacred writings and Josephus, appear to have believed in dæmoniacal possession. The case of Saul may be recollected as one among many in which superior created beings were believed by the Jews to exert in this manner their influence over human life. The general tenor of their history and language, and their doctrines concerning good and evil spirits, prove the opinion of dæmoniacal possession to have been well known and generally received among them.

5 Of mankind in general in the days of our Saviour.

In the days of our Saviour, it would appear that dæmoniacal possession was very frequent among the Jews and the neighbouring nations. Many were the evil spirits whom Jesus is related in the gospels to have ejected from patients that were brought unto him as possessed and tormented by those malevolent dæmons. His apostles too, and the first Christians, who were most active and successful in the propagation of Christianity, appear to have often exerted the miraculous powers with which they were endowed on similar occasions. The dæmons displayed a degree of knowledge and malevolence which sufficiently distinguished them from human beings: and the language in which the dæmoniacs are mentioned, and the actions and sentiments ascribed to them in the New Testament, show that our Saviour and his apostles did not consider the idea of dæmoniacal possession as being merely a vulgar error concerning the origin of a disease or diseases produced by natural causes.

The more enlightened cannot always avoid the use of metaphorical modes of expression; which, though founded upon error, have yet been so established in language by the influence of custom, that they cannot be suddenly dismissed. When we read in the book of Joshua, that the sun on a certain occasion stood still, to allow that hero time to complete a victory; we easily find an excuse for the conduct of the sacred historian, in accommodating his narrative to the popular ideas of the Jews concerning the relative motions of the heavenly bodies. In all similar instances, we do not complain much of the use of a single phrase, originally introduced by the prevalence of some groundless opinion, the falsity of which is well known to the writer.

But in descriptions of characters, in the narration of facts, and in the laying down of systems of doctrine, we require different rules to be observed. Should any person, in compliance with popular opinions, talk in serious language of the existence, dispositions, declarations, and actions of a race of beings whom he knew to be absolutely fabulous, we surely could not praise him for candid integrity: we must suppose him to be either exulting in irony over the weak credulity of those around him, or taking advantage of their weakness, with the dishonest and the selfish views of an impostor. And if he himself should pretend to any connexion with this imaginary system of beings, and should claim, in consequence of his connexion with them, particular honours from his contemporaries; whatever might be the dignity of his character in all other respects, nobody could hesitate even for a moment to brand him as an impostor of the basest character.

6 Jesus Christ and his apostles must have believed dæmoniacal possession to be real.

Precisely in this light must we regard the conduct of our Saviour and his apostles, if the ideas of dæmoniacal possession were to be considered merely as a vulgar error. They talked and acted as if they believed that evil spirits had actually entered into those who were brought to them as possessed with devils, and as if those spirits were actually expelled by their authority out of the unhappy persons whom they had possessed. They expected, they demanded too, to have their profession and declarations believed, in consequence of their performing such mighty works, and to be honoured as having thus triumphed over the powers of hell. The reality of dæmoniacal possession stands upon the same evidence with the gospel system in general.

7 Reasonableness of this doctrine.

Neither is there any thing absurd or unreasonable in this doctrine. It does not appear to contradict those ideas which the general appearance of nature and the series of events suggest concerning the benevolence and wisdom of the Deity, and the councils by which he regulates the affairs of the universe. We often fancy ourselves able to comprehend things to which our understanding is wholly inadequate: we persuade ourselves, at times, that the whole extent of the works of the Deity must be well known to us, and that his designs must always be such as we can fathom. We are then ready, whenever any difficulty arises to us, in considering the conduct of Providence, to model things according to our own ideas; to deny that the Deity can possibly be the author of things which we cannot reconcile; and to assert, that he must act on every occasion in a manner consistent with our narrow views. This is the pride of reason; and it seems to have suggested the strongest objections that have been at any time urged against the reality of dæmoniacal possession. But the Deity may surely connect one order of his

his creatures with another. We perceive mutual relations and a beautiful connexion to prevail through all that part of nature which falls within the sphere of our observation. The inferior animals are connected with mankind, and subjected to their authority, not only in instances in which it is exerted for their advantage, but even where it is tyrannically abused to their destruction. Among the evils to which mankind have been subjected, why might not their being liable to dæmoniacal possession be one? While the Supreme Being retains the sovereignty of the universe, he may employ whatever agents he thinks proper in the execution of his purposes; he may either commission an angel or let loose a devil; as well as bend the human will, or communicate any particular impulse to matter.

All that revelation makes known, all that human reason can conjecture, concerning the existence of various orders of spiritual beings, good and bad, is perfectly consistent with, and even favourable to, the doctrine of dæmoniacal possession. It was generally believed through the ancient heathen world; it was equally well known to the Jews, and equally respected by them; it is mentioned in the New Testament in such language, and such narratives are related concerning it, that the gospels cannot well be regarded in any other light than as pieces of imposture, and Jesus Christ must be considered as a man who dishonestly took advantage of the weakness and ignorance of his contemporaries, if this doctrine be nothing but a vulgar error: it teaches nothing inconsistent with the general conduct of Providence; it is not the caution of philosophy, but the pride of reason, that suggests objections against this doctrine.

8
Arguments of the Antidæmonists.

Those, again, who are unwilling to allow that angels or devils have ever intermeddled so much with the concerns of human life, urge a number of specious arguments in opposition to these.

9
The cases in which the Greeks and Romans supposed dæmoniacal possession, were only instances of madness, &c.

The Greeks and Romans of old, say they, did believe in the reality of dæmoniacal possession. They supposed that spiritual beings did at times enter into the sons or daughters of men, and distinguish themselves in that situation by capricious freaks, deeds of wanton mischief, or prophetic enunciations. But in the instances in which they supposed this to happen, it is evident that no such thing took place. Their accounts of the state and conduct of those persons whom they believed to be possessed in this supernatural manner, show plainly that what they ascribed to the influence of dæmons were merely the effects of natural diseases. Whatever they relate concerning the *larvati*, the *cerriti*, and the *lymphatici*, shews that these were merely people disordered in mind, in the same unfortunate situation with those madmen and idiots and melancholy persons whom we have among ourselves. Festus describes the *Larvati* as being *furiosi et mente moti.* Horace says,

> *Hellade percussa, Marius cum præcipitat se,*
> *Cerritus fuit?*

10
The same is true of the dæmoniacs of the New Testament.

Plato, in his *Timæus*, says ουδεις γαρ εννους εφαπτεται μαντικης ενθιουκ, αληθους. Lucian describes dæmoniacs as lunatic, and as staring with their eyes, foaming at the mouth, and being speechless.

It appears still more evidently, that all the persons spoken of as possessed with devils in the New Testament, were either mad or epileptic, and precisely in the same condition with the madmen and epileptics of modern times. The Jews, among other reproaches which they threw out against our Saviour, said, *He hath a devil, and is mad: why hear ye him?* The expressions, *he hath a devil*, and *is mad*, were certainly used on this occasion as synonymous. With all their virulence, they would not surely ascribe to him at once two things that were inconsistent and contradictory. Those who thought more favourably of the character of Jesus, asserted concerning his discourses, in reply to his adversaries, *These are not the words of him that hath a dæmon;* meaning, no doubt, that he spoke in a more rational manner than a madman could be expected to speak. The Jews appear to have ascribed to the influence of dæmons, not only that species of madness in which the patient is *raving and furious*, but also *melancholy* madness. Of John, who secluded himself from intercourse with the world, and was distinguished for abstinence and acts of mortification, they said, *He hath a dæmon.* The youth, whose father applied to Jesus to free him from an evil spirit, describing his unhappy condition in these words, *Have mercy on my son, for he is lunatic and sore vexed with a dæmon; for oft times he falleth into the fire, and oft into the water*, was plainly epileptic. Every thing indeed that is related in the New Testament concerning dæmoniacs, proves that they were people affected with such natural diseases as are far from being uncommon among mankind in the present age. When the symptoms of the disorders cured by our Saviour and his apostles as cases of dæmoniacal possession, correspond so exactly with those of diseases well known as natural in the present age, it would be absurd to impute them to a supernatural cause. It is much more consistent with common sense and sound philosophy to suppose, that our Saviour and his apostles wisely, and with that condescension to the weakness and prejudices of those with whom they conversed, which so eminently distinguished the character of the Author of our holy religion, and must always be a prominent feature in the character of the true Christian, adopted the vulgar language in speaking of those unfortunate persons who were groundlessly imagined to be possessed with dæmons, though they well knew the notions which had given rise to such modes of expression to be ill-founded; than to imagine that diseases, which arise at present from natural causes, were produced in days of old by the intervention of dæmons, or that evil spirits still continue to enter into mankind in all cases of madness, melancholy, or epilepsy.

Besides, it is by no means a sufficient reason for receiving any doctrine as true, that it has been generally received through the world. Error, like an epidemical disease, is communicated from one to another. In certain circumstances, too, the influence of imagination predominates, and restrains the exertions of reason. Many false opinions have extended their influence through a very wide circle, and maintained it long. On every such occasion as the present, therefore, it becomes us to inquire, not so much how generally any opinion has been received, or how long it has prevailed, as from what causes it has originated, and on what evidence it rests.

11 Inference from the analogy of nature.

When we contemplate the frame of nature, we behold a grand and beautiful simplicity prevailing through the whole: Notwithstanding its immense extent, and though it contains such numberless diversities of being; yet the simplest machine constructed by human art does not display easier simplicity, or an happier connection of parts. We may therefore venture to draw an inference, by analogy, from what is observable of the order of nature in general to the present case. To permit evil spirits to intermeddle with the concerns of human life, would be to break through that order which the Deity appears to have established through his works; it would be to introduce a degree of confusion unworthy of the wisdom of Divine Providence.

Such are the most rational arguments that have been urged on both sides in this controversy. Perhaps the dæmonianists have the stronger probabilities on their side; but we will not presume to take upon ourselves the office of arbitrators in the dispute.

DÆMONIACS, in church history, a branch of the Anabaptists; whose distinguishing tenet is, that the devils shall be saved at the end of the world.

DAFFODIL. See NARCISSUS, BOTANY *Index*.

DAGELET, an island on the coast of Corea, discovered by La Perouse in the year 1787. It is about three leagues in circumference, and is encircled with steep rocks, excepting a few sandy creeks, which form convenient landing-places. The island is covered with fine trees; and at the time the French navigator visited it, some boats were found on the stocks of a Chinese construction. The workmen, who were supposed to be Corean carpenters, were employed upon them, but fled to the woods on the approach of the ships. La Perouse supposes that the island is uninhabited, and that these people go from Corea, and live there only during the summer, for the purpose of building boats. The north-east point of this island is in N. Lat. 33. 15. E. Long. 129. 2. from Paris.

DAGHESTAN, a country of Asia, bounded by Circassia on the north, by the Caspian sea on the east, by Chirvein a province of Persia on the south, and by Georgia on the west. Its chief towns are Tarku and Derbent, both situated on the Caspian sea.

DAGNO, a town of Turkey in Europe, in Albania, with a bishop's see. It is the capital of the district of Ducagini, and is seated on the rivers Drino and Nero, near their confluence. It is 15 miles south-east of Scutari, and 15 north-east of Alessio. E. Long. 19. 48. N. Lat. 42. 0.

DAGO, or DAGHO, an island in the Baltic sea, on the coast of Livonia, between the gulf of Finland and Riga. It is of a triangular figure, and is about 20 miles in circumference. It has nothing considerable but two castles, called *Dagger-wort* and *Paden*. E. Long. 22. 30. N. Lat. 58. 48.

DAGON, the false god of Ashdod*, or as the Greeks call it *Azotus*. He is commonly represented as a monster, half man and half fish; whence most learned men derive his name from the Hebrew *dag*, which signifies "fish." Those who make him to have been the inventor of *bread corn*, derive his name from the Hebrew *Dagon*, which signifies *frumentum*; whence Philo Biblius calls him Ζευς Αροτριος, *Jupiter Aratrius*.

This deity continued to have a temple at Ashdod during all the ages of idolatry to the time of the Maccabees; for the author of the first book of Maccabees tells us, that "Jonathan, one of the Maccabees, having beaten the army of Apollonius, Demetrius's general, they fled to Azotus, and entered into Bethdagon (the temple of their idol): but that Jonathan set fire to Azotus, and burnt the temple of Dagon and all those who had fled into it."

Dagon, according to some, was the same with Jupiter, according to others Saturn, according to others, Venus, and according to most, Neptune.

DAHALAC is the largest island in the Red sea, and is placed by Mr Bruce, who has given a minute description of it, between 15. 27. and 15. 54. N. Lat. It is a low, flat island, with a sandy soil, mixed with shells, and in summer destitute of every kind of herbage, excepting a small quantity of bent grass, which is barely sufficient to feed a few antelopes and goats. In many places the island is covered with extensive plantations of acacia trees, which rarely exceed eight feet in height, spreading wide, and turning flat at top, probably from the influence of the wind, which blows from the sea. No rain falls in Dahalac from the end of March to the beginning of October; but in the intermediate months there are heavy showers, during which the water is collected in a great number of artificial cisterns, to serve the inhabitants during the ensuing summer. Of these cisterns, which are said to be the work of the Persians, or, as some suppose, of the first Ptolemies, 370 yet remain, cut out of the solid rock.

The inhabitants of Dahalac are a simple, fearful, and inoffensive people. It is the only part of Arabia where no one is furnished with arms of any kind. After the rains fall, the grass springs up with great luxuriance, and then the goats give the inhabitants a copious supply of milk, which in winter is the principal part of their subsistence. The poorer sort live entirely on shell and other fish. The sole employment of the inhabitants is to work the vessels which trade to the different parts of the coast. Dahalac contains 12 villages or towns, each of which is surrounded with a plantation of *doom* trees. Of the leaves of this tree, which are of a glossy white when dried, the inhabitants make baskets of great beauty and neatness. This seems to be the only thing like manufacture in the island. Dahalac, as well as the other islands of the Red sea is dependent upon Masuah. Each of the 12 villages furnishes a goat monthly to the governor, and every vessel putting in there for Masuah, pays him a pound of coffee, and every one from Arabia a dollar. These are his principal revenues. In the time of the Ptolemics, the pearl fishery in the vicinity of Dahalac flourished greatly, as well as another valuable fishery, namely that of tortoises.

DAHOMY, or DAUMA, a powerful kingdom of Africa, on the coast of Guinea. Abomy, the modern capital, lies in N. Lat. 7. 59. This kingdom occurs in its true position, in the maps of Sanuto, Plancius, and Mercator, where Dawhee, the ancient capital, is denominated *Dauina*. In 1700, it was erased from the maps of Africa, and the existence of the ancient nation of Dauma denied, till 1727, when it emerged from obscurity, and became known by the conquests of the maritime states of Whidah and Ardra. Between

---

*See 1 *Sam.* chap. v.

Dahomy.

Dauma and Gago the lake Sigesmes, or Guarda, (which extends about 100 leagues from east to west, and 50 from north to south, which lies about 370 miles N. N. E. of Arada, and is represented as the source of various large rivers, which descend into the gulf of Guinea) is placed by Barbot and Snelgrave, who derived their authority from the native traders. It neither occurs in Edrisi nor Leo, though it is found in the maps to Ruscelli's edition of Ptolemy, in 1561. Dahomy is a fertile cultivated country; the soil is a deep rich reddish clay, intermixed with sand, scarcely containing a stone of the size of an egg in the whole country. It is extremely productive of maize, millet, beans, yams, potatoes, cassada, plantain, and the banana; indigo, cotton, tobacco, palm-oil, and sugar, are raised, as well as a species of black pepper. Bread, and a species of liquor, or rather diluted gruel, are formed of the lotus-berry. Animals, both wild and tame, are numerous, and the lakes abound in fish. The maritime districts of Whidah and Ardra, before they were ruined by the Dahomans, were highly cultivated and beautiful.

The character of the Daumanese, or Dahomans, is original and strongly marked; they have retained peculiar manners, and have had little intercourse with either Europeans or Moors. They exhibit the germ of peculiar institutions and modifications of manners, that have appeared incredible to modern nations, when they perused the ancient records of the Egyptians, Hindus, and Lacedæmonians. Like the Lacedæmonians, they display a singular mixture of ferocity and politeness, of generosity and cruelty. Their conduct towards strangers is hospitable, without any mixture of rudeness or insult. Their appearance is manly, and their persons strong and active; and though they are less addicted to the practice of tatowing than their neighbours, their countenance rather displays ferocity than courage. Their government is the purest despotism; every subject is a slave; and every slave implicitly admits the right of the sovereign to dispose of his property and of his person. "I think of my king," said a Dahoman to Mr Norris, "and then I dare engage five of the enemy myself. My head belongs to the king, not to myself: if he pleases to send for it, I am ready to resign it; or if it be shot through in battle, I am satisfied—if it be in his service." This attachment continues unshaken, even when their nearest relations become the victims of the avarice or caprice of the king, and his enormities are always attributed to their own indiscretions. With this devoted spirit, the Dahoman rushes fearless into battle, and fights as long as he can wield his sabre.

The modern history of the Dahomans realizes all that history has recorded of ancient Lacedæmon, and of those Lacedæmonians of the north, the inhabitants of Jomsburgh, who were forbidden to mention the name of *Fear*, even in the most imminent dangers, and who proudly declared that they would fight their enemies, though they were stronger than the gods. Saxo relates, that when Frotho, king of Denmark, was taken prisoner in battle, he obstinately refused to accept of life, declaring, that the restoration of his kingdom and treasures could never restore his honour, but that future ages would always say, *Frotho has been taken by his enemy.*

Dahomy, Daille.

The palace of the king of Dahomy is an extensive building of bamboo and mud-walled huts, surrounded by a mud-wall about 20 feet high, inclosing a quadrangular space of about a mile square. The entrance to the king's apartment is paved with human sculls, the lateral walls adorned with human jaw-bones, with a few bloody heads intermixed at intervals. The whole building resembles a number of farm-yards, with long thatched barns and sheds for cattle, intersected with low mud-walls. On the thatched roofs, numerous human sculls are ranged at intervals, on small wooden stakes. In allusion to these, when the king issues orders for war, he only announces to his general, *that his house wants thatch*. In this palace, or *large house*, as it is termed by the Dahomans, above 3000 females are commonly immured, and about 500 are appropriated by each of the principal officers. From this injurious and detestable practice, originate many flagrant abuses; the population is diminished, the sources of private happiness destroyed, and the best feelings of human nature being outraged, the energies of passion are converted into bitterness and ferocity.

The religion of Dahomy is vague and uncertain in its principles, and rather consists in the performance of some traditionary ceremonies, than in any fixed system of belief, or of moral conduct. They believe more firmly in their amulets and fetiches, than in the deity; their national fetiche is *the Tiger;* and their habitations are decorated with ugly images, tinged with blood, stuck with feathers, besmeared with palm-oil, and bedaubed with eggs. As their ideas of deity do not coincide with those of Europeans, they imagine that their tutelary gods are different. "Perhaps," said a Dahoman chief to Snelgrave, "that god may be yours, who has communicated so many extraordinary things to white men; but as that god has not been pleased to make himself known to us, we must be satisfied with this we worship." The Dahomans manufacture and dye cotton-cloth, and form a species of cloth of palm-leaves. They are tolerably skilful in working in metals. The bards, who celebrate the exploits of the king and his generals, are likewise the historians of the country.

DAILLE, John, a Protestant minister near Paris, was one of the most learned divines of the 17th century, and was the most esteemed by the Catholics of all the controversial writers among the Protestants. He was tutor to two of the grandsons of the illustrious M. Du Plessis Mornai. M. Daille having lived 14 years with so excellent a master, travelled into Italy with his two pupils; one of them died abroad; with the other he saw Italy, Switzerland, Germany, Flanders, Holland, and England, and returned in 1621. He was received minister in 1623, and first exercised his office in the family of M. Du Plessis Mornai; but this did not last long, for that lord died soon after. The memoirs of this great man employed M. Daille the following year. In 1625 he was appointed minister of the church of Saumur, and in 1626 removed to Paris. He spent all the rest of his life in the service of this last church, and composed several works. His first piece was his masterpiece, and an excellent work, Of the Use of the Fathers, printed 1631. It is a strong chain of reasoning, which forms a moral demonstration against those who would have religious disputes decided ed by the authority of the fathers. He died in 1670, aged 77.

DAIRI, or DAIRO, in the history of Japan, is the sovereign pontiff of the Japanese; or, according to Kæmpfer, the hereditary ecclesiastical monarch of Japan. In effect, the empire of Japan is at present under two sovereigns, viz. an ecclesiastical one called the *dairo*, and a secular one who bears the title of *kubo*. The last is the emperor, and the former the oracle of the religion of the country.

DAIRY, in rural affairs, a place appropriated for the management of milk, and the making of butter, cheese, &c. See AGRICULTURE *Index*.

The dairy-house should always be kept in the neatest order, and so situated as that the windows or lattices never front the south, south-east, or south-west. Lattices are also to be preferred to windows, as they admit a more free circulation of the air than glazed lights possibly can do. It has been objected, that they admit cold air in winter and the sun in summer; but the remedy is easily obtained, by making a frame the size of or somewhat larger than the lattice, and constructing it so as to slide backward and forward at pleasure. Packthread strained across this frame, and oiled cap-paper pasted thereon, will admit the light, and keep out the sun and wind.

It is hardly possible in the summer to keep a dairy-house too cool; on which account none should be situated far from a good spring or current of water. They should be neatly paved either with red brick or smooth hard stone; and laid with a proper descent, so that no water may lodge. This pavement should be well washed in the summer every day, and all the utensils belonging to the dairy should be kept perfectly clean. Nor should we ever suffer the churns to be scalded in the dairy, as the steam that arises from hot water will injure the milk. Nor should cheese be kept therein, nor rennet for making cheese, nor a cheese-press be fixed in a dairy, as the whey and curd will diffuse their acidity throughout the room.

The proper receptacles for milk are earthen pans, or wooden vats or trundles; but none of these should be lined with lead, as that mineral certainly contains a poisonous quality, and may in some degree affect the milk: but if people are so obstinate as to persist in using them, they should never forget to scald them, scrub them well with salt and water, and to dry them thoroughly, before they deposit the milk therein. Indeed all the utensils should be cleaned in like manner before they are used; and if after this, they in the least degree smell sour, they must undergo a second scrubbing. See DAIRY, SUPPLEMENT.

DAIS, a genus of plants belonging to the decandria class; and in the natural method ranking under the 31st order, *Vepreculæ*. See BOTANY *Index*.

DAISY. See BELLIS, BOTANY *Index*.

DAKIR, in our statutes, is used for the twentieth part of a last of hides. According to the statute of 51 Hen. III. *De compositione ponderum et mensurarum*, a last of hides consists of twenty dakirs, and every dakir of ten hides. But by 1 Jac. cap. 33. one last of hides or skins is twelve dozen. See DICKER.

DALACA, an island of the Red sea, which is said to be very fertile, populous, and remarkable for a pearl fishery. It is probably the same with DAHALAC, which see.

DALBERGIA, a genus of plants belonging to the diadelphia class. See BOTANY *Index*.

DALEA, a province of Sweden, bounded on the west by Dalecarlia, on the east by the Wermeland and the lake Wener, on the south by Gothland, and on the north by Norway and the sea.

DALEBURG, a town of Sweden, and capital of the province of Dalea, seated on the western bank of the lake Wener, 50 miles north of Gottenburg. E. Long. 13. 0. N. Lat. 59. 0.

DALECARLIA, a province of Sweden, so called from a river of the same name, on which it lies, near Norway. It is divided into six districts, and is about 175 miles in length and 100 in breadth. It contained 124,806 inhabitants in 1811. It is full of mountains, which abound in mines of copper and iron, some of which are of a prodigious depth. Idra is the capital. The inhabitants are rough, robust, and warlike: and all the great revolutions in Sweden had their rise in this province.

DALECHAMP, JAMES, a physician, was born at Caen in Normandy, in 1513. He was distinguished for his industry in botany, as well as in other branches of literature. He wrote notes on Pliny's Natural History, and translated Athenæus into Latin. He added 30 plates of rare plants to the Dioscorides of Ruellius, printed in 1552. After his death appeared his "*Historia generalis Plantarum in* xviii. *libros digesta*," Lugd. 1587, two vols folio. In this work, which is said to have been the labour of 30 years, the author proposed to include all the botanical discoveries previous to his own time, as well as those which he had made himself in the vicinity of Lyons and the Alps. He also published editions of Paulus Ægineta, and Cælius Aurelianus, with notes; a work on surgery, and another *De Peste*, lib. iii.

He practised physic at Lyons from 1552 to 1558, when he died, aged 75.

DALECHAMPIA, a genus of plants belonging to the monœcia class; and in the natural method ranking under the 38th order, *Tricoccæ*. See BOTANY *Index*.

DALEM, a town in the kingdom of the Netherlands, and capital of a district of the same name. It was taken by the French in 1672, who demolished the fortifications. It is seated on the river Bervine, five miles north-east of Liege. E. Long. 5. 43. N. Lat. 50. 40.

D'ALEMBERT. See ALEMBERT.

DALGARNO, GEORGE, an old and unjustly neglected Scottish writer. See SUPPLEMENT.

DALKEITH, a town of Scotland, in Mid-Lothian, six miles south-east of Edinburgh; W. Long. 2. 20. N. Lat. 55. 50. It is the principal residence of the duke of Buccleugh, who has here a noble house and extensive parks. In this house, which at the time was the head quarters of General Monk, the restoration of Charles II. was planned.—The duke's eldest son has the title of Earl of Dalkeith. Here is a considerable corn market weekly on Thursdays. Population 4709 in 1811.

DALMATIA, a province in Europe, bounded on the

the north by Bosnia, on the south by the gulf of Venice, on the east by Servia, and on the west by Morlachia. Spalatro is the capital of that part belonging to the Venetians; and Raguza, of a republic of that name; the Turks have a third, whose capital is Herzegovina. The air is wholesome, and the soil fruitful; and it abounds in wine, corn, and oil.

DALRYMPLE, Sir David, a Scottish lawyer and judge, was born in Edinburgh, on the 28th October new style, 1726. His father was Sir James Dalrymple, of Hailes, Bart. and his mother Lady Christian Hamilton, a daughter of the Earl of Haddington. His grandfather Sir David Dalrymple was the youngest son of the first Lord Stair, and is said to have been the ablest of that family, so much distinguished for ability. He was lord advocate for Scotland, in the reign of George I. and his son, Sir James, had the auditorship of the exchequer for life. Sir David Dalrymple was bred at Eton school, where he was distinguished as a scholar, and remarkable as a virtuous and orderly youth: from thence he went to the university of Utrecht, where he remained till after the rebellion in 1746. He was called to the bar at Edinburgh, 23d February 1748; where he was much admired for the elegant propriety of the cases he drew. He did not attain indeed to the highest rank as a practising lawyer, but his character for sound knowledge and probity in the profession was great. He was appointed one of the judges of the Court of Session in the room of Lord Nesbit, March 6th 1776, with the warmest approbation of the public; and in May 1776, one of the lords commissioners of Justiciary, in the room of Lord Coalston, who resigned. He took his seat on the bench, according to the usage of the Court of Session, by the title of Lord Hailes, the name by which he is generally known among the learned of Europe. As a judge of the supreme civil and criminal courts, he acted in the view of his country; from which he merited and obtained high confidence and approbation.

But he was not only conspicuous as an able and upright judge, and a sound lawyer; he was also eminent as a profound and accurate scholar; being a thorough master of classical learning, the belles lettres, and historical antiquities, particularly of his own country, to the study of which he was led by his profession. Indefatigable in the prosecution of the studies he cultivated, his time was sedulously devoted to the promotion of useful learning, piety, and virtue. Numerous are the works that have issued from his pen, all of them distinguished by uncommon accuracy, taste, and learning. Besides some occasional papers, both serious and humorous, of his composing, that appeared in the World; and a variety of communications, critical, and biographical, in the Gentleman's Magazine, and other publications of like nature; he allotted some part of his time to the illustration and defence of primitive Christianity. In the year 1771 he composed a very learned and ingenious paper, or law-case, in the disputed peerage of Sutherland. He was one of the trustees of the Lady Elizabeth, the daughter of the last earl; and being then a judge, the names of two eminent lawyers were annexed to it. In that case, he displayed the greatest accuracy of research, and the most profound knowledge of the antiquities and rules of descent, in this country; which he managed with such dexterity of argument, as clearly to establish the right of his pupil, and to form a precedent, at the same time, for the decision of all such questions in future. In the year 1773, he published a small volume, entitled, "Remarks on the History of Scotland." These appeared to be the gleanings of the historical research which he was making at that time, and discovered his lordship's turn for minute and accurate inquiry into doubtful points of history, and at the same time displayed the candour and liberality of his judgment. This publication prepared the public for the favourable reception of the Annals of Scotland, in 2 vols 4to, the first of which appeared in 1776, and the second in 1779, and fully answered the expectations which he had raised. The difficulties attending the subject, the want of candour, and the spirit of party, had hitherto prevented our having a genuine history of Scotland, in times previous to those of Queen Mary; which had been lately written, in a masterly manner, by the elegant and judicious Dr Robertson. Lord Hailes carried his attention to the Scottish history, as far back as to the accession of Malcolm Canmore, in 1057, and his work contains the annals of 14 princes, from Malcolm III. to the death of David II. And happy it was that the affairs of Scotland attracted the talents of so able a writer, who to the learning and skill of a lawyer, joined the industry and curiosity of an antiquarian; to whom no object appears frivolous or unimportant, that serves to elucidate his subject. Lord Hailes has so well authenticated his work by references to historians of good credit, or deeds and writings of undoubted authority; and has so happily cleared it from fable, uncertainty, and conjecture, that every Scotsman, since its appearance, has been able to trace back, with confidence in genuine memoirs, the history of his country, for 736 years, and may revere the memory of the respectable judge, who with indefatigable industry, and painful labour, has removed the rubbish under which the precious remains were concealed.

Lord Hailes at first intended, as appears by an advertisement prefixed to his work, to carry down his Annals to the accession of James I. but to the great disappointment of the public, he stopped short at the death of David II. and a very important period of our history still remains to be filled up by an able writer. Lord Hailes's Annals of Scotland, it is believed, stand unrivalled in the English language, for a purity aad simplicity of style, an elegance, perspicuity, and conciseness of narration, that particularly suited the form of his work; and is entirely void of that false ornament and stately gait, which makes the works of some other writers appear in gigantic, but fictitious majesty. In 1786, Lord Hailes came forward with the excellent Dr Watson, and other writers in England, to repel Mr Gibbon's attack on Christianity, and published a 4to volume, entitled, "An Enquiry into the Secondary causes which Mr Gibbon has assigned for the rapid Progress of Christianity," in which there is a great display of literary acumen, and of zeal for the cause he espouses, without the rancour of theological controversy. This was the last work he sent from the press, except a few biographical sketches of eminent Scotchmen, designed as specimens of a *Biographia Scotica*, which he justly considered as a desideratum in our literature;

terature; and which, it is much to be regretted, the infirmities of age, increasing fast upon him, did not allow him to supply; for he was admirably qualified for the undertaking, not only by his singular diligence and candour, but from the uncommon extent and accuracy of his literary and biographical knowledge: in which, it is believed, he excelled all his contemporaries.

Although his lordship's constitution had been long in an enfeebled state, he attended his duty on the bench till within three days of his death, which happened on the 29th of November 1792, in the 66th year of his age. His lordship was twice married. By his first wife, Anne Brown, daughter of Lord Coalston, he left issue one daughter, who inherits the family estate. His second marriage, of which there is issue also one daughter, was to Helen Fergusson, youngest daughter of Lord Kilkerran, who survived him. Though our church does not encourage funeral discourses in general, because they are liable to much abuse, a very laudable endeavour was made, in these degenerate times, to render his lordship's pre-eminent talents and virtues a theme of instruction to mankind, in a sermon preached, soon after his death, in the church of Inveresk, by his learned friend, and venerable pastor, Dr Carlyle; from which we shall transcribe a summary view of his character as a judge, a scholar, a Christian, and a citizen. "His knowledge of the laws was accurate and profound, and he applied it in judgment with the most scrupulous integrity. In his proceedings in the criminal court, the satisfaction he gave to the public could not be surpassed. His abhorrence of crimes, his tenderness for the criminals, his respect for the laws, and his reverential awe of the Omniscient Judge, inspired him on some occasions, with a commanding sublimity of thought, and a feeling solemnity of expression, that made condemnation seem just, as the doom of Providence, to the criminals themselves, and raised a salutary horror of crimes in the breasts of the audience. Conscious of the dignity and importance of the high office he held, he never departed from the decorum that becomes that reverend character; which indeed it cost him no effort to support, because he acted from principle and sentiment, both public and private. Affectionate to his family and relations, simple and mild in his manners, pure and conscientious in his morals, enlightened and entertaining in his conversation; he left society only to regret, that, devoted as he was to more important employments, he had so little time to spare for intercourse with them. He was well known to be of high rank in the republic of letters, and his loss will be deeply felt through many of her departments. His labours in illustration of the history of his country, and many other works of profound erudition, remain as monuments of his accurate and faithful research for materials, and his sound judgment in the selection of them. Of his unfeigned piety and devotion, you have very often been witnesses where we now are. I must add, however, that his attendance on religious ordinances, was not merely out of respect to the laws, and for the sake of example, (motives which should never fail to have influence on persons of superior rank, for the most obvious reasons); but from principle and conviction, and the most conscientious regard to his duty: for he not only practised all the virtues and charities in proof of his faith, but he demonstrated the sincerity of his zeal, by the uncommon pains he took to illustrate primitive Christianity, and by his elaborate and able defences of it against its enemies. His profound researches into history, and his thorough knowledge of the laws, made him perfectly acquainted with the progress of the constitution of Britain, from the first dawn of liberty in the common law of the land, and the trial by jury, which precede all written records, and afterwards in the origin and establishment of parliaments, through all its vicissitudes and dangers, till at last, by the blessing of divine Providence, which brought many wonderful events to concur to the same end, it was renewed, strengthened, and finally confirmed by the Revolution. It was this goodly and venerable fabric of the British constitution, which the deceased most respectable character contemplated with admiration and delight, (of late indeed with a mixture of anxiety and fear) as the temple of piety, as the genuine source of greater happiness and freedom, to a larger portion of mankind, than ever flowed from any government upon earth. Ill indeed can the times bear the loss of such an affectionate patriot, and able guardian of the laws of his country. But we must not murmur at the will of Providence, which in its mercy may have withdrawn the good man from the evil to come. In mercy, I say, to him, whose righteous spirit was so deeply grieved, when he saw the wicked rage, and the people imagine a vain thing." Such is the memorial which, in the hour of recent sorrow, followed this excellent man to the grave! Beside the works already mentioned, Lord Hailes published a great number of others, which consisted chiefly of re-editions and translations of old works, and editions of MS. papers.

DALTON, a town of Lancashire, in England. It is seated on the spring-head of a river, in a champaign country, not far from the sea; and the ancient castle is made use of to keep the records, and prisoners for debt in the liberty of Furnes. Population 643 in 1811. W. Long. 3. 0. N. Lat. 54. 18.

DALTON, *John*, D. D. an eminent divine and poet, was the son of the Rev. Mr John Dalton, rector of Dean near Whitehaven in Cumberland, where he was born in 1709. He was educated at Queen's College, Oxford; and became tutor or governor to the Lord Beauchamp, only son of the earl of Hertford, late duke of Somerset; during which time he adapted Milton's admirable mask of Comus to the stage, by a judicious insertion of several songs and different passages selected from other of Milton's works, as well as of several songs and other elegant additions of his own, suited to the characters and to the manner of the original author. During the run of this piece he industriously sought out a grand-daughter of Milton's, who was then oppressed with age and poverty; and procured her a benefit from it, the profits of which amounted to a very considerable sum. He was promoted by the king to a prebend of Worcester; where he died on the 22d of July 1763. Besides the above, he wrote a descriptive poem, addressed to two ladies at their return from viewing the coal-mines near Whitehaven; and Remarks on 12 historical designs of Raphael, and the *Museum Græcum et Egyptiacum.*

DAM, a boundary or confinement, as to *dam* up or *dam* out. *Infra damnum suum*, within the bounds or limits of his own property or jurisdiction.

DAMAGE, in *Law*, is generally understood of a hurt or hinderance attending a person's estate: but, in common law, it is a part of what the jurors are to inquire of in giving verdict for the plaintiff or defendant in a civil action, whether real or personal; for after giving verdict on the principal cause, they are likewise asked their consciences touching costs and damages, which contain the hinderances that one party hath suffered from the wrong done him by the other. See COSTS.

DAMAN, a maritime town of the East Indies, at the entrance into the gulf of Cambay. It is divided by the river Daman into two parts; one of which is called *New Daman*, and is a handsome town, well fortified, and defended by a good Portuguese garrison. The other is called *Old Daman*, and is very ill built. There is a harbour between the two towns, defended by a fort. It was taken by the Portuguese in 1535. Ship-building is carried on here to a considerable extent, the teak forests being at no great distance. E. Long. 73. N. Lat. 20. 22.

DAMASCENUS, JOHN, an illustrious father of the church in the 8th century, born at Damascus, where his father, though a Christian, enjoyed the office of counsellor of state to the Saracen caliph; to which the son succeeded. He retired afterwards to the monastery of St Sabas, and spent the remainder of his life in writing books of divinity. His works have been often printed: but the Paris edition in 1712, two vols folio, is esteemed the best.

DAMASCIUS, a celebrated heathen philosopher, born at Damascus in the year 540, when the Goths reigned in Italy. He wrote the life of his master Isidorus; and dedicated it to Theodora, a very learned and philosophical lady, who had also been a pupil to Isidorus. In this life, which was copiously written, he frequently made oblique attacks on the Christian religion. We have nothing remaining of it but some extracts preserved by Photius. Damascius succeeded Theon in the rhetorical school, and Isidorus in that of philosophy, at Athens.

DAMASCUS, a very ancient city of Syria, in Asia, seated in E. Long. 36. 40. N. Lat. 33. 20. Some of the ancients suppose this city to have been built by one Damascus, from whom it took its name; but the most generally received opinion is, that it was founded by Uz the eldest son of Aram. It is certain, from Gen. xiv. 5. that it was in being in Abraham's time, and consequently may be looked upon as one of the most ancient cities in the world. In the time of King David it seems to have been a very considerable place; as the sacred historian tells us, that the Syrians of Damascus sent 20,000 men to the relief of Hadadezer king of Zobah. We are not informed whether at that time it was governed by kings, or was a republic. Afterwards, however, it became a monarchy which proved very troublesome to the kingdom of Israel, and would even have destroyed it entirely, had not the Deity miraculously interposed in its behalf. At last this monarchy was destroyed by Tiglath Pileser king of Assyria, and Damascus was never afterwards governed by its own kings. From the Assyrians and Babylonians it passed to the Persians, and from them to the Greeks under Alexander the Great. After his death it belonged, with the rest of Syria, to the Seleucidæ; till their empire was subdued by the Romans, about 70 years before Christ. From them it was taken by the Saracens in 633; and it is now in the hands of the Turks.—Notwithstanding the tyranny of the Turks, Damascus is still a considerable place, and is supposed to contain 200,000 inhabitants. It is situated in a plain of so great extent, that one can but just discern the bounding mountains. It stands on the west side of the plain, about two miles from the head of the river Barrady, which waters it. It is of a long, straight figure, extending about two miles in length, adorned with mosques and steeples, and encompassed with gardens computed to be full 30 miles round. The river Barrady, as soon as it issues from the clefts of the Antilibanus into the plain, is divided into three streams, whereof the middlemost and biggest runs directly to Damascus, and is distributed to all the cisterns and fountains of the city. The other two seem to be artificial; and are drawn round, one to the right and the other to the left, on the borders of the gardens, into which they are let by little currents, and dispersed everywhere. The houses of the city, whose streets are very narrow, are all built on the outside either with sun-burnt brick or Flemish wall: and yet it is no uncommon thing to see the gates and doors adorned with marble portals, carved and inlaid with great beauty and variety; and within these portals to find large square courts beautified with fragrant trees and marble fountains, and compassed round with splendid apartments. In these apartments the ceilings are usually richly painted and gilded; and their duans, which are a sort of low stages seated in the pleasantest part of the room, and elevated about 16 or 18 inches above the floor, whereon the Turks eat, sleep, say their prayers, &c. are floored, and adorned on the sides with variety of marble mixed in mosaic knots and mazes, spread with carpets, and furnished all round with bolsters and cushions, to the very height of luxury. In this city are shown the church of John the Baptist, now converted into a famous mosque; the house of Ananias, which is only a small grotto or cellar, wherein is nothing remarkable; and the house of Judas with whom Paul lodged. In this last is an old tomb, supposed to be that of Ananias; which the Turks hold in such veneration, that they keep a lamp continually burning over it. There is a castle belonging to Damascus, which is like a little town, having its own streets and houses; and in this castle a magazine of the famous Damascus steel was formerly kept. The fruit-tree called the *damascene*, and the flower called the *damask rose*, were transplanted from the gardens belonging to this city; and the silks and linens known by the name of *damasks*, were probably invented by the inhabitants.

DAMASCUS Steel. See DAMASK.

DAMASIA, in *Ancient Geography*, a town of Vindelicia, on the Licus. Afterwards called *Augusta*. Now *Augsburg* in Suabia, on the Lech. E. Long. 10. 50. N. Lat. 48. 20.

DAMASK, a sort of silken stuff, having some parts rising above the ground, representing flowers or other figures. Damask should be of dressed silks, both in warp and woof. It has its name from its being originally brought from Damascus in Syria.

There

There is also a stuff in France called the *caffart-damask*, made in imitation of the true damask, having woof of hair, coarse silk, thread, wool, or cotton. Some have the warp of silk and the woof of thread; others are all thread or all wool.

Damask is also a kind of wrought linen, made in Flanders; so called, because its large flowers resemble those of damasks. It is chiefly used for tables; a table-cloth and a dozen of napkins are called a *damask-service.*

Damask is also applied to a very fine steel, in some parts of the Levant, chiefly at Damascus in Syria: whence its name. It is used for sword and cutlass blades, and is finely tempered.

DAMASKEENING, or **Damasking**, the art or operation of beautifying iron, steel, &c. by making incisions therein, and filling them up with gold or silver wire; chiefly used for adorning sword-blades, guards and grips, locks of pistols, &c.

Damaskeening partakes of the mosaic, of engraving, and of carving: like the mosaic, it has inlaid work; like engraving, it cuts the metal, representing divers figures; and, as in chasing, gold and silver are wrought in relievo. There are two ways of damasking: the one, which is the finest, is when the metal is cut deep with proper instruments, and inlaid with gold and silver wire: the other is superficial only.

DAMELOPRE, a kind of bilander, used in Holland for conveying merchandise from one canal to another; being very commodious for passing under the bridges.

DAMIANISTS, in church-history, a branch of the ancient acephali-severitæ. They agreed with the catholics in admitting the sixth council, but disowned any distinction of persons in the Godhead; and professed one single nature, incapable of any difference: yet they called God "the Father, Son, and Holy Ghost."

DAMIENS, Robert François, an assassin by whom Louis XV. of France was wounded in the year 1757. He was born in the suburbs of Arras, in the year 1714; and seems rather to have been actuated by frenzy or insanity in the perpetration of the horrid deeds of which he was guilty, than by any of the motives to which they have been ascribed. This spirit appeared in the early period of his life; and such were the extravagance and violence of his conduct, that he was distinguished, while a boy, by the appellation of *Robert the Devil.*

When he grew up he entered into the army, served as a soldier at the siege of Philipsburgh, and was present at several engagements. He returned afterwards to France, and became a domestic servant in the college of Jesuits at Paris. He married in 1738, which rendered it necessary for him to resign this service. He was then employed in the same capacity by different masters, one of whom, it is said, he poisoned; and having robbed another, he was obliged to abscond to escape the punishment due to his crimes. During a period of five months after the dicovery of the robbery, he lurked in the neighbourhood of St Omer, Dunkirk, and Brussels; and was observed to express himself in an absurd and incoherent manner concerning some disputes which at this time prevailed in France. The following soliloquy is said to have been uttered by him in a small town near Ypres: "If I return to France—Yes, I will return, I will die there, and the greatest man on earth shall die likewise, and you shall hear news of me." These expressions were uttered in the month of August 1756; and it is probable that they were regarded at the time only as the ravings of a madman. He spoke indeed in a similar strain in the December following, at the house of a relation, at Falesque near Arras, saying, "That the kingdom, his wife, and daughter, were all ruined!" It was about this time that he set out for Paris, and arrived there on the 31st of December. He was seen at Versailles, on the first day of January 1757. To blunt his feelings, and to prepare himself for the perpetration of the horrid act, it is said that he swallowed opium for several days. But the state of mind in which Damiens is described to have been for some time before, seemed to render such auxiliaries unnecessary.

It was on the 5th of January, between five and six in the evening, that Louis XV. was wounded by the hand of this frantic assassin. He struck with a knife the right side of the king, while he was surrounded with his courtiers, and just as he was entering his carriage to go to Trianon. Damiens was instantly seized, examined at Versailles, and afterwards sent to Paris and confined in the tower of Montgommeri, in an apartment prepared for him, near to that which was formerly occupied by Ravaillac the murderer of Henry IV. The great court of parliament was charged by the king to institute his process; and although he was subjected to the most cruel tortures, which he bore with unexampled fortitude, no confession or acknowledgment could be extorted which afforded the smallest ground for suspicion that he had a single accomplice. When it was found that the torture failed of the purpose for which it was inflicted, he was condemned to die by the same punishment which Ravaillac suffered.

The 28th of March following was fixed as the day of his execution. On that day he was brought to the *Place de Greve*, where the apparatus and instruments of his destruction were prepared. All these he beheld with an undismayed countenance and a tearless eye, although he must have known well that new and more dreadful tortures yet awaited him. His punishment commenced with burning his right hand; his flesh was then torn with red-hot pincers; and the wounds were filled with melted wax, pitch, and lead. In attempting to quarter his body, the four horses which were employed pulled in vain for 50 minutes. All their efforts seemed to be ineffectual, till the executioners cut with knives the ligaments with which the limbs are attached to the body. Even after the legs were cut he was still alive, and it was only after the arms were treated in the same way that he ceased to breathe, and his body was dismembered. The period of his punishment, from the time he was put upon the scaffold till his death, was not less than an hour and a half; during the greater part of it he seemed to retain his recollection; for he raised his head many times, and cast his eyes on his mangled and burned limbs, and on the horses which were then exerting their whole force to tear his body asunder. And even during the severest of his tortures, the firmness of his mind was so little shaken, that he affected some degree of jocularity.

Damiens, Damietta.

Thus perished this unfortunate assassin, the history of whose life, considered in itself, is scarcely worthy of a place even for the shortest sketch; and indeed we should probably not have introduced it here, were it not for the purpose of rectifying the mistaken views of some of his biographers. While we are told that he was an insane assassin, he is charged with the same degree of guilt, as if he had been all his life in full possession of every rational faculty. But the events of his life leave no doubt of his insanity; and the last horrid deed which he perpetrated strongly confirms it. He was not actuated by either public or private revenge; he had no accomplices; and it does not appear that he had any purpose whatever to serve by taking away the life of the monarch, even if he had succeeded and escaped. In the midst of his most cruel tortures, he obstinately persisted that it was not his intention to kill the king. According to his own fanatical language, he wished that God would touch his heart to induce him to give peace to his kingdom. Our readers will probably anticipate us in remarking the needless excess of lingering punishment which was inflicted on the insane Damiens; and some of them will perhaps be surprised to be told that the execution was attended by some of the ladies of the court. Many of them too will naturally compare this event with what has happened more lately in our own country; and recollect, that a Nicholson and a Hadfield, influenced by a similar frenzy which urged them to a similar attempt, have been only doomed to perpetual confinement, not as a punishment, but merely to preclude the possibility of perpetrating such deeds; because in such a state of mind they are not recognized by our milder and more equitable laws as rational beings; and therefore they are improper objects of punishment.

DAMIETTA, a port-town of Egypt, situated on the eastern mouth of the river Nile, four miles from the sea, and 100 miles north of Grand Cairo. E. Long. 31. 49. and N. Lat. 31. 25. The present town stands upon a different site from the ancient Damietta, so repeatedly attacked by the European princes. The latter, according to Abulfeda, was "a town surrounded by walls, and situated at the mouth of the eastern branch of the Nile." Stephen of Byzantium informs us, that it was called *Thamiatis* under the government of the Greeks of the lower empire, but that it was then very inconsiderable. It increased in importance every day, in proportion as Pelusium, which was frequently plundered, lost its power. The total ruin of that ancient town occasioned the commerce of the eastern parts of the Delta to be transferred to Damietta. It was, however, no longer a place of strength, when, towards the year 238 of the Hegira, the emperors of Constantinople took possession of it a second time. The importance of a harbour so favourably situated opened the eyes of the caliphs. In the year 244 of the Hegira, Elmetouakkel surrounded it with strong walls. This obstacle did not prevent Roger king of Sicily from taking it from the Mahometans in the year 550 of the Hegira. He did not, however, long enjoy his conquest. Salah Eddin, who about that period mounted the throne of Egypt, expelled the Europeans from Damietta. Fifteen years after they returned to besiege it; but this able sultan baffled all their efforts. Notwithstanding their land army was supported by a fleet of 1200 sail, they were obliged to make a disgraceful retreat.

Damietta.

It was the fate of this place to be constantly besieged. In the year 615 of the Hegira, under the reign of Eladel, the crusaders attacked it with a very considerable force. They landed on the western shore of the Nile; and their first care was to surround their camp with a ditch and pallisado. The mouth of the river was defended by two towers, furnished with numerous garrisons. An enormous iron chain, stretching from one side to the other, hindered the approach of vessels. The crusaders carried by storm the tower on the same side with their camp, broke the chain, and opened the entrance of the river for their fleet. Nejm Eddin, the sultan's son, who was encamped near Damietta, covered it with an army. To stop the enemies vessels he threw a bridge over the Nile. The Franks overturned it, and the prince adopted the measure of choking up the mouth of the river, which he almost rendered impassable by several large boats he sunk there. After alternate and various successes, many bloody battles, and a siege of 17 months, the Christian princes took Damietta by storm. They did not, however, long enjoy the fruit of so much blood spilt, and of an armament which had cost immense sums. Completely invested near the canal of Achmoun, by the waters of the Nile and by the Egyptian army, they purchased their lives and their liberty by the sacrifice of their conquest.

One-and-thirty years after this defeat St Louis carried Damietta without striking a stroke. The Arabs, however, soon recovered it; but tired of keeping a place which continually drew upon them the most warlike nations of Europe, they totally destroyed it, and rebuilt it further up in the country. This modern Damietta, first called *Menchié*, as Abulfeda tells us, has preserved the memory of its origin in a square still called by that name. Writers in general have confounded these two towns, ascribing to the one the attributes of the other. The modern Damietta is rounded in a semicircle on the eastern bank of the Nile, two leagues and a half from the mouth of it. The eye, placed at one of the extremities of the crescent, takes in its whole extent. Savary reckoned it to contain 80,000 souls, others reduce it to 40,000. It has several squares, the most considerable of which has retained the name of *Menchié*. Spacious *okals* or *khans*, collecting under their porticoes the stuffs of India, the silks of Mount Lebanon, sal ammoniac, and pyramids of rice, proclaim that it is a commercial town. The houses, those in particular which are on the banks of the river, are very lofty. They have in general handsome saloons built on the top of their terraces, which are cheerful belvideres, open to every wind, where the Turk, effeminately reclining on a sofa, passes his life in smoking, in looking on the sea, which bounds the horizon on one side, on the great lake that extends itself on the other, and on the Nile, which, running between them, traverses a rich country. Several large mosques, adorned with lofty minarets, are dispersed over the town. The public baths, lined with marble, are distributed in the same manner as those of Grand Cairo. The linen you are served with is clean, and the water very pure. The heat and the treatment in them, so far from injuring the health, serve to strengthen, nay even to improve it, if used with moderation.

This

This custom, founded on experience, is general in Egypt.

The port of Damietta is continually filled with a multitude of boats and small vessels. Those called *scherm* serve to convey the merchandise on board the ships in the road, and to unload them; the others carry on the coasting-trade. This town carries on a great trade with Syria, with Cyprus, and Marseilles. The rice called *mezelaoni*, of the finest quality there is in Egypt, is cultivated in the neighbouring plains. The exports of it amount annually to about six millions of livres. The other articles of the produce of the country are linens, sal ammoniac, corn, &c. A ruinous policy for the country prohibits the exportation of this last article; but the law is evaded, and it passes under the name of rice.

The Christians of Aleppo and Damascus, settled in this town, have for several ages carried on its principal commerce. Turkish indolence, content with extorting from them from time to time, suffers them to become rich. The exportation of rice to foreign countries is prohibited; but by means of some *douceurs* to the customhouse-officers, the people of Provence load annually several ships with it. The *Bogaz* preventing them from entering the Nile, their cargoes are conveyed on board by the boats of the country. This inconvenience is the source of endless vexation and abuses. The boat, which is loaded in the evening with rice of the first quality, is frequently not that which arrives at the ship; an inferior quality is substituted for it during the night. The Marseilles captains, aware of these rogueries, without being able to prevent them, endeavour to play off trick against trick, so that this commerce has become a general scene of knavery. But the badness of the port is still more detrimental to Damietta. The road where the vessels lie being exposed to every wind, the slightest gale obliges the captains to cut their cables and take shelter at Cyprus, or to stand off to sea. It would be easy, by cutting a canal only of half a league, to open a passage for ships into the Nile, where there is deep water. This work, which might be executed at very little expence, would render Damietta a noble harbour; but despotism, insensible to the interest of the people, is always surrounded by destruction in its progress, and wants both the will and the power to create.

The tongue of land on which Damietta is situated, straitened on one side by the river, and on the other by the western extremity of Lake *Menzalé*, is only from two to six miles wide from east to west. It is intersected by innumerable rivulets in every direction, which render it the most fertile spot in Egypt. The soil there produces, *communibus annis*, 80 bushels of rice for one. The other produce is in the same proportion. It is there that nature, lavishing profusely her pomp and riches, presents flowers, fruits, and harvests, at every season of the year. Winter never deprives it of these advantages; its beauties are never impaired by summer. Destructive heats, as well as chilling colds, are equally unknown in that happy spot. The thermometer varies only from 9 to 24 degrees above the freezing point. Damietta is indebted for this charming temperature to the immense quantity of water with which it is surrounded. The verdure is nowhere so fresh; the trees are nowhere covered with such quantities of fruit. The rivulets around the fields of rice are lined with several kinds of reeds, some of which rise to a great height. The reed *calamus* is here found in abundance, which is made use of for writing by the orientals. Its slender stalks bear long narrow leaves, which hang gracefully, and spreading branches covered with white flowers. Here also are to be seen forests of papyrus, of which the ancient Egyptians made their paper. Strabo, who calls it *biblius*, gives an accurate description of it. It is here also that the *lotus*, of which the Arabs have preserved the primitive name of *nuphar*, exalts its lofty stalk above the waters. Its large calyx blows either of an azure blue or of a brilliant white, and it appears with the majesty of the king of the aquatic plants. The marshes and the canals in the interior parts of the country are filled with this superb flower, which diffuses a most agreeable odour.

There are a great many villages around Damietta, in most of which are manufactures where the most beautiful linens of the country are fabricated. The finest napkins in particular are made there, fringed with silk. You are served at table with them, but especially on ceremonial visits, when the slave presents you with one to wipe your mouth with, after you have drank your sherbet, or eaten the sweetmeats, which are carried round on a silver plate to all the company. These small towns, generally surrounded with little woods, or trees promiscuously planted, form a whimsical and picturesque assemblage. By the side of the sycamore and the melancholy tamarind, one sees the elegant cassia-tree, with its clusters of yellow flowers, like those of the cytisus. The top of the date-tree, loaded with enormous bunches, rises above the grove. The cassia, with its sweet-scented flower, grows under its shade. The orange and lemon trees cover the labourer's cabin with their golden fruit. The banana tree with its long leaves, the pomegranate with its scarlet flower, and the fig-tree with its sugary fruit, throw a vast variety into these landscapes.

DAMNII, anciently a people of Britain; situated between the Selgovæ to the south and the Caledonii to the north. Now *Clydesdale*.

DAMNONII. See DANMONII.

DAMOCLES, one of the flatterers of Dionysius the Elder of Sicily. He admired the tyrant's wealth, and pronounced him the happiest man on earth. Dionysius prevailed upon him to undertake for a while the charge of royalty, and be convinced of the happiness which a sovereign enjoyed. Damocles ascended the throne, and while he gazed upon the wealth and splendour that surrounded him, he perceived a sword hanging over his head by a horse hair. This so terrified him that all his imaginary felicity vanished at once, and he begged Dionysius to remove him from a situation which exposed his life to such fears and dangers.

DAMON, the name of several illustrious ancients; particularly of a Pythagorean philosopher very intimate with Pythias. When he had been condemned to death by Dionysius, he obtained from the tyrant leave to go and settle his domestic affairs, on promise of returning at a stated hour to the place of execution. Pythias pledged himself to undergo the punishment which was to be inflicted on Damon, should he not return in time, and he consequently delivered himself into to the hands of the tyrant. Damon returned at the appointed moment, and Dionysius was so struck with the fidelity of those two friends, that he remitted the punishment, and entreated them to permit him to share their friendship and enjoy their confidence.

DAMPIER, William, an English navigator, was born at East Coker in Somersetshire, about the year 1652. His parents died while he was young, and having thus become an orphan, he was removed from the Latin school, and placed with the master of a ship at Weymouth. In this ship he made a voyage to Newfoundland; but, on his return, he left his master, with the resolution, as he himself observes, of never again exposing himself to the pinching cold of that northern climate. As the acquisition of experience in the art of navigation was ever his great object, he engaged himself as a common sailor in a voyage to the East Indies. He served in the Dutch war under Sir Edward Sprague, and was present at two engagements. The declining state of his health would not permit him to remain on board the fleet; he therefore came on shore, and removed to the country, where he remained some time. The year following he accepted an offer of employment in Jamaica as an under manager of an estate: but he only continued a short time in that situation; after which he engaged in a coasting trader, and thus acquired an accurate knowledge of all the ports and bays of that island. Soon after he entered on board a vessel bound to the bay of Campeachy, and returning a second time to the same coast, he remained with the log-wood-cutters, and engaged himself as a common workman. During his stay in this country he collected the materials for the minute and interesting account which he has given of the laborious life of these people, as well as of the geographical description and the natural history of the tract which they occupy.

Satisfied with the knowledge which he had obtained of the nature of the trade and country, he returned to Jamaica, and from thence to England, where he arrived in 1678. About the beginning of the year following he went out to Jamaica as a passenger, with the intention of revisiting the bay of Campeachy; but he was persuaded to associate himself with a body of *privateers*, as they were called, who were then lying in several vessels in a bay of that island. These people who were called *privateers*, were pirates, who, having no commission whatever from any government, undertook a predatory warfare on the commerce and settlements of the Spaniards. This body of plunderers was composed of English, Dutch, and French. In this expedition Dampier crossed the isthmus of Darien with his associates, and spent the year 1680 on the Peruvian coast, and was occasionally successful in plundering the towns. The following year, in consequence of a dissension which arose among them, Dampier, and the minority with whom he had joined, recrossed the isthmus, and entered with another fleet of privateers, which was then stationed on the Spanish main; and, having spent another year among the West India islands, he, with some others, proceeded to Virginia in a single ship to dispose of their prize goods. Here he remained for a year; and afterwards engaged with a Captain Cook, who, with about 70 men, undertook an expedition against the Spaniards in the South seas. They sailed in 1683 in the month of August, touched at the coast of Guinea, and then proceeded round Cape Horn into the Pacific ocean. Having fallen in with a ship from London, which had sailed on a similar expedition, they joined company; and, having touched at the island of Juan Fernandez, they made the coast of South America, cruizing along Chili and Peru. They took some prizes, and with them they proceeded to the Mexican coast, which they fell in with near Cape Blanco. While they lay here Captain Cook died, and the command devolved on Captain Davis. Having separated from the London ship, they were joined by another commanded by Captain Swan. An attempt to plunder the town of Guaiaquil was unsuccessful, but at the mouth of the river they took some vessels which had about 1000 slaves on board. With these negroes Dampier proposed to work the gold mines in the neighbourhood of Santa Maria on the isthmus of Darien, from which the Spaniards had been driven away by some privateers. But this plan was not attempted. The next object of plunder was the Spanish fleet having on board the treasure of the Peruvian mines; but the English being ill supported by some French ships which had joined them, the fleet, after a running fight, got safe into Panama.

The English ships afterwards cruizing along the coast of Mexico, landed, took the town of Puebla Nova, and burnt two others. Dampier leaving Davis, went on board of Swan's ship, and proceeded with him along the northern parts of Mexico, as far as the southern part of California. During this expedition they frequently landed for the purpose of plunder, but particularly when they were in want of provisions. Returning from the plunder of one place, 50 of the party were killed by the Spaniards. This disaster so discouraged them that they relinquished all farther attempts on these coasts. Swan then proposed to run across the Pacific ocean, and return by the East Indies; and in hopes of a successful cruise off the Manillas the crew were persuaded, with a very slender provision, to risk this long passage. On the last day of March 1686, they took their departure from Cape Corrientes, and on the 52d day reached Guam, one of the Ladrone islands. About this time the crew talked of killing and eating Swan and the officers, in case their stock of provision should be exhausted before it could be supplied. From Guam they proceeded to Mindanao. While the ship lay here a mutiny arose among the crew, and the majority carried her off, Swan and some of his people being left on the island. Among the former was Dampier, although it is said that he had no concern in the mutiny. After cruizing some time off Manilla, and having careened their vessel at Pulo Condore, in 1687 they were driven to the Chinese coast, made the circuit of Luzonia and Mindanao, passed through the group of Spice islands, and reached the coast of New Holland in the beginning of 1688. They left this in March, and having passed along the west coast of Sumatra, they arrived at the Nicobar islands, where Dampier, at his own request, and two other Englishmen, a Portuguese, and some Malays, were set on shore. Dampier's object was to establish a trade in ambergris. Attempting to navigate a canoe to Acheen in Sumatra, they were overtaken by a severe storm, in which they experienced great hardships.

They at last reached Sumatra; but the fatigues and distress of the voyage proved fatal to several of them, who were carried off by a fever. Dampier himself was scarcely recovered at the end of a twelvemonth. After making several voyages to different places of the East Indies, he acted for some time as gunner at the English fort of Bencoolen. In 1691, wishing to revisit his native country, he embarked on board a ship for England, where he arrived in September. At this time he brought with him a native of Meangis, one of the Spice islands, who was supposed to be the son of a chief, and after being exhibited as a sight, died of the smallpox at Oxford.

It is not known in what manner Dampier was employed for some years after this period. It appears, however, that he was at last engaged in the king's service. He had the command of the Roebuck, a sloop of 12 guns and 50 men. This vessel, it is supposed, was fitted out for some voyage of discovery, for she had 20 months provisions on board. He sailed from Britain in 1699, touched at the coast of Brasil, and then ran across to the coast of New Holland, and arrived there on the 1st of August, about latitude 26°. He proceeded northwards along the coast, exploring the country in different places where he landed. To procure refreshments he found it necessary to direct his course towards Timor; and from this he sailed to the coast of New Guinea, where he arrived on the 3d of December. By sailing along to its easternmost extremity, he discovered that it was terminated by an island, which he circumnavigated, and named New Britain.

Here it would appear from his own journal that he encountered considerable difficulties from the small number of his men, and their eager desire to hasten home. On account of these difficulties he was prevented from prosecuting his discoveries. In May he returned to Timor, and from thence proceeded homeward by Batavia and the Cape of Good Hope. In February 1701 he arrived off the island of Ascension, when the vessel sprung a leak and foundered; and it was with much difficulty that the crew reached the island. They remained at Ascension till they were taken away by an East India ship, and conveyed to England. This closes the account of Dampier's life and adventures, as it is detailed by himself. It appears, however, from the preface to the third volume, that he was preparing in 1703 for another voyage. It is mentioned also in Woodes Rogers' Voyage round the World, that Dampier had the command of a ship in the South seas about the year 1705, along with Captain Stradling, whose vessel foundered at sea. Dampier accompanied Woodes Rogers in his voyage round the world, in the years 1708, 1709, 1710, and 1711; but only in the capacity of pilot, which is supposed to be owing to something faulty in his conduct. During this expedition Guaiaquil was taken, and Dampier had the command of the artillery. Nothing farther is known of the life of Dampier; and we are equally ignorant of the place and time of his death.

The works of Dampier are well known, and have been often reprinted. They consist of, 1. A Voyage round the world, 3 vols octavo. 2. A Supplement to it, describing the countries of Tonquin, Malacca, &c. 3. Two Voyages to Campeachy. 4. A Discourse of Trade-winds, Seasons, Tides, &c. in the Torrid Zone. 5. A Voyage to New Holland. His observations are curious and important, and conveyed in a plain manly stile. His nautical remarks discover a great deal of professional knowledge. His knowledge in natural history is not scientific; but it appears to be accurate, and has been frequently quoted.

DAMPS, in *Natural History*, (from the Saxon word *damp*, signifying vapour or exhalation), are certain noxious exhalations issuing from some parts of the earth, and which prove almost instantly fatal to those who breathe them.

These damps are chiefly observed in mines and coal-pits; though vapours of the same kind often issue from old lavas of burning mountains, and, in those countries where volcanoes are common, it is said that they fill the houses, and destroy people suddenly without the least warning of their approach. In mines and coal-pits they are chiefly of two kinds, called by the miners and colliers the *choke* and *fire damps;* and both go under one general name of *foul air*. The *choke-damps*, known in modern chemistry by the name of *fixed air*, or *carbonic acid gas*, usually infests those places which have been formerly worked, but long neglected, and are called by the miners *wastes*. No place, however, can be reckoned safe from this kind of damps, except where there is a due circulation of air; and the procuring of this is the only proper means of preventing accidents from damps of all kinds. The choke-damp suffocates the miners suddenly, with all the appearances found in those that are suffocated by fixed air. Being heavy, it descends towards the lowest parts of the workings, and thus is dangerous to the miners, who can scarce avoid breathing it. The *fire-damp*, which is inflammable air, *hydrogen gas*, rises to the roof of the workings, as being specifically lighter than the common atmosphere; and hence, though it will suffocate as well as the other, it seldom proves so dangerous in this way as by its inflammable property, by which it often takes fire at the candles, and explodes with extreme violence.

In the Phil. Trans. N° 119. there is an account of some explosions by damps of this kind, on which we have the following observations. 1. Those who are in the place where the vapour is fired suddenly find themselves surrounded with flames, but hear little or no noise; though those who are in places adjacent, or above ground, hear a very great one. 2. Those who are surrounded by the inflamed vapour feel themselves scorched or burnt, but are not moved out of their places, though such as unhappily stand in the way of it are commonly killed by the violence of the shock, and often thrown with great force out at the mouth of the pit; nor are the heaviest machines found able to resist the impetuosity of the blast. 3. No smell is perceived before the fire, but a very strong one of brimstone is afterwards perceptible. 4. The vapour lies towards the roof, and is not perceived if the candles are held low; but when these are held higher, the damp descends like a black mist, and catches hold of the flame, lengthening it to two or three handfuls; and this appearance ceases when the candles are held nearer the ground. 5. The flame continues in the vault for several minutes after the crack. 6. Its colour is blue, something inclining to green, and very bright. 7. On the explosion of the vapour, a dark smoke like that proceeding from fired gunpowder is perceived. 8. Damps are generally observed to come about the latter end of May, and to continue during the heat of summer. They return several times during the summer season, but observe no certain rule.

Besides these kinds of damps, which are very common, we find others described in the Philosophical Transactions, concerning the nature of which we can say nothing. Indeed the account seems somewhat suspicious. They are given by Mr Jessop, from whom we have the foregoing observations concerning the fire-damp, and who had these from the miners in Derbyshire. After describing the common damp, which consists of fixed air, "They call the second sort (says he) the *pease-bloom damp*, because, as they say, it smells like pease-bloom. They tell me it always comes in the summer time; and those grooves are not free which are never troubled with any other sort of damps. I never heard that it was mortal; the scent, perhaps, freeing them from the danger of a surprise: but by reason of it many good grooves lie idle at the best and most profitable time of the year, when the subterraneous waters are the lowest. They fancy it proceeds from the multitude of red-trefoil flowers, by them called *honeysuckles*, with which the limestone meadows in the Peake do much abound. The third is the strangest and most pestilential of any; if all be true which is said concerning it. Those who pretend to have seen it (for it is visible) describe it thus: In the highest part of the roof of those passages which branch out from the main groove, they often see a round thing hanging, about the bigness of a foot-ball, covered with a skin of the thickness and colour of a cobweb. This, they say, if it is broke by any accident, as the splinter of a stone, or the like, disperseth itself immediately, and suffocates all the company. Therefore, to prevent casualties, as soon as they have espied it, they have a way, by the help of a stick and long rope, of breaking it at a distance; which done, they purify the place well with fire, before they dare enter it again. I dare not avouch the truth of this story in all its circumstances, because the proof of it seems impossible, since they say it kills all that are likely to bear witness to the particulars: neither do I deny but such a thing may have been seen hanging on the roof, since I have heard many affirm it."—Some damps, seemingly of the same nature with those last mentioned, are noticed by the author of the Chemical Dictionary, under the word *Damps*. "Amongst the noxious mineral exhalations (says he), we may place those which are found in the mines of sal gem in Poland. These frequently appear in form of light flocks, threads, and spiders webs. They are remarkable for their property of suddenly catching fire at the lamps of the miners with a terrible noise and explosion. They instantly kill those whom they touch. Similar vapours are found in some mines of fossil coal."

With regard to the formation of damps we have as yet no certain theory; nor, though the experiments of aerologists are abundantly able to show the composition and manner of forming these noxious airs artificially, have they yet thrown much light on the method by which nature prepares them on a large scale. There are two general ways in which we may suppose this to be done: one by the stagnation of atmospherical air in old waste places of mines in coal-pits, and its conversion into these mephitic exhalations; the other by their original formation from the phlogistic or other materials found in the earth, without any interference of the atmosphere. In favour of the former opinion it may be urged, that old wastes are never free from damps, especially those of the kind resembling fixed air; nor are they always deficient in the inflammable kind. The same is also true of old wells, or even cellars, and in short every place where the air stagnates for any considerable time. But, on the other hand, we have many instances of fixed air coming out of the earth, and that in vast quantities, where no considerable stagnation of the atmosphere could be suspected; as for instance, in the grotto del Cani in Italy, where a continual stream of it has issued from time immemorial. The same seems to be the case with the tops of some high mountains, particularly Mont Blanc, the highest in Europe; on the top of which M. Saussure found the atmosphere so much impregnated with fixed air, that lime water exposed to it very quickly gathered a crust on its surface. Sir William Hamilton, in his account of the eruptions of Vesuvius, informs us, that the inhabitants in the neighbourhood of that mountain are infested with a kind of pestilential vapours named by them *mofetes*, which issue from the old lava thrown out by the volcano. These are of the nature of the damps in our mines or coal-pits, and issue forth in such quantity as either to infect the atmosphere for a very considerable way round, or to do mischief by being carried from place to place by the atmospherical currents, which are not strong enough to dissipate them for some time. From some late accounts the *samiel* (or scorching winds, as they have been represented) in the eastern countries, seem to be no other than streams of fixed air of considerable extent, which exert their usual and fatal effects on those who breathe them. A strong argument in favour of this opinion is, that these winds cannot cross a river, it being the nature of water to absorb fixed air, and thus destroy them.

Hence it is rendered probable that these mephitic vapours are often to be met with in the open atmosphere, and consequently cannot always be the effect of stagnation; nor indeed does it at all appear that mere stagnation can affect the quality of the atmosphere either one way or other. This fluid cannot have its properties altered but by something immersed in it upon which it can act, and by means of which action its component parts may be changed or separated. While this process is going on, there is generally, if not always, an *absorption* of air, accompanied indeed frequently with an emission of some aerial fluid equal in quantity to that which is absorbed. Mr Scheele, in his Essay on Fire, has shown by a number of experiments the effect of exposing certain substances to the action of air, both on the substances themselves and on the aerial fluid. The result of all these is no other than what we might expect from a very slow combustion, and which perhaps may on inquiry be found to be the only way by which air can be decomposed. If the substance exposed to the air was capable of absorbing that part of the fluid which had undergone a change, there was always an evident diminution

nution, but not otherwise. Thus, on inclosing some caustic fixed alkali in a phial of atmospheric air, a considerable diminution took place; and the alkali, by becoming saturated with fixed air, showed that a decomposition had taken place, and that the dephlogisticated part of the air had separated from the other, attached itself to the fixed alkali, and become fixed air by uniting with a certain proportion of phlogistic matter. Hence we may conceive, that in any place where the air was confined over a vast quantity of caustic alkaline salt, it would soon become unfit for the purposes of animal life, and we might say that a *damp* would be formed. But this would be a damp of a very different kind from that usually met with in mines; for here the dephlogisticated part of the atmosphere being converted into fixed air, and absorbed by the salt, only the azotic gas, or, as it has been called, *phlogisticated* air, would remain, so that no fixed air could ever be separated from it.

Let us now suppose, that instead of the alkaline salt a quantity of burning charcoal is confined in a place where there is not a proper circulation of air, and we shall soon see that a damp of the very same kind with that called by miners the *choke-damp* will be formed. But this takes place by reason of the dissipation of the charcoal by heat, and its union with the pure part of the atmosphere, or oxygen gas, which always constitutes fixed air. In this case, however, the damp must be but of short continuance, and will soon be dissipated after the charcoal is extinguished; but if, instead of the charcoal, we substitute a large quantity of fermenting liquor, from whence the fixed air is naturally emitted, a damp will be formed much more difficult to be dissipated than the former, because it renews itself in a very short time; and, unless there is a very constant circulation of air, it will be dangerous to enter the place where it is.

From the last example we may form an idea of the manner in which these damps, consisting chiefly of fixed air, are formed. We know not indeed thoroughly the nature of fermentation; but we are assured, that it is always accompanied by an internal heat; which, in some cases, is raised to the utmost height, insomuch that large quantities of moist vegetable substances, packed together, will sometimes burst out into flame. It is not, however, at all times necessary for the extrication of fixed air, that the heat should come to this extremity. The example of fermenting liquors shows, that in some cases a very moderate heat is sufficient for the purpose. Now, though the comparison may seem somewhat inadequate between the solid substance of the earth and a fermenting liquid, yet we know that a gentle heat constantly takes place in the bowels of the earth; and that almost all terrestrial substances will emit fixed air on being exposed to heat. It is not at all improbable, therefore, that, on the large scale of nature, the quantity of materials may compensate for the weakness of the heat, and thus occasion a constant emission of fixed air; which, though slow in comparison of what is effected in our experiments by a violent artificial heat, may yet accumulate in the narrow spaces of mines in such a manner as to be very troublesome. In volcanic countries, where the heat of the earth is much greater, the emission of fixed air is in proportion: and thus we may account for that continued stream of it, which issues from the grotto del Cani, and perhaps other places. The *mofetes*, which are said to proceed from old lavas, can only be accounted for by supposing the heat, which originally took place in them, to be in some measure renewed; or that they have been again, by some means or other, disposed to take fire as formerly: but this we offer merely as a conjecture; there not being as yet sufficient data to determine any thing positively upon the subject.

It may be objected to the hypothesis just now laid down, that, if there is a continual disposition in the earth to produce fixed air, the whole surface of it must pour out such a quantity as would destroy every living creature upon it. This indeed might be granted, were the surface of the earth quite bare, and destitute of vegetation: but there is no absurdity, in supposing that the fixed air may be continually decomposed by the vegetables which grow all over the surface of the earth; and the atmosphere not only thus preserved from any taint from it, but supplied with a quantity of pure air, which it is certain vegetables give out. It is also certain, that wherever the atmosphere is suffered to be in contact with the bare surface of the ground for some time, a considerable quantity of fixed air will be produced, unless there is a constant circulation of atmospherical air to carry off the former before it has time to produce any sensible effect. Hence we may account for the damps in wells, cellars, and even in the confined places of old castles and ruinous buildings, where the air is not in contact with the surface of the ground itself, but with mere heaps of rubbish and old walls.

With regard to what is called the *fire-damp*, the case seems to be more plain. In the Phil. Trans. N° 136. we have the following account of one of this kind, which seemed evidently to issue from the earth: "This work is upon a coal of five yards in thickness, and hath been begun upon about six or eight and thirty years ago. When it was first found, it was extremely full of water, so that it could not be wrought down to the bottom of the coal; but a *witchet*, or cave, was driven out of the middle of it, upon a level, for gaining room to work, and drawing down the spring of water that lies in the coal to the eye of the pit. In driving of which witchet, after they had gone a considerable way under ground, and were scanted of wind, the fire-damps began by little and little to breed, and to appear in crevices and slits of the coal, where water had lain before the opening of the coal, with a small bluish flame, working and moving continually; but not out of its first seat, unless the workmen held their candles to it; and then being weak, the blaze of the candle would drive it out with a sudden fizz away to another crevice, where it would soon after appear blazing and moving as formerly. This was the first knowledge of it in this work, which the workmen made but a sport of, and so partly neglected, till it had gotten some strength; and then upon a morning the first collier that went down, going forwards in the witchet with his candle in his hand, the damp presently darted out so violently at his candle, that it struck the man clear down, singed all his hair and clothes, and disabled him from working for a while after. Some other small warnings it gave them, inso-much

much that they resolved to employ a man on purpose that was more resolute than the rest, to go down a while before them every morning, to chase it from place to place, and so to weaken it. His usual manner was to put on the worst rags he had, and to wet them all in water, and when he came within the danger of it, then he fell down grovelling upon his belly, and so went forward, holding in one hand a long wand or pole, at the head whereof he tied candles burning, and reached them by degrees towards it; then the damp would fly at them, and, if it missed of putting them out, would quench itself with a blast, and leave an ill-scented smoke behind. Thus they dealt with it till they had wrought the coal down to the bottom, and the water following, and not remaining as before in the body of it, among sulphureous and brassy metal that is in some veins of the coal, the fire-damp was not seen nor heard of till the latter end of the year 1675, which happened as followeth:

"After long working of this coal, it was found upon the rising grounds that there lay another roach of coal at the depth of 14 yards under it, which proved to be $3\frac{1}{2}$ yards thick, and something more sulphureous. This encouraged us to sink in one of the pits we had formerly used on the five-yards coal. As we sunk the lower part of it, we had many appearances of the fire-damp in the watery crevices of the rocks we sunk through, flashing and darting from side to side of the pit, and showing rainbow-like colours upon the surface of the water in the bottom; but upon drawing up of the water with buckets, which stirred the air in the pit, it would leave burning, till the colliers at work, with their breath and sweat, and the smoke of their candles, thickened the air in the pit, and then it would appear again; they lighted their candles at it sometimes when they went out; and so in this pit it did no farther harm."

In another pit, however, it soon appeared, and at last produced a most terrible explosion. This was occasioned by one of the workmen going imprudently down with a lighted candle, after a cessation of work for some days, and the force exerted by it seemed equal to that of gunpowder.

The formation of inflammable air in mines is to be ascribed, according to the doctrines of modern chemistry, to the decomposition of water, a process which is constantly going on in places where metallic substances are exposed to its action. As the metals are oxidated by their combination with the oxygen, one of the component parts of water, the hydrogen, its other component parts, is set at liberty, and accumulates in those places where it is generated.

A much more important consideration than the formation of damps, however, is the proper method of avoiding their pernicious effects. The inflammability of one kind affords an easy method of preventing it from accumulating, viz. by setting fire to it. This may be done with safety, unless it has been suffered to go too far before the experiment is made: for the inflammable air being much lighter than any other kind will naturally rise to the top; so that a man, lying flat on the ground to avoid the force of the explosion, and holding up a lighted candle fixed upon a pole, may at once free the mine from such a troublesome guest. But where it has been allowed to accumulate in too great quantity, so that this method cannot be used, or in the other kind, which is not inflammable, the method commonly practised is to produce a constant circulation of air as much as possible through all parts of the mine. To procure this, they make a perpendicular opening, which they call a *shank*, or *shaft*, so that the mine may have two or more openings: and thus by reason of the difference of temperature between the open atmosphere and that in the mine, there is a continual draught of air through them both. This current will always be stronger in proportion to the difference between the external atmosphere and that of the mine; and likewise in proportion to the difference between the depth of the two shafts. But as the temperature of the atmosphere is variable, it happens at certain seasons of the year, that there is not a sufficient difference between that of the atmosphere and in the mine to produce the necessary circulation. This happens principally in the spring and autumn; at which seasons it is necessary to light fires in the shafts, which are always efficacious for the purpose desired.

Among the other uses to which dephlogisticated air might be applied, Mr Cavallo reckons that of securing people from the dangerous effects of damps in mines, and other subterraneous places. "If a large bladder," says he, "into which a solution of lime in water is introduced, be filled with dephlogisticated air, and a small wooden or glass pipe be adapted to its neck, a man may hold that pipe in his mouth, and may breathe the dephlogisticated air; and thus equipped, he may enter into these subterranean places, amidst the various elastic fluids contained in them. A large bladder of dephlogisticated air will serve for above a quarter of an hour, which is a length of time sufficient for various purposes; besides, if longer time is required to be spent in these places, a person may have two or more bladders of dephlogisticated air along with him, and may shift as soon as the air of one is contaminated. Without the necessity of any more complicated apparatus, the bladders full of dephlogisticated air may be kept stopped by putting corks into the glass or wooden pipes that are tied to their necks. This air might also be used for diving-bells."

DAMSEL, from the French *damoisel* or *damoiseau*, an appellation anciently given to all young people of either sex, that were of noble or genteel extraction, as the sons and daughters of princes, knights, and barons: thus we read of Damsel Pepin, Damsel Louis le Gros, Damsel Richard Prince of Wales.

From the sons of kings this appellation first passed to those of great lords and barons, and at length to those of gentlemen who were not yet knights.

At present damsel is applied to all maids or girls not married, provided they be not of the vulgar.

DAN, or JOR-DAN, which last literally denotes "the river Dan;" so named from the people where it has its source, which is a lake called *Phiala*, from its round figure, to the north of its apparent rising from the mountain Panium or Paneum, as was discovered by Philip, tetrarch of Trachonites; for on throwing light bodies into the Phiala, he found them to emerge again at Paneum (Josephus). From Paneum it runs in a direct course to a lake called *Samachonites*, as far as which it is called *Jordan the less*; and thence to the lake

lake Genesareth, or of Tiberias, where it comes increased by the lake Samachonites and its springs, and is called the *Greater Jordan;* continuing its direct course southwards, till it fall into the Asphaltites.

DAN, in *Ancient Geography*, a town to the west of the source of the Jordan; formerly called *Lais* (Joshua, Judges, Josephus). This was the north, as Beersheba was the south, boundary of the Israelites; as appears from the common expression in Scripture from *Dan* to *Beersheba.* At Dan Jeroboam erected one of the golden calves (1 Kings xii.).

DAN, the tribe, extended itself westward of Judah, and was terminated by Azotas and Dora on the Mediterranean (Josephus.)

DANAE, in antiquity, a coin somewhat more than an obolus, used to be put into the mouths of the dead, to pay their passage over the river Acheron.

DANAE, in fabulous history, was the daughter of Acrisius king of Argos, by Eurydice. She was confined in a brazen tower by her father, who had been told by an oracle that his daughter's son would put him to death. His endeavours to prevent Danae from becoming a mother proved fruitless; and Jupiter, who was enamoured of her, introduced himself into her bed by changing himself into a golden shower. From his embraces Danae had a son, with whom she was exposed on the sea by her father. The wind drove the bark which carried her to the coasts of the island of Seriphus, where she was saved by some fishermen, and carried to Polydectes king of the place, whose brother, called *Dictys*, educated the child called *Perseus*, and tenderly treated the mother. Polydectes fell in love with her; but as he was afraid of her son, he sent him to conquer the Gorgons, pretending that he wished Medusa's head to adorn the nuptials which he was going to celebrate with Hippodamia the daughter of Oenomaus. When Perseus had victoriously finished his expedition, he retired to Argos with Danae to the house of Acrisius, whom he inadvertently killed. Some suppose that it was Proetus the brother of Acrisius who introduced himself to Danae in the brazen tower; and instead of a golden shower, it was maintained that the keepers of Danae were bribed by the gold of her seducer. Virgil mentions that Danae came to Italy with some fugitives of Argos, and that she founded a city called *Ardea*.

DANAIDES, in fabulous history, the fifty daughters of Danaus king of Argos. When their uncle Ægyptus came from Egypt with his fifty sons, they were promised in marriage to their cousins; and before the celebration of their nuptials, Danaus, who had been informed by an oracle that he was to be killed by the hands of one of his sons-in-law, made his daughters solemnly promise that they would destroy their husbands. They were provided with daggers by their father; and all except Hypermnestra stained their hands with the blood of their cousins the first night of their nuptials; and, as a pledge of their obedience to their father's injunctions, they presented him each with the head of the murdered sons of Ægyptus. Hypermnestra was summoned to appear before her father, and answer for her disobedience in suffering her husband Lynceus to escape; but the unanimous voice of the people declared her innocent, and she dedicated a temple to the goddess of Persuasion. The sisters were purified of this murder by Mercury and Minerva by order of Jupiter; but according to the more received opinion, they were condemned to severe punishment in hell, and were compelled to fill with water a vessel full of holes, so that the water ran out as soon as poured into it; and therefore their labour was infinite, and their punishment eternal. The heads of the sons of Ægyptus were buried at Argos; but their bodies were left at Lerna, where the murder had been committed.

DANAUS, in fabulous history, a son of Belus and Anchinoe, who, after his father's death, reigned conjointly with his brother Ægyptus on the throne of Egypt. Some time after, a difference arose between the brothers, and Danaus set sail with his fifty daughters in quest of a settlement. He visited Rhodes, where he consecrated a statue to Minerva, and arrived safe on the coast of Peloponnesus, where he was hospitably received by Gelanor king of Argos. Gelanor had lately ascended the throne, and the first years of his reign were marked with dissensions with his subjects. Danaus took advantage of Gelanor's unpopularity, and obliged him to leave the crown. In Gelanor, the race of the Inachidæ was extinguished, and the Belides began to reign at Argos in Danaus. Some authors say, that Gelanor voluntarily resigned the crown to Danaus, on account of the wrath of Neptune, who had dried up all the waters of Argolis, to punish the impiety of Inachus. The success of Danaus invited the fifty sons of Ægyptus to embark for Greece. They were kindly received by their uncle; who, either apprehensive of their number, or terrified by an oracle which threatened his ruin by one of his sons-in-law, caused his daughters, to whom they were promised in marriage, to murder them the first night of their nuptials. His order was executed. Hypermnestra alone spared the life of Lynceus: (See DANAIDES). Danaus at first persecuted Lynceus with unremitted fury; but he was afterwards reconciled to him, and he acknowledged him for his son-in-law and successor after a reign of 50 years. He began his reign about 1586 years before the Christian era; and after death he was honoured with a splendid monument in the town of Argos, which still existed in the age of Pausanias. According to Æschylus, Danaus left Egypt, not to be present at the marriage of his daughters with the sons of his brothers; a connexion which he deemed unlawful and impious.

DANCE, or DANCING, as at present practised, may be defined "an agreeable motion of the body, adjusted by art to the measures or tone of instruments, or of the voice."—But, according to what some reckon more agreeable to the true genius of the art, dancing is "the art of expressing the sentiments of the mind, or the passions, by measured steps or bounds that are made in cadence, by regulated motions of the body, and by graceful gestures: all performed to the sound of musical instruments or of the voice."

There is no account of the origin of the practice of dancing among mankind. It is found to exist among all nations whatever, even the most rude and barbarous; and, indeed, however much the assistance of art may be necessary to make any one perfect in the practice, the foundation must certainly lie in the mechanism of the human body itself.

The connexion that there is between certain sounds and those motions of the human body called *dancing*, hath seldom or never been inquired into by philosophers, though it is certainly a very curious speculation. The power of certain sounds not only over the human species, but even over the inanimate creation, is indeed very surprising. It is well known, that the most solid walls, nay the ground itself, will be found to shake at some particular notes in music. This strongly indicates the presence of some universally diffused and exceedingly elastic fluid, which is thrown into vibrations by the concussions of the atmosphere upon it, produced by the motion of the sounding body.—If these concussions are so strong as to make the large quantity of elastic fluid vibrate that is dispersed through a stone wall or a considerable portion of earth, it is no wonder they should have the same effect upon that invisible and exceedingly subtle matter that pervades and seems to reside in our nerves.

Some there are that have their nerves constructed in such a manner, that they cannot be affected by the sounds which affect others, and some scarce with any; while others have such an irritability of the nerves in this case, that they cannot, without the greatest difficulty, sit or stand still when they hear a favourite piece of music played.

It is conjectured by very eminent philosophers, that all the sensations and passions to which we are subject, do immediately depend upon the vibrations excited in the nervous fluid above mentioned. Hence, musical sounds have the greatest power over those people who are of a delicate sensible frame, and who have strong passions. If it be true, therefore, that every passion in the human nature immediately depends upon a certain affection of the nervous system, or a certain motion or vibration in the nervous fluid, we shall immediately see the origin of the different dances among different nations. One kind of vibration, for instance, raises the passions of anger, pride, &c. which are indispensably necessary in warlike nations. The sounds, for such there are, capable of exciting a similar vibration, would naturally constitute the martial music among such nations, and dances conformable to it would be instituted. This appears to be the case particularly among barbarous nations, as we shall presently have occasion to remark. Other vibrations of the nervous fluid produce the passions of joy, love, &c.; and sounds capable of exciting these particular vibrations will immediately be formed into music for dancers of another kind.

As barbarous people are observed to have the strongest passions, so they are also observed to be the most easily affected by sounds, and the most addicted to dancing. Sounds to us the most disagreeable, the drumming of sticks upon an empty cask, or the noise made by blowing into reeds incapable of yielding one musical note tolerable to us, is agreeable music to them. Much more are they affected by the sound of instruments which have any thing agreeable in them. Mr Gallini informs us, that "The spirit of dancing prevails almost beyond imagination among both men and women in most parts of Africa. It is even more than instinct, it is a rage, in some countries of that part of the globe.—Upon the Gold coast especially, the inhabitants are so passionately fond of it, that in the midst of their hardest labour, if they hear a person sing, or any musical instrument played, they cannot refrain from dancing.—There are even well attested stories of some negroes flinging themselves at the feet of an European playing on a fiddle, entreating him to desist, unless he had a mind to tire them to death; it being impossible for them to cease dancing while he continued playing."

The same thing is found to take place in America, though, as the inhabitants of that continent are found to be of a more fierce and barbarous nature than the African nations, their dances are still more uncouth and barbarous than those of the negroes. "In Mexico, says Gallini, they have also their dances and music, but in the most uncouth and barbarous style. For their symphony they have wooden drums, something in form of a kettle-drum, with a kind of pipe or flagelet, made of a hollow cane or reed, but very grating to an European ear. It is observed they love every thing that makes a noise, how disagreeable soever the sound is. They will also hum over something like a tune when they dance 30 or 40 in a circle, stretching out their hands, and laying them on each others shoulders. They stamp and jump, and use the most antic gestures for several hours, till they are heartily weary. And one or two of the company sometimes step out of the rings to make sport for the rest, by showing feats of activity, throwing their lances up into the air, catching them again, bending backwards, and springing forwards with great agility."

The origin of dancing among the Greeks was most certainly the same as among all other nations; but as they proceeded a certain length in civilization, their dances were of consequence more regular and agreeable than those of the more barbarous nations. They reduced dancing into a kind of regular system; and had dances proper for exciting, by means of the sympathy above mentioned, any passion whatever in the minds of the beholders. In this way they are said to have proceeded very great lengths, to us absolutely incredible. At Athens it is said, that the dance of the Eumenides or Furies on the theatre had so expressive a character as to strike the spectators with irresistible terror: men grown old in the profession of arms trembled; the multitude ran out; women with child miscarried; people imagined they saw in earnest those terrible deities commissioned with the vengeance of heaven to pursue and punish crimes upon earth.

The Greeks had martial dances, which they reckoned to be very useful for keeping up the warlike spirit of their youth; but the Romans, though equally warlike with the Greeks, never had any thing of the kind. This probably may be owing to the want of that romantic turn for which the Greeks were so remarkable. The Romans had no heroes among them, such as Hercules, Achilles, or Ajax; nor does the whole Roman history furnish an example of a general that made war after the manner of Alexander the Great. Though their soldiers were as valiant as ever the Greeks could pretend to be, the object with them was the honour of the republic, and not their own personal praise. Hence there was less fury, and much more cool deliberate valour, exercised by the Romans than any other nation whatever. The passions of pride, resentment, obstinacy, &c. were excited in them, not by the mechanical means of music and dancing, but by being taught that it was their chief honour to fight for the republic. It does not

not however appear, that the Romans were at all less capable of being affected in this mechanical manner than the Greeks. When dancing was once introduced, it had the very same effects at Rome as at Athens.

Among the Jews, dancing seems to have made a part of the religious worship on some occasions, as we learn from some passages in the Psalms, though we do not find either that or singing positively enjoined as a divine precept. In the Christian churches mentioned in the New Testament, there is no account of dancing being introduced as an act of worship, though it is certain that it was used as such in after ages. Mr Gallini tells us, that "at Limoges, not long ago, the people used to dance the round in the choir of the church which is under the invocation of their patron saint; and at the end of each psalm, instead of the *Gloria Patri*, they sung as follows: *St Marcel, pray for us, and we will dance in honour of you.*"—Though dancing would now be looked upon as the highest degree of profanation in a religious assembly, yet it is certain, that dancing, considered as an expression of joy, is no more a profanation than singing, or than simple speaking; nor can it be thought in the least more absurd, that a Christian should dance for joy that Jesus Christ is risen from the dead, than that David danced before the ark when it was returned to him after a long absence.

Plato reduces the dances of the ancients to three classes. 1. The military dances, which tended to make the body robust, active, and well disposed for all the exercises of war. 2. The domestic dances, which had for their object an agreeable and innocent relaxation and amusement. 3. The mediatorial dances, which were in use in expiations and sacrifices.—Of military dances there were two sorts: the *gymnopedique* dance, or the dance of children; and the *enoplian*, or armed dance. The Spartans had invented the first for an early excitation of the courage of their children, and to lead them on insensibly to the exercise of the armed dance. This children's dance used to be executed in the public place. It was composed of two choirs; the one of grown men, the other of children: whence, being chiefly designed for the latter, it took its name. They were both of them in a state of nudity. The choir of the children regulated their motions by those of the men, and all danced at the same time, singing the poems of Thales, Alcman, and Dionysodotus.—The *enoplian* or *pyrrhic* was danced by young men armed cap-a-pee, who executed, to the sound of the flute, all the proper movements either for attack or for defence. It was composed of four parts.—The first the *podism* or footing; which consisted in a quick shifting motion of the feet, such as was necessary for overtaking a flying enemy, or for getting away from him when an overmatch.—The second part was the *xiphism*: this was a kind of mock fight, in which the dancers imitated all the motions of combatants; aiming a stroke, darting a javelin, or dexterously dodging, parrying, or avoiding a blow or thrust. The third part, called the *komos*, consisted in very high leaps or vaultings, which the dancers frequently repeated for the better using themselves occasionally to leap over a ditch, or spring over a wall. The *tetracomos* was the fourth and last part: this was a square figure, executed by slow and majestic movements; but it is uncertain whether this was everywhere executed in the same manner.

Of all the Greeks, the Spartans were those who most cultivated the Pyrrhic dance. Athenæus relates, that they had a law by which they were obliged to exercise their children at it from the age of five years. This warlike people constantly retained the custom of accompanying their dances with hymns and songs. The following was sung for the dance called *trichoria*, said to be instituted by Lycurgus, and which had its name from its being composed of three choirs, one of children, another of young men, and the third of old. The old men opened the dance, saying, "In time past we were valiant." The young men answered, "We are so at present." "We shall be still more so when our time comes," replied the chorus of children. The Spartans never danced but with real arms. In process of time, however, other nations came to use only weapons of wood on such occasions. Nay, it was only so late as the days of Athenæus, who lived in the second century, that the dancers of the Pyrrhic, instead of arms, carried only flasks, ivy-bound wands (thyrsus) or reeds. But, even in Aristotle's days, they had begun to use thyrsuses instead of pikes, and lighted torches in lieu of javelins and swords. With these torches they executed a dance called the *conflagration of the world*.

Of the dances for amusement and recreation, some were but simply gambols, or sportive exercises, which had no character of imitation, and of which the greater part exist to this day. The others were more complex, more agreeable, figured, and were always accompanied with singing. Among the first or simple ones was the *ascoliasmus*: which consisted in jumping, with one foot only, on bladders filled with air or wine, and rubbed on the outside with oil. The *dypodium* was jumped with both feet close. The *kybeslesis* was what is called in this country the *somerset*.—Of the second kind was that called the *wine-press*, of which there is a description in Longinus, and the Ionian dances: these last, in the original of their institution, had nothing but what was decent and modest; but, in time, their movements came to be so depraved, as to be employed in expressing nothing but voluptuousness, and even the grossest obscenity.

Among the ancients there were no festivals nor religious assemblies but what were accompanied with songs and dances. It was not held possible to celebrate any mystery, or to be initiated, without the intervention of these two arts. In short, they were looked upon to be so essential in these kinds of ceremonies, that to express the crime of such as were guilty of revealing the sacred mysteries, they employed the word *kheistæ*, "to be out of the dance." The most ancient of these religious dances is the *Bacchic*; which was not only consecrated to Bacchus, but to all the deities whose festival was celebrated with a kind of enthusiasm. The most grave and majestic was the *hyporchematic*; it was executed to the lyre, and accompanied with the voice. At his return from Crete, Theseus instituted a dance at which he himself assisted at the head of a numerous and splendid band of youths, round the altar of Apollo. The dance was composed of three parts: the *strophe*, the *antistrophe*, and the *stationary*. In the strophe, the movements were from the right to the left; in the antistrophe,

phe, from the left to the right. In the stationary, they danced before the altar; so that the stationary did not mean an absolute pause or rest, but only a more slow or grave movement. Plutarch is persuaded, that in this dance there is a profound mystery. He thinks, that by the strophe is indicated the motion of the world from east to west; by the antistrophe, the motion of the planets from the west to the east; and by the stationary, the stability of the earth. To this dance Theseus gave the name of *geranos*, or "the crane:" because the figures which characterised it bore a resemblance to those described by cranes in their flight.

With regard to the modern practice of dancing as an art, there are few directions that can be of much service. The following is extracted from Mr Gallini's description of the several steps or movements.

"The dancing (says he) is generally on a theatre, or in a saloon or room. At the theatre there are four parts to be considered. 1. The nearest front to the spectators. 2, and 3. The two sides or wings. 4. The farthest front from the spectators.

"In a saloon or room, the place in which are the spectators decides the appellation respectively to them of right and left. The dancer should place himself in as advantageous a point of view to them as possible.

"In the dance itself, there are to be distinguished, the attitude of the body, the figure, the position, the bends, the risings or leaps, the steps, the cabriole, the fallings, the slides, the turns of the body, the cadences.

"The *attitude* of the body requires the presenting one's self in the most graceful manner to the company.

"The *figure* is to follow the track prescribed to the steps in the dance.

"The *position* is that of the varied attitudes, which must be at once striking and easy, as also of the different exertions of the legs and feet in dancing.

"The *bends* are inflections of the knees, of the body, of the head, of the arms.

"The *risings* are the contrast to the bends, the extension of the knee. One of these two motions necessarily precedes the other.

"The *step* is the motion by the foot or feet from one place to another.

"The *leap* is executed by springing up into the air; it begins with a bend, and proceeds with a quick extension of the legs, so that both feet quit the ground.

"The *cabriole* is the crossing, or cutting of capers, during the leap, before the return of the feet to the ground.

"The *falling* is the return of the feet to the ground, by the natural gravitation of the body.

"The *slide* is the action of moving the foot along the ground without quitting it.

"The *turn* is the motion of the body towards either side, or quite round.

"The *cadence* is the knowledge of the different measures, and of the times of movement the most marked in the music.

"The *track* is the line marked by the dance: it may be either straight or curve, and is susceptible of all the inflections correspondent to the various designs of the composer. There are the right, the diametral line, the circular line, and the oblique line. The *right* line is that which goes lengthwise, reckoning from one end of the room towards the other. The *diametral* line is across the room, from one side to the other. The *circular* line is waving, or undulatory, from one place to another. The *oblique* line proceeds obliquely from one quarter of the room towards another.—Each of these lines may directly or separately form the dancer's track, diversified with steps and positions.

"The *regular* figure is when two or more dancers move in contrary directions; that is to say, that when one moves towards the right, the other moves to the left. The *irregular* line is when the couples figuring together are both on the same side.

"Commonly the man gives the right hand to the lady in the beginning or ending of the dance, as we see in the *minuet*, *louvre*, &c.

"When a great number of dancers figure together, they are to execute the figure agreeably to the composition of the dance, with special attention to keep an eye constantly on the partner. When, in any given dance, the dancers have danced for some time in the same place, the *track* is only to be considered as the conductor of the *steps*, but not of the *figure*; but when the dance continues, without being confined to the same place, then the *track* must be considered as the conductor both of the steps and of the figure.

"Now, to observe the figure, the dancer must have placed himself at the beginning of the track upon which he is to dance, and comprehend the figure before he himself begins it. He is to remark and conceive whether the figure is right, diametrical, circular, or oblique; if it is progressive or retrogressive, or towards the right or left. He should have the air played or sung to him, to understand the movement.—Where the tracks cross one another, the steps of each of the couples must leave a sufficient distance between them not to confuse the figure.

"There are commonly reckoned ten kinds of positions, which are divided into *true* and *false*, five each.—There are three principal parts of the foot to be observed; the toes, the heel, and the ancle.

"The true positions are when the two feet are in a certain uniform regularity, the toes turned equally outwards.—The false are divided into regular and irregular. They differ from the true, in that the toes are either both turned inwards; or if the toes of one foot are turned outwards, the others are turned inwards.

"In the first of the true positions, the heels of the two feet are close together, so that they touch; the toes being turned out. In the second, the two feet are open in the same line, so that the distance between the two heels is precisely the length of one foot. In the third, the heel of one foot is brought to the ancle of the other, or seems to lock in with it. In the fourth the two feet are the one before the other a foot's length distance between the two heels, which are on the same line. In the fifth, the two feet are across, the one before the other; so that the heel of one foot is directly opposite to the toes of the other.

"In the first of the false positions, the toes of both feet are turned inwards so that they touch, the heels being open. The second is, when the feet are asunder at a foot's distance between the toes of each, which are turned inward, the heels being on a line. The third is when the toes of one foot are turned outwards, the other

other inwards, so that the two feet form a parallel. The fourth is, when the toes of the two feet are turned inwards; but the toes of one foot are brought nearer the ancle of the other. The fifth is, when the toes of the two feet are turned inwards, but the heel of one foot is opposite to the toes of the other.

" There are mixed positions, composed of the true and false in combination; which admit of such infinite variety, and are in their nature so unsusceptible of description by words, that it is only the sight of the performance that can give any tolerable idea of them.

" Of the bends of the knee there are two kinds; the one *simple*, the other *forced*. The simple bend is an inflection of the knees without moving the heel, and is executed with the foot flat on the ground. The forced bend is made on the toes with more force and lower.

" Much is to be observed on the head of *steps*. First, not to make any movement before having put the body in an upright posture, firm on the haunches.

" Begin with the inflection of the knee and thigh; advance one leg foremost, with the whole foot on the ground, laying the stress of the body on the advanced leg.

" There are some who begin the step by the point of the toes; but that has an air of theatrical affectation. Nothing can be more noble than a graceful ease and dignity of step. The quantity of steps used in dancing are almost innumerable; they are nevertheless reducible under five denominations, which may serve well enough to give a general idea of the different movements that may be made by the leg, viz. the direct step, the open step, the circular step, the twisted step, and the cut step.

" The *direct* step is when the foot goes upon a right line, either forwards or backwards.

" The *open* step is when the legs open. Of this step there are three kinds; one when they open outwards; another, when, describing a kind of circle, they form an in-knee'd figure; a third, when they open sidewise; this is a sort of right step, because the figure is in a right line.

" The *round* is when the foot, in its motion, makes a circular figure, either inwards or outwards.

" The *twisted* step, or *pas tortille*, is when the foot in its motions turns in and out. There are three kinds of this step; one forwards, another backwards, and the third sidelong.

" The *cut* step is when one leg or foot comes to strike against the other. There are also three sorts of this step; backwards, and sidelong.

" The steps may be accompanied with bendings, risings, leaps, cabrioles, fallings, slidings, the foot in the air, the tip-toe, the rest on the heel, quarter-turns, half-turns, three-quarter turns, and whole turns.

" There may be practised three kinds of bends, or sinkings, in the steps; viz. bending before the step proceeds, in the act of stepping, and at the last of the steps.

" The beginning or initial sink-pace is at the first setting off, on advancing the leg.

" The bend in the act of stepping continues the march or walk.

" The final sink-pace closes the march.

" The rising is just the reverse of the bend, or sink-pace, which shall have preceded it.

" Some great masters in the art of dancing, having observed that music, which is inseparable from it, was capable of being preserved and conveyed by the musical characters, imagined by analogy, that the like advantage could be procured to the composition of dancers. Upon this plan they attempt what is called the *chorography*, an art which they suppose was either utterly unknown to the ancients, or not transmitted to us from them.

" It may indeed be easily allowed, that the track or figure of a dance may be determined by written or engraved lines; but those lines will necessarily appear so perplexing, so intricate, so difficult, if not impossible to seize in their various relations, that they are only fit to disgust and discourage, without the possibility of their conveying a satisfactory or retainable instruction.— Whence it is, that the article *Chorography* in the French *Encyclopedie* is universally exploded as unintelligible and useless: though nothing more than an elementary indication of the art; and an explanation, such as it is, of some of the technical terms of it."

Stage-DANCES. The Greeks were the first who united the dance to their tragedies and comedies; not indeed as making part of those spectacles, but merely as an accessary.

The Romans, as usual, copied after the Greeks; but in the reign of Augustus they left their instructors far behind them. Two very extraordinary men made their appearance at that time: they invented a new species of entertainment, and carried it to an astonishing degree of perfection. Nothing was then talked of but the wonderful talents and amazing performances of Pylades and Bathylus, who were the first to introduce among the Romans what the French call the *ballet d'action*, wherein the performer is both actor and dancer.

Pylades undertook the hard task of representing, with the assistance of the dance alone, strong and pathetic situations. He succeeded perhaps beyond his own expectation, and may be called the father of that style of dancing which is known to us by the name of *grave* or *serious pantomime*.

Bathylus an Alexandrian and a freedman of Mecenas, took upon himself to represent such subjects as required a certain liveliness and agility. He was handsome in his person; and the two great scourges of Roman follies, Persius, and especially Juvenal, speak of him as the gallant of every woman in Rome. The latter, in his cynic style, even goes so far as to say, that when Bathylus performed the dance called, after the name of a celebrated female dancer, *Cheromenos-Leda*, the gravest matron was turned off her guard, and the young virgin longed for the dancer's addresses.

Nature had been excessively partial to those two men. They were endowed with genius, and all the exterior charms that could captivate the eye. By their study, application, and the desire to establish a lasting reputation, they displayed to the greatest advantage all the resources which the art of dancing could supply. These, like two phenomena, disappeared, and never did the world see " their like again." Government withdrew

withdrew its protection; the art gradually sunk into obscurity, and became even entirely forgotten on the accession of Trajan to the empire.

Thus buried with the other arts in entire oblivion, dancing remained uncultivated till about the 15th century, when ballets were revived in Italy at a magnificent entertainment given by a nobleman of Lombardy at Tortona, on account of the marriage between Galeas duke of Milan and Isabella of Arragon. Every resource that poetry, music, dancing, and machinery could supply, was employed and exhausted on the occasion. The description given of so superb an entertainment excited the admiration of all Europe, and excited the emulation of several men of genius, who improved the hint to introduce among their countrymen a kind of spectacle equally pleasing and novel.

It would seem, however, that at first the women had no share in the public or theatrical dance; at least we do not see them mentioned in the various entertainments given at the opera in Paris till the 21st of January 1681, when the then dauphiness, the princess of Conti, and some other ladies of the first distinction in the court of Louis XIV. performed a ballet with the opera called *Le Triomphe de l'Amour*. This union of the two sexes served to enliven and render the spectacle more pleasing and more brilliant than it ever was at any other period. It was received with so much applause, that on the 16th of May following, when the same opera was acted in Paris at the theatre of the Palais Royal, it was thought indispensable for the success of that kind of entertainment to introduce female dancers. They have continued ever since to be the principal support of the opera.

The dance is now in such commendation, that, particularly in France, the opera-house seems rather an academy for dancing, than calculated for the representation of lyric poems. The disgusting and immoderate length of their recitatives is one of the chief causes of that general taste for dancing which prevails amongst them. A wit being asked one day what could be done to keep up an opera threatened with a most complete damnation? "Do! (says he); why, lengthen the dances and shorten the petticoats." So evident it is, that singing, though apparently the chief purpose of an opera, is by no means the most pleasing part of the entertainment for the spectators.

Thus what was at first introduced as a mere accessary to the musical performance, became in process of time its only support; and this circumstance excited the emulation of several eminent ballet-masters. The art, however, of composing those grand dances, which are now so much admired, was for many years in a state of infancy, till Monsieur Noverre stept forth and gave it that degree of perfection which it seems impossible to exceed. This celebrated ballet-master and performer, in a work lately published, has with great elegance and ingenuity delineated the nature, objects, and powers of dancing, enumerated the proper requisites to give it effect, and shown how much it may be ennobled by an acquaintance with the kindred arts.

Ballets, he observes, have hitherto been the faint sketches only of what they may be one day. An art entirely subservient, as this is, to taste and genius, may receive daily variation and improvements. History, painting, mythology, poetry, all join to raise it from that obscurity in which it lies buried; and it is truly surprising, that composers have hitherto disdained so many valuable resources.

According to our author, the reason why this art has remained so long in its infancy, is because its effects have been restrained to the transitory ones of fire-works calculated only to please the eye: and it never was supposed to have powers sufficient to speak to the heart: whereas it may vie, he says, with the best dramatic pieces, prove equally interesting, and captivate the spectator by the charms of the most complete illusion.

If ballets, therefore, says he, "are for the most part uninteresting and uniformly dull: if they fail in the characteristic expression which constitutes their essence, the effect does not originate from the art itself, but should be ascribed to the artists. Are then the latter to be told that dancing is an imitative art? I am indeed inclined to think that they know it not, since we daily see the generality of composers sacrifice the beauties of the dance, and give up the graceful *naiveté* of sentiment, to become the servile copyists of a certain number of figures, known and hackneyed for above a century; so that the ballets of Phaeton, or of any ancient opera, revived by a modern composer, would prove so very similar to former ones, that one would think they have undergone no alteration, and are the same in every step.

"Ballet-masters should consult the productions of the most eminent painters. This would bring them nearer to nature, and induce them to avoid, as often as possible, that symmetry of figures, which, by repeating the object, present two different pictures on one and the same canvas.

"Those symmetrical figures from right to left, according to my judgment, are supportable only in the entrées, which are not meant to express any thing in particular, but are only calculated to afford some relief to the principal dancers. They may be introduced in a general dance at the conclusion of an entertainment; they may also be admitted in the *pas* of four, six, &c. though in my opinion it be ridiculous even in this case to prefer the display of bodily strength and agility to expression and sentiment. But such figures must give way to nature in what we call *ballets d'action*. An instance, though perhaps not very forcible, may serve to elucidate and support my argument.

"At the sudden and unexpected appearance of some young fauns, a troop of nymphs take themselves to flight with equal affright and precipitation. The former are in pursuit of the latter with that eagerness which the very hope of pleasure can inspire. Now they stop to observe what impression they have made on the nymphs; these at the same time, and for a similar reason, check their career; with fear they survey their pursuers, endeavour to guess at their intentions, and provide for a retreat to some spot, where they may rest secure from the dangers that threaten them. Both troops now join, the nymphs resist, defend themselves, and at last effect their escape with no less swiftness than dexterity.

"This I call a busy active scene, in which the dance, as it were, should speak with energy. Here studied and symmetrical figures cannot be introduced, without a manifest violation of the truth, without destroying

stroying the rules of probability, and without weakening the action and lessening the effect.—This scene should be conspicuous; for its beautiful disorder, and the art of the composer, must here be the handmaids of nature.

"A ballet-master, devoid of taste and discernment, will make of this a mechanical piece of dancing, and thus deprive it of the effect it was calculated to produce, for want of entering into the spirit of it. His nymphs and fauns will be arranged upon a parallel line: he will place the former in attitudes awkwardly uniform, and insist on the latter holding up their arms to an even altitude; rather than deviate from the beaten path, and the antique rules of opera-dancing, he will cautiously avoid to have, on the right and left, his nymphs placed in unequal numbers, but will reduce a scene of action, which ought to be supported with spirit, to an exercise equally affected and uninteresting.

"Perhaps some ill-disposed critics, so far strangers to the art as not to judge of it from its various effects, will maintain, that the above scene should present only two different objects, the one pourtrayed in the love-sick fauns, the other expressed by the affright of the nymphs. But how many shades may serve to embellish those pictures? how varied may be the strokes of the pencil? how opposite the lights? and what a number of tints ought to be employed in order to draw from this twofold situation a multiplicity of images, each more lively and spirited than the other?

"As all men share the same passions, and these differ in proportion to their sensations and feelings, they may therefore be worked upon more or less powerfully in proportion as they manifest themselves outwardly with more or less force and impetuosity. This principle once acknowledged, and nature indeed enforces it daily, it would certainly be more to the purpose to diversify the attitudes and vary the expression; for then the pantomime action of each personage would be divested of a disgusting uniformity. The truth of imitation and the skill of the painter would conspicuously appear in giving a different aspect to the features, some of them expressing a kind of ferocity, others betraying less eagerness, these casting a more tender look; and to the rest, the languishing air of voluptuousness. The sketch of this first picture naturally leads to the composition of the second: here some nymphs appear divided between fear and desire; there some others express by the contrast of their attitudes the various emotions of their soul. Some are more scornful than their companions, whilst others betray a curiosity equal to their fears. This ensemble gives life to the whole picture, and is the more pleasing that it is perfectly consistent with nature. From this exposition, you will not hesitate to agree with me, that symmetry, the offspring of art itself, should never find place in the *ballets d'action.*

"I shall beg leave to inquire of all those who reason from habitual prejudice, whether they will look for their favourite symmetry in a herd of sheep flying from the wolf, or among wretched peasants leaving their huts and fields, in order to shelter themselves from the fury of a party of enemies? By no means. But the art lies in concealing art itself: my aim is by no means to introduce disorder and confusion; on the contrary, I will have regularity even in irregularity. What I most insist on is, the introducing of well-concerted groups, situations forcibly expressed, but never beyond nature, and above all, a certain ease in the composition, which betrays not the labour of the composer. As for the figures, they are likely to please only in proportion as they quickly succeed each other, and are devised with equal taste and elegance."

A ballet perfect in all its parts, our author proceeds to observe, is a picture drawn from life, of the manners, dresses, ceremonies, and customs of all nations. It must therefore be a complete pantomime, and through the eyes speak, as it were, to the very soul of the spectator. If it wants expression, if it be deficient in point of situation and scenery, it degenerates into a spectacle equally flat and monotone.

According to Plutarch, a ballet is, if the expression may be allowed, a mute conversation, or a speaking and animated picture, whose language consists of motions, figures, and gestures.—These figures, says our author, are unlimited in their number, because there are a thousand things that the ballet may express. Phrynicus, one of the oldest tragedy writers, says, that he could find in our ballet as many figures as the sea rolls waves in a high winter tide.

A well-composed ballet, therefore, may do without the assistance of words: M. Noverre even remarks that these only serve to weaken the action, and partly destroy its effects. He has no opinion of a pantomime which, in order to be understood, must borrow the help of a verbal explanation. "Any ballet whatever (says he) destitute of intrigue, action, and interest, displaying nothing more than the mechanical beauties of the art, and though decorated with a pompous title, unintelligible throughout, is not unlike those portraits and pictures to which the painters of old subscribed the names of the personages and actions they meant to represent: because they were imperfect in point of imitation, the situations weakly expressed, the outlines incorrect, and the colours unseemly.

"When dancers shall feel, and, Proteus-like, transform themselves into various shapes to express to the life the conflict of passions; when their features, their very looks, shall speak their inward feelings; when extending their arms beyond the narrow circle prescribed by the rigid rules of pedantry, and with equal grace and judgment giving them a fuller scope, they shall by proper situations describe the gradual and successive progress of the passions; when, in fine, they call good sense and genius to the assistance of their art; then they may expect to distinguish themselves: explanatory speeches will become useless; a mute but powerful eloquence will be substituted to much better effect; each motion will be a sentence; every attitude will pourtray a situation; each gesture convey a thought, and each glance a new sentiment: every part will please, because the whole will be a true and faithful imitation of nature.

A ballet, in whatever style it may be, should, according to Aristotle, be composed, as well as poetry, of two different parts, which he calls parts of quality and parts of quantity. Nothing exists in nature without matter, form, and figure: the ballet therefore becomes a mere nonentity, if it be deficient in any of those

those essential parts which mark and constitute the being of any one thing animate or inanimate. The matter here is the subject intended for representation; its form consists in the ingenious distribution of the plan; and the various compounding parts constitute its figure. Form therefore contains the parts of quality, and the extent the parts of quantity.

Thus it appears, that ballets are in some degree subject to the rules of poetical composition. They, nevertheless, differ from tragedies and comedies, in that the former are not subject to the three unities of time, place, and action: Yet they require an unity of plot, in order that the various scenes may meet and end on the same point.—The ballet, therefore, may be termed the brother of the dramà, though not restrained to its stricter rules, which only serve to cramp the imagination, check its flight, and confine genius; and if adhered to, must set aside all thought of composition of ballets, by depriving them of their chief ornament, pleasing variety.

M. Noverre considers tragedy as the subject most suitable for the art of dancing. The former abounds in noble incidents, situations, &c. and these produce the best stage effects. Besides, the passions are more forcibly expressed by great characters than by common men: the imitation is of course less difficult, the action in the pantomime more significant, natural, and intelligible.

"The business of a skilful master (he observes), is to foresee, as it were at one glance, the general effect that may result from the ensemble, and never give the preference to one single part over the whole. The only way for him to bestow his thoughts on the greatest number, is to forget for a while the principal characters of the drama; if his whole attention should entirely be taken up with the parts of his first dancers of both sexes, the action is suspended, the scenes are slow in their progress, and the whole performance must fall short of its desired effect.

"In the tragedy of Merope by Voltaire, the principal characters are Merope, Polifonte, Egiste, and Narbas: But although the parts of the inferior actors are not of equal importance, yet they all concur to the general action, and to the progression of the drama, which would appear deficient in some parts, should either of those characters be wanting in the representation. No useless personage should be obtruded on the stage. Every thing therefore that may tend to weaken the effect of the drama ought to be carefully avoided, and only that number of actors introduced which is barely requisite for the execution of the performance.

"A ballet is a production of the same kind. It must be divided into acts and scenes, each of which, as well as the act itself, must have its beginning, its middle, and its end; that is, in other words, exposition, plot, and denouement.

"I have observed above, that the principal performers in a ballet should be forgotten for a while: My reason is, that, in my opinion, it is easier to give striking parts to Hercules and Omphale, Ariadne and Bacchus, Ajax and Ulysses, &c. than to 24 persons in their retinue. If these have nothing to say, they are superfluous, and of course ought to be rejected; but if they are to speak, let their conversation be consonant with that of the principal characters.

"The difficulty, therefore, does not lie in assigning a primary and distinctive part to Ajax or Ulysses; since it springs naturally from the importance of their situation in the play; but in introducing the figures in a becoming style, giving them parts of more or less importance, connected with the action of the two heroes; in introducing women, some of whom will appear concerned for Ajax, and the greater number showing their partiality for Ulysses. The triumph of the latter, the former's death, present to the man of genius a series of images that vie with each other in point of interesting and picturesque situations. These, by means of a colouring skilfully contrasted, cannot but produce the most lively sensations. In fine, a ballet pantomime should be dramatic in all its parts; and the figure-dancers, who succeed to the principal performers, ought to continue the scene, not by a number of symmetrical figures and studied steps, but by that kind of animated expression which keeps up the attention of the spectators to the main subject for which the preceding actors have prepared the audience.

"Yet, either through ignorance, or in consequence of a vitiated habit, there are but few well supported ballets. Dance is introduced for the mere purpose of dancing; the end is supposed to be answered by the mechanical motions of the feet, or by high jumping, and that the idea which people of real taste may have of a ballet is fully answered, when inactive performers are introduced in it, who mix and jostle each other, presenting a confused heap of pictures, sketched without taste, awkwardly grouped, and totally devoid of that harmony and expression, the offspring of the soul, which alone can embellish art by giving it life."

M. Noverre, in considering the knowledge necessary for attaining perfection in the present art, observes, that mythology, ancient poetry, and chronology, ought to be the primary study of a ballet-master, who ought also to possess a genius for poetry and painting, since the art borrows all its charms from a perfect imitation of nature.

A slight knowledge of geometry cannot but prove very advantageous, as it will help the master to introduce his figures in due proportion, to calculate exactly, and execute with precision. By means of that unerring guide, he will retrench every superfluous accessary, and thus enliven the performance. Taste will introduce elegance, genius create variety, and judgment direct the whole.

What is a ballet but a piece of more or less complicated machinery, which strikes or surprises the beholder by its various effects, only in proportion as those are diversified and sudden: That chain and connection of figures, those motions succeeding each other with rapidity, those various forms turning contrary ways, that mixture of different incidents, the ensemble and harmony which mark the steps and accompany the exertions of the dancers; do not all these give you the idea of a mechanism most ingeniously contrived?

Ballets are often built on preternatural subjects; several of them require the assistance of machinery. For instance, few of the subjects taken from Ovid will be be fit for representation, without a change of scenery, flights through the air, metamorphoses, &c. This author, therefore, must never be taken for a model, unless the ballet-master himself be an expert mechanist. None are to be found out of the capital, but journeymen and stage-sweepers, whom the patronage of some mighty son of the sock has preferred by degrees to that employment. The talents of those upstarts consist in, and reach not beyond, the capacity of putting up the lights which they were wont to snuff for many years, or letting down awkwardly a glory of the most wretched style. The theatres in Italy are not remarkable for their machinery; those of Germany, built upon the same plan, are not less deficient in point of that enchanting part of stage-exhibition; so that a ballet-master must, in these countries, find himself greatly embarrassed, if, unskilled in the mechanical arts, he cannot convey his ideas with perspicuity, by building for that purpose small models, which are better understood by the generality of workmen than the clearest verbal explanation.

The theatres of Paris and London are the best supplied with these resources. The English are very ingenious; their stage machinery is more simplified than the French, and of course produces a quicker effect. Among them all these kinds of works are most exquisitely finished; that neatness, care, and exactitude, which are remarkable throughout every part, greatly contribute to the precision of the whole. Those chef-d'œuvres of mechanism particularly display themselves in their pantomimes; which, however, are low and trivial, devoid of taste and interest, and built upon the meanest incidents. It may be said that this kind of entertainment, which is got up at a prodigious expence, is only calculated to please those eyes which are shocked at nothing; and that it would meet with no success on the French theatres, where no other pleasantry is permitted but such as is not incompatible with decency, abounds with delicacy and wit, and is nowise levelled against morals and humanity.

A composer who wishes to rise superior to the generality of ballet-masters, should study the painters, and trace them in their various manners of drawing and composing. Both arts have the same object in view, whether it be for taking likenesses, mixing the colours and preserving the clare-obscure; or for grouping the figures properly, laying on the draperies, throwing the former into elegant attitudes, and giving them life and expression.

Upon the same principle, the knowledge of anatomy will serve to render more clear and intelligible the precepts which he has to lay down for his pupils. It will be an easy matter for him to distinguish properly between the natural and habitual defects in their conformation. These are the greatest obstacles that so often impede the progress of young beginners. Thus once knowing the cause, he will be able to remedy the evil; as his lessons and precepts will then be the result of strict attention, they never can fail of becoming profitable.

Drawing is too useful in the composition of ballets for the master not to pay a serious attention to that art; it will contribute to the beauty of the forms; will give to the figures an air of novelty and elegance, animate the groups, throw the body into graceful positions, and show the attitudes in a just precision.

A ballet-master who is no proficient in music, will make a bad choice of his airs. He will not enter into the spirit or character of them. The motions of his dancers will not beat time with that precision and delicacy which are absolutely necessary, unless he is endued with that sensibility of organ which is more commonly the gift of nature than the result of art, and is far above what may be acquired by long practice and steady application.

A good choice of music is as essential to dancing, as the choice of words and the phrasing of a speech is to eloquence. It is the tune and time of the music that fix and determine the motion of the dancers. If the former be uniform and devoid of taste, the ballet will, like its model, be dull and unmeaning.

By this immediate connection between music and dancing, it clearly appears that, from a practical knowledge of the former, the ballet-master will derive the greatest advantages. He will then be able to impart his thoughts to the composer; and if taste and knowledge combine together, he will either set the music himself, or at least furnish the composer with the principal outlines, to characterise the action of the dancer; as this will be varied and expressive, the ballet cannot fail of being equally so. Music well composed should paint and speak; and the dance set to those sounds, will be, as it were, the echo to repeat the words. If, on the contrary, it be mute, if it speak not to the ear of the dancer, then all sentiment and expression are banished from the performance.

As nothing can appear trifling to the man of genius, nothing should seem so to the ballet-master. It is impossible for him to distinguish himself in his profession, unless he applies to study those arts which have been just mentioned. Yet to insist that he should be master of them all in that degree of perfection which is attainable only by those who give themselves entirely up to the study of each of them in particular, would be requiring a mere impossibility.

All that can be deemed strictly requisite, therefore, is a general knowledge, a slight tincture of those sciences which, by the connection they have with each other, are likely to contribute to the improvement of the art and to its reputation. From the natural union, however, that subsists between the arts, and from the harmony which reigns amongst them, that ballet-master will ennoble his composition with the most fire, spirit, liveliness, and interest, who has most genius and imagination, and whose knowledge is most extensive.

As to performers and their personal qualifications: The first point to which it is directed to pay attention when one takes up the profession of a dancer (at least so soon as he becomes capable of reflection), is his bodily formation: If one is conscious of any natural defect which seems irremediable by art, it will be best immediately to renounce every idea that may have been formed of the advantage arising from popular approbation. But where personal defects can be reformed by application, study, or the advice and assistance of judicious masters, then it becomes an essential concern quickly to exert every effort, before the parts to be corrected have acquired strength and consistence, before nature has unalterably taken her bent, and the error becomes too habitual and inveterate.

Among other personal defects, there are two which deserve particular notice: The first is that of being *jarreté*, "knock-kneed;" the other of being *arqué*, or "bow-legged."

A man is said to be *jarreté* or inknee'd when the haunches are strait, and inclining inwardly, the thighs lie near, and the knees are protuberant, and so close that they touch and knock together at every step, even when the feet are at a distance; so that such a person, from the knees to the feet, makes the figure of a triangle. In people of this formation, likewise, there is a clumsiness in the inside of the ancle, a great elevation in the instep, while the *tendo Achillis* is not only very slender, but much extended in the articulation.

The other defect of being *arqué* or bow-legged, is the opposite of the former, and exists in the same parts, namely, from the haunches to the feet, which describe a sort of bow or arch; for the haunches being in this case hollow, the thighs and knees stand open, and at a distance, so that they can never be brought in proper contact like those of a well-shaped person; their feet also are long and flat, the ancle juts out, and the *tendo Achillis* is large and closely inserted. A single view of these diametrically opposite effects, proves more forcibly than any arguments that the instructions which might correct the errors of one of this sort of dancers, would tend only to increase the defects of the other; and that consequently their aim and study ought to be correspondently opposite.

The dancer whose defect is of the first kind, that of being *jarreté*, must use the means which art furnishes him with, to separate and widen the too closely connected parts. The first step to this end is to turn the thighs outwardly, endeavouring to move them in that position, by taking the advantage of the free rotation which the thigh bone has in the *cotyloidal* cavity of the haunches: assisted by this exercise, the knees will follow the same direction, and return, as it were, to their proper position. The knee-pan (which seems intended to prevent the knee from being thrown too far backward from its insertion) will stand perpendicular over the point of the foot, while the thigh and leg thus placed describe a line that will ensure firmness and stability to the whole body.

The second remedy to be used is, to keep the knees in a constant bend, and to make them appear very much stretched, without their being really so. This must be the result of long and constant practice; but when the habit is firmly contracted, it is impossible to return to the former vicious position, without causing an insupportable pain and numbness. Some dancers have been able to conceal this defect so artfully, that it was entirely undiscoverable, unless in dancing strait-capers or in very quick movements. The reason of its becoming visible at such times is, that the contraction of the muscles in the effort of leaping makes them stiff about the articulation, and forces every part into its former and natural situation; the knees thus strained, turn inwardly, and (for the time) regain their usual protuberance, which becomes an obstacle to the display of the *entre-chat*. The more these parts connect, to the greater distance will the lower extremities be thrown; hence the legs, neither being able to beat nor cross, remain motionless at the time of the knees rolling over each other, while the *entre-chat*, being neither cut, beat, nor crossed by the feet, is deprived of that life and brilliancy which are its chief merit.

A person thus formed, should entirely renounce the *entre-chat*, *cabrioles*, and every kind of dance that requires very quick and complicated movements, as it will infallibly render him weak and powerless; for the haunches being so strait, the muscles that are attached to them (whereon the motions of the trunk depend), have not a proper and easy play, which will be always in proportion to the dimension of these bones, because then the muscles shoot out or divide from a point more distant from the centre of gravity: therefore the grander sort of dancing, and *terre à terre*, is the best adapted to such dancers; and we may add, that whatever they lose on the score of strength, they regain in elegance and address. They are luxuriant and shining in the simplest parts; easy even in difficult ones, where no great efforts are required; just in their execution; elegant in their display; and their spring is always exerted with an infinity of grace, as they dexterously employ every resource which the motion of the instep can give them. These are advantages which atone for want of personal strength; and in dancing, agility and address are always preferable to the mere efforts of force.

The art of concealing or overcoming the defects of such performers as we have characterized by being *arqué* or bow-legged, is in a great measure the opposite of the former; namely, by endeavouring to bring together the parts that are too much separated, and lessening that vacancy which is particularly observable between the knees. These require no less exercise than the former in turning the thighs outwardly, and generally are less able to disguise their faults: for being more robust and vigorous, there is less pliability in their muscles, and their joints move less easily. And it must be added, if the deformity results from a natural distortion of the bone, labour will be as useless as all the aids of art will be impotent.

It was remarked, that dancers of the first class, or *jarretés*, should preserve a slight genuflexion or bend in their performance; while these, for the opposite reason, ought to keep their limbs rather extended or stretched, and to cross more closely, by that means diminishing the vacancy occasioned by the natural separation. Such dancers are nervous, lively, and brilliant in all cases which require more strength than elegance; vigour and agility may be inferred from their muscular force, and the firmness and resistance of their articular ligaments; lively in their dancing, because they cross low rather than high; and requiring on that account less space in beating time, they perform it with more liveliness: they display more brilliancy, because the light becomes visible between the limbs at the moment of crossing and recrossing; and this is precisely the *clair-obscure* of dancing; for if the time in the *entre-chat* or cross-caper is neither cut nor beat, but rolled or huddled over, there is no light to give distinction to the shadows, and the limbs, so closely joined, present an indistinct and effectless mass.

These dancers have less address than the others, as they generally depend on their strength; and indeed that strength is a constant obstacle to ease and pliancy; if it forsakes them a single moment, they appear awkward and ridiculous: nor can they conceal their situation by any trifling display; that, requiring mere address, would give them time to recover, which their want of natural elasticity otherwise prevents.

Dancers who are *jarretés*, are weak, slender, and delicate; the others, strong and vigorous, large made, and nervous. It is a common opinion, that stout, squat-built men are heavy and sluggish; which they doubtless are in respect of bodily weight; but the notion is erroneous so far as regards dancing; for activity owes its very existence to muscular strength, and every man who has not a requisite share of that will always fall heavy. The reason is evident; the weak parts, in the instant of falling, not being able to resist the stronger (that is, the weight of the body, which acquires a *momentum* in proportion to the height it falls or descends from), yield and bend; and it is at the moment of relaxation or flexion that the noise of the fall is heard; a circumstance greatly lessened, or rather entirely avoided, when the body is able to maintain itself in a perpendicular direction; and while the muscular spring is sufficient to oppose that descending force, and vigorously resist a shock which would otherwise destroy it.

Nature has not exempted the fair sex from those imperfections we have been taking notice of; but art, and the use of petticoats, come fortunately to the help of the female dancer. The hoop conceals a multitude of defects, which the critic's curious eye cannot ascend to discover. Most of them dance with their knees open, as if they were naturally *arquées*; but, thanks to this bad habit, and to the petticoats, they appear more brilliant than the men; because, as they beat from the lower part of the leg, they perform the time quicker than we, who, concealing nothing from the spectator, are obliged to beat at a greater extent, and to do it originally from the haunch.

The vivacity of the sex contributes much to the brilliancy of their execution; though certainly not less is owing to the petticoats, which, by concealing the length of the limbs, catch the attention, and fix it more advantageously: thus all the fire of the beats being united in one point, appears more lively and brilliant; while the eye embraces one object only, without being hurried and confused in proportion to the space it has to overlook.

To perfection in dancing, M. Noverre observes, nothing is more necessary than the outward turn of the thigh; yet nothing is more natural to mankind than the contrary position; it is born with us. It will be superfluous, in establishing this truth, to cite for example the Asiatics, the Africans, or any people who dance, or rather leap and move, without art or principle. If we attend only to children, or the rustic inhabitants of the villages, we shall see that they all turn their feet inwardly. The other position is purely invention; and a proof, far from equivocal, of this fault being an imaginary one, is, that a painter would transgress as much against nature as the rules of his art, were he to place the feet of his portrait in the situation of a dancer's. It is plain, then, that to dance elegantly, walk gracefully, or address ourselves with ease and manliness, we must absolutely reverse the nature of things; and force our limbs, by artificial applications equally tedious and painful, to assume a very different situation from what they originally received.

Such a change, however necessary in this art, can only be accomplished by laying its foundation in the earliest stages of infancy, when every bone and muscle are in a state of pliability, and capable of receiving any direction which we choose to give them.

The difficulty of attaining the outward position of the limbs, is owing to our ignorance of the proper arts to be employed. Most beginners persuade themselves that it is to be acquired by forcing the feet to turn outward: and though this part may readily take such a direction, from their suppleness, and being so easily moved at their articulation with the leg; yet this method is so far false, as it tends to displace the ancle-bones, and besides has not any effect upon either the knees or thighs.

Neither is it possible to throw the knees outwardly without the assistance of the thigh. The knees have only two motions, bending and extension; the one drawing the leg backward, the other throwing it forward: they have no power, therefore, of themselves to determine or assume an outward position; but must eventually depend on the thigh, which entirely commands all the lower part of the body, and turns them in consequence of its own rotatory motion; so that, in fact, whatever motion or position that takes, the knee, foot, and leg, are obliged to follow.

M. Noverre condemns the *tourne-haunch* as a clumsy and useless invention, which, instead of producing any good effect, serves only to lame those who use it, by giving a distortion to the waist, much more disagreeable than what it was intended to remove.

The simplest and most natural means are those which reason and good sense ought to adopt; and of these a moderate but continual exercise is indispensable: the practice of a circular motion or turning of the legs, both inwardly and outwardly, and of boldly beating at full extent from the haunch, is the only certain exercise to be preferred. It insensibly gives freedom, spring and pliancy; while the motions acquired by using the machine have more an air of constraint, than of that liberty and ease which should shine conspicuous in them.

It has been maintained, that a strong and vigorous person ought to spring higher and better than a slender or weaker man. But experience (says M. Noverre) daily proves the contrary. We see many dancers, who cut the time very strong, who beat with much vigour and firmness, and yet cannot spring to any considerable perpendicular elevation: for an oblique elevation, or on one side, ought here to be distinguished from the former; the latter is faint, and depends entirely upon address in the dancer. There are others, again, whose slender form renders their execution less bold, and rather elegant than forcible, rather lively than nervous, but who can rise to an extraordinary height: it is to the shape and formation of the foot, and to the length and elasticity of the tendon, that this power of elevation is originally owing; the knees, the loins, and the arms, all co-operate in this action; the stronger the pressure upon the muscles, the greater is the re-action, and the spring or leap is proportionably high. The alternate motion of the knees participates with those of the instep and *tendo Achillis*, though the latter are still the most essential auxiliaries; the muscles of the trunk lend their assistance, and preserve the body in a perpendicular direction; while the arms, running imperceptibly to the mutual assistance of all the parts, serve as wings to counterbalance the machine.

Observe all those animals that have long and slender ancles, as stags, roebucks, sheep, cats, monkeys, &c. and you will perceive that they have a quickness and facility of springing and leaping, which animals differently formed in that part can never obtain.

But were a man endowed with all the other qualities essential to the perfection of the art, yet still without strength and firmness in his loins he never can be a good dancer. This strength is certainly the gift of nature; but it may be much improved by the assiduity of an able teacher. We daily see dancers who have neither perpendicularity nor firmness, and whose performance is altogether unstable and irregular; and we likewise see others, who, though they possess not so great a degree of native force, have all the appearance of sinewy firmness and muscular strength in their haunches, back, and loins. Art has furnished a substitute for nature, in the lessons of some excellent teacher, who has convinced them, that when once they forego an attention to the loins, it is impossible to keep themselves in a right perpendicular line; and therefore all their exertions will be devoid of taste: that all wavering and instability in this part is inconsistent with perpendicularity and firmness, and will certainly cause distortion of the shape and waist: that the depressure and sinking of the body deprives the lower parts of that liberty which is necessary to their easy motion: that hence the body is undetermined in its positions; frequently drags the limbs, and constantly loses the centre of gravity; and therefore cannot recover an equilibrium, but after various efforts and contortions totally repugnant to the graceful and harmonious motions of good dancing.

Such is the performance of those dancers who have no strength in their loins, or at least do not exert what they possess. In order to dance well, the body should be firm and steady: it should particularly be motionless and free from wavering while the legs are in exertion; for when the body follows the action of the feet, it displays as many grimaces and distortions as the legs execute different steps; the performance is then robbed of its ease, uniformity, harmony, exactness, firmness, perpendicularity, and equilibrium; in a word, of all those beauties and graces which are so essential to make dancing give pleasure and delight.

Many dancers are of opinion, that to be soft and luxuriant, the knees must be bent very low. But in this they are most certainly mistaken; for a more than ordinary flexion of the knees gives rather a dryness and insipidity to dancing; and a dancer may be very inelegant, and jerk, as it were, all his movements, as well in bending very low as in not bending at all. The reason will appear natural and evident, when we reflect, that the time and motions of the dancer are strictly subordinate to the time and movements of the music: pursuing this principle, it is not to be doubted, that when the flexion of the knees is greater than what the air or time of the dance requires, the measure then drawls along, languishes, and is lost. To recover and catch again the time which this unnecessary flexion had destroyed, the extension of the knee must be equally quick; and it is this sudden transition which gives such a harshness and sterility to the execution, and renders it as disgustful as the opposite fault of stiffness and inflexibility.

That luxuriant softness requires more to its perfection than merely an exact flexion and extension of the knees; the spring of the instep must add its assistance, while the loins must balance the body to preserve these springs in proper bounds. It is this rare harmony of motion (says M. Noverre) which has procured the celebrated Dupré the glorious title of the *God of Dance.*

There are many dancers, and of an inferior class only, who can display a great variety of steps, badly enough chosen to be sure, and often displayed without either judgment or taste; but it is very uncommon to find among them that exactness of ear (that rare but innate talent of a dancer), which gives life to and stamps a value upon steps, and which diffuses over all their motions a spirit that animates and enlivens them.

There are some ears stupid and insensible even to the most simple, plain, and striking movements; there are others, more cultivated or refined, that can feel and comprehend the measure, but cannot seize its intricacies; and there are others again to whom the most difficult airs and movements are easy and intelligible, and at once comprehended. It is nevertheless certain, that a dancer may have a very perfect and nice feeling, and yet not make his feelings intelligible to the audience, if he has not the art of commanding those resources which depend upon a proper exertion of the *coup de pied*: awkwardness becomes visible where the exactest proportion was necessary; and every step which would have been becoming, and produced the happiest effect, had it been smartly introduced at the conclusion of the measure, will now be cold and lifeless, if all the limbs are in motion at once. It requires more time to move the whole body than to exert any single member; the flexion and extension of the instep is more readily and quickly made than the reciprocal motion of all the joints. This principle allowed, that the dancer is destitute of precision, who (supposing he possesses a musical ear) knows not how to time his steps; the elasticity of the instep, and the more or less active play of the muscles, add to the natural sensibility of the ear, and stamp value and brilliancy on the dance. The joint charms of the harmony springing from the movements of the music, and the motions of the dancer, captivate even those whose ears are the most insensible and least susceptible of musical impression.

There are some countries where the inhabitants in general are endowed with this innate musical taste. The Palatinate, Wirtemberg, Saxony, Brandenburg, Austria, and Bohemia, supply the orchestras of the German princes with many excellent musicians and eminent composers. The Germans, indeed, are born with a very lively and just taste for music, and have in them the seeds of true harmony; nothing is more common than to hear concerts, both in the streets and in the shops of their mechanics, performed with the greatest skill and exactness.

Such a natural and native taste for music as we have been

been mentioning, is usually accompanied by, or includes in it, a similar one for dancing; they are kindred arts; the tender and harmonious accents of the one excite and produce the agreeable and expressive motions of the other, and their union entertains the eye and ear with animated pictures of sentiments; these two senses again convey to the heart the interesting images which affect them, while the heart, in its turn, communicates them to the mental faculty: thus the pleasure resulting from the harmony and intelligence of these two arts, enchants the spectator, and fills him with the most seducing pleasures of voluptuousness.

Dancing is probably nowhere varied to such a degree as in the provinces of Germany; where the well known dances of one village are strangers in the adjacent hamlet; their songs of mirth and merriment have no less different airs and movements, though they are all marked with that of gaiety. Their dances are pleasing and engaging, because the offspring of simple nature; their motions express joy and pleasure; and the exactness with which the whole is performed, gives a peculiar agreeableness to their steps, gestures, and attitudes. Do they spring?—a hundred persons, assembled round an oak, or some ancient pillar, seize the time at one instant, bound up and descend with the same exactness. Do they wish to mark the measure by a *coup-de pied?*—all strike with one consent; or when they catch up their women, you see them all in the air at an equal height, nor do they descend but at the precise note that marks the time.

The counter-point, which is doubtless the touchstone of a delicate ear, is to them an object of no difficulty; hence their dance is so particularly animated, and the nicety of that organ has the effect of giving their different motions an air of gaiety and variety altogether exquisite.

A dancer whose ear is untuned to harmony, displays his steps without order or regularity, wanders from his part, and pursues the measure without being able to teach it: devoid of judgment, his dancing has neither sentiment nor expression; and the music which should direct his motions, regulate his steps, and guide his time, serves only to expose his imperfections and insufficiency. The study of music should therefore be applied to for the purpose of obviating this defect, and giving more sensibility and exactness to the organs of hearing.

It will not be expected that we should proceed to give a description of all the intricacies and combinations of steps that are or can be exerted in dancing; or enlarge on the mechanical particulars of the art. A dissertation on the latter would be insipid and disgustful; for the language of the feet and limbs is addressed to the eyes, and not to the ears; and a detail of the former would be endless, since every dancer has his peculiar manner of joining or varying the time. It may be sufficient just to mention on this point, that it is in dancing as in music, and with dancers as with musicians: dancing does not abound with more fundamental steps than music with notes; but there are octaves, breves, semibreves, minims, crotchets, double and treble crotchets; times to count and measures to follow. This mixture, however, of a small number of steps, and a few notes, furnishes dancers with a multitude of connexions and a variety of figures; taste and genius will always find a source of novelty in arranging them in different manners, and to express various ideas. Slow and lengthened, or quick and precipitate steps, and the time correspondently varied, give birth to this endless diversity.

*Country-*DANCE. See COUNTRY-*Dance*.

Country-Dance, commonly so written, and hence seeming to imply a rustic way of dancing borrowed from country people or peasants, is by others supposed to be a corruption of the French *Contre-danse*, where a number of persons placing themselves opposite one to another begin a figure.

*Rope-*DANCER, (*schœnobates*), a person who walks, leaps, dances, and performs several other feats upon a small rope or wire.

The ancients had their rope-dancers as well as we. These had four several ways of exercising their art: The first vaulted, or turned round the rope like a wheel round its axis, and there hung by the heels or neck. The second flew or slid from above, resting on their stomachs, with the arms and legs extended. The third ran along a rope stretched in a right line or up and down. Lastly, the fourth not only walked on the rope, but made surprising leaps and turns thereon. They had likewise the *cremnobates* or *orobates;* that is, people who walked on the brinks of precipices. Nay more, Suetonius *in Galba*, c. 6. Seneca in his 85th Epistle, and Pliny, lib. viii. c. 2. make mention of elephants, that were taught to walk on the rope.

St Vitus's DANCE. See MEDICINE *Index*.

DANCETTE, in *Heraldry*, is when the outline of any bordure, or ordinary, is indented very largely, the largeness of the indentures being the only thing that distinguishes it from indented.

DANCING. See DANCE.

DANCING-*Girls* of Egypt. See ALME.

Dancing-girls are employed all over the east, as affording great diversion at all public entertainments. They are all prostitutes; and, by the laws of their society, are bound to refuse no one for their price, which is rated according to their beauty and other accomplishments. There are even particular sets of them appropriated to the service of the Gentoo temples, and the use of the Bramin priests who attend them. These poor creatures say that they were first debauched by their *god*, and afterwards by him consigned over to the use of the priests who belong to his temple.

These dancing-girls, whether in a settled or unsettled condition, live in a band or community under the direction of some superannuated female of the same profession, under whom they receive a regular education, and are trained up in all the arts of love and pleasing, like scholars in an academy. Thus they acquire the art of captivating the affections of the other sex to such a degree, that nothing is more common than for one of the princes or chief people of the country to take a liking to one of these girls, and waste immense sums on her, though at the same time their own haram is stocked with beauties far superior, and who are besides possessed of the natural modesty of the sex, to which the others have not the smallest pretensions. Thus some of these girls acquire immense wealth. In the neighbourhood of Goa, for instance on a part of the continent bordering on the district of that island, the dancing-girls founded a village, after being driven from Goa by the zeal of the archbishop. Here they reside in a body corporate, and attend the parties of pleasure of the noblemen and principal inhabitants, for it is not every one's purse that can afford them. Here many of them acquire considerable fortunes by this scandalous traffic, and throw it into a common stock for the sake of carrying on merchandise; being concerned in shipping and the most profitable voyages, for which they have regular factors and brokers.

The dress of these women varies according to the country they live in; but in all it is the most gorgeous imaginable. They are loaded with jewels, literally from top to toe, since even on their toes they wear rings. Their necks are adorned with carcanets, their arms with bracelets, and their ancles with chains of gold and silver, often enriched with precious stones. They also wear nose-jewels, which at first have an odd appearance, but to which the eye is soon reconciled. In Indostan, these dancing-girls, as well as the other women of the country, have a peculiar method of preserving and managing their breasts, which at the same time makes no inconsiderable part of their finery. They inclose them in a pair of hollow cases, exactly fitted to them; made of very light wood, linked together and buckled at the back. These at once confine their breasts so that they cannot grow to any disgustfully exuberant size; though, from their smoothness and pliancy, they play so freely with every motion of the body, that they do not crush the tender texture of the flesh in that part, like the stiff whalebone stays in use among the Europeans. The outside of them is spread over with a thin plate of gold or silver, or set with gems, if they can afford it. Another occassional ornament the dancing-girls put on, particularly when they resort to their gallants, viz. a necklace of many loose turns, composed of flowers strung together, which they call *mogrees*, somewhat resembling Spanish double jessamy, but of a much stronger and more agreeable fragrant odour, and far preferable to any perfumes. "They have nothing," says Mr Grose, "of that nauseous boldness which characterizes European prostitutes, their style of seduction being all softness and gentleness."

With regard to the performances of these women as dancers, we have various accounts. The author of Memoirs of the late war in Asia, acquaints us, "that their attitudes as well as movements are not ungraceful. Their persons are delicately formed, gaudily attired, and highly perfumed. By the continuation of wanton attitudes, they acquire, as they grow warm in the dance, a frantic lasciviousness themselves, and communicate, by a natural contagion, the most voluptuous desires to the beholders." Mr Ives seems to have been very cool on this subject. "I could not (says he) see any thing in their performance worthy of notice. Their movements are more like tumbling or showing postures than dancing. Their dress is thin and light; and their hair, necks, ears, arms, wrists, fingers, legs, feet, and even their toes, are covered with rings of gold and silver, made after a clumsy manner. They wear two rings in their noses; and by their staring looks and odd gesticulations, you would rather suspect them to be mad women than morris dancers. The band of music that attends them is not less singular in its way: it is chiefly composed of three or four men, who hold two pieces of bell-metal in their hand, with which they make an incessant noise; another man beats what he is pleased to call a drum; and that they may not want vocal music to complete the band, there are always two others appointed to sing. These last generally lay in their mouths a good loading of betel-nut before they begin, which, after having been well chewed, tinges the saliva with such a redness, that a stranger would judge them to bleed at the mouth by too violent an exertion of their voice. These gentry are called *ticky-taw* boys, from the two words *ticky taw*, which they continually repeat, and chant with great vehemence. The dancing-girls are sometimes made use of in their religious ceremonies, as when the priests bring forth the images of their gods into the open fields on a car ornamented with lascivious figures, these girls dance before the images amidst a great crowd of people; and having been selected for their superior beauty, are very profitable to their masters the priests, who are said to prostitute them to all comers."

Mr Grose informs us, that "these dances would hardly at first relish with Europeans, especially as they are accompanied with a music far from delightful, consisting of little drums called *gumgums*, cymbals, and a sort of fife, which makes a hideous din, and are played on by men, whose effeminacy, grimaces, and uncouth shrivelled features, all together shock the eye and torture the ear. However by use we become reconciled to the noise, and may observe some not unpleasant airs, with which the dancers keep time: the words often express the matter of a pantomime dance, such as a lover courting his mistress; a procuress bringing a letter, and endeavouring to seduce a woman from one gallant in favour of another; a girl, timorous and afraid of being caught in an intrigue. All these love-scenes the girls execute in character dances, and with no despicable expression, if they are proficients in their art; for then their gestures, air, and steps, are marking and well adapted. In some of their dances, even in public, modesty is not much respected by the lascivious attitudes into which they throw themselves, without exposing any nudity; being richly clad and bedecked with jewels after their manner. But in private parties to which they are called, as in gardens, they give themselves a great loose, and have dances in reserve, in which, though still without any grossness in discovering their bodies, they are mistresses of such motions and lewdness of looks and gestures as are perhaps more provoking.

DANDELION. See LEONTODON, BOTANY *Index*.

DANDINI, PIETRO, an eminent painter, was born at Florence in 1646, and received his first instructions in the art of painting from Valero Spada, who excelled in small drawings with a pen. Whilst he was under the care of that artist, he gave such evident proofs of a ready genius, that he was then placed as a disciple with his uncle Vincencio Dandini, a master of great reputation through all Italy, who had been bred up under Pietro da Cortona. He afterwards travelled through most of the cities of Italy, studying the works of those who were most distinguished; and resided for a long time at Venice, where he copied the paintings

paintings of Titian, Tintoretto, and Paolo Veronese. He next visited Parma and Modena, to design the works of Corregio; omitting no opportunity that might contribute to improve his hand or his judgment. When he returned to Florence, the grand duke Cosmo III. the grand duchess Victoria, and the prince Ferdinand, kept him perpetually employed, in fresco painting as well as in oil; his subjects being taken not only from sacred or fabulous history, but from his own invention and fancy, which frequently furnished him with such as were odd and singular, and especially with whimsical caricatures. He died in 1712.—This master had a most extraordinary talent for imitating the style of even the most celebrated ancient painters of every school, particularly Titian, Veronese, and Tintoretto; and with a force and elegance, equal to his subjects of history, he painted portraits, landscapes, architecture, flowers, fruit, battles, animals of all kinds, and likewise sea pieces; proving himself an universal artist, and excellent in every thing he undertook.

He had a son, Octavio, who proved not inferior to him in any branch of his profession, and was an honour to his family and his country.

Dandini, *Cæsare*, history painter, was born at Florence; and was the elder brother and first instructor of Vincentio Dandini, the uncle of Pietro. This master had successively studied as a disciple with Cavalier Curradi, Passignano, and Cristofano Allori; from whom he acquired a very pleasing manner of designing and colouring. He was extremely correct in his drawing, and finished his pictures highly. Several noble altarpieces in the churches of Florence are the productions of his pencil; and one, which is in the chapel l'Annonciata, is particularly admired.

DANDOLA, Henry, doge of Venice, a brave admiral and politician. With a Venetian fleet he took Constantinople in 1203, and had the moderation to refuse to be emperor. He died in 1250.

DANEGELT, an annual tax laid on the Anglo-Saxons, first of 1s. afterwards of 2s. for every hide of land throughout the realm, for maintaining such a number of forces as were thought sufficient to clear the British seas of Danish pirates, which heretofore greatly annoyed our coasts.

Danegelt was first imposed as a standing yearly tax on the whole nation, under King Ethelred, A. D. 991. That prince, says Camden, *Britan.* 142. much distressed by the continued invasions of the Danes, to procure a peace, was compelled to charge his people with heavy taxes called *Danegelt.*—At the first he paid 10,000l. then 16,000l. then 24,000l. after that 36,000l. and lastly 48,000l.

Edward the Confessor remitted this tax: William I. and II. reasumed it occasionally. In the reign of Henry I. it was accounted among the king's standing revenues; but King Stephen, on his coronation day, abrogated it for ever.

No church or church-land paid a penny to the *danegelt;* because, as is set forth in an ancient Saxon law, the people of England placed more confidence in the prayers of the church than in any military defence they could make.

DANET, Peter, abbot of St Nicholas de Verdun, was one of the persons chosen by the duke of Montausier to write on the classics for the use of the dauphin. He had a share in Phædrus, which he published with notes and explications in Latin. He also wrote a dictionary in Latin and French, and another in French and Latin. He died at Paris in 1709.

DANIEL, the fourth of the greater prophets, was born in Judea, of the tribe of Judah, about the 25th year of the reign of Josiah. He was led captive to Babylon, with other young Hebrew lords, after the taking of Jerusalem by Nebuchadnezzar, who took them into his service. That prince gave them masters to instruct them in the language and sciences of the Chaldeans, and ordered them to be fed with the most delicate viands: but they, fearing that they should eat meat forbidden by the law of Moses, desired the king's officers to allow them only pulse. The wisdom and conduct of Daniel pleasing Nebuchadnezzar, that prince gave him several posts of honour. It is commonly believed, that this prophet, when but 12 years of age, made known the innocence of the chaste Susannah: but the learned are not agreed, that the young Daniel, who confounded the old men, was the same with this prophet. However, he explained Nebuchadnezzar's dream of the mysterious statue, which foretold the four great monarchies; on which account he was made prefect of the province of Babylon. In the reign of Darius, the king of the Medes, he refused to adore the golden statue of the king, and was cast into the lions den, when those beasts, though pinched with hunger, did him no manner of hurt. And he explained the characters written on the wall of the room where Belshazzar was feasting.

It is believed that Daniel died in Chaldea, and that he did not take advantage of the permission granted by Cyrus to the Jews of returning to their own country. St Epiphanius says he died at Babylon; and herein he is followed by the generality of historians.

The prophecies of Daniel concerning the coming of the Messiah, and the other great events of after-times, are so clear and explicit, that, as St Jerome tells us, Porphyry objected to them, that those which related to the kings of Syria and Egypt, chap. xi. must have been written after the times of Antiochus Epiphanes; whereas his prophecy was translated into Greek 100 years before his time, and the translation was in the hands of the Egyptians, who had no great kindness for the Jews and their religion. And those prophecies foretelling the success of Alexander, chap. viii. 5. xi. 3. were shown to Alexander by the Jews, in consequence of which they obtained several privileges from him; (*Ant.* lib. xi. c. 8.). The style of Daniel is not so lofty and figurative as that of the other prophets; it is clear and concise, and his narrations and descriptions simple and natural: in short, he writes more like a historian than a prophet.

The Jews do not reckon Daniel among the prophets; part of his book, that is, from the fourth verse of his second chapter to the end of the seventh chapter, was originally written in the Chaldee language; the reason of which was, that in that part he treats of the Chaldean or Babylonish affairs: all the rest of the book is in Hebrew. The first six chapters of the book of Daniel are a history of the kings of Babylon, and what befel the Jews under their government. In the last six he is altogether prophetical, foretelling not only

only what should happen to his own church and nation, but events in which foreign princes and kingdoms were concerned.

Daniel, *Samuel*, an eminent poet and historian, was born near Taunton in Somersetshire in the year 1562, and educated at Oxford; but leaving that university without a degree, he applied himself to English history and poetry under the patronage of the earl of Pembroke's family. He was afterwards tutor to the lady Anne Clifford; and, upon the death of Spenser, was created poet-laureat to Queen Elizabeth. In King James's reign he was appointed gentleman extraordinary, and afterwards one of the grooms of the privy-chamber to the queen consort, who took great delight in his conversation and writings. He wrote a history of England, several dramatic pieces, and some poems; and died in 1619.

Daniel, *Gabriel*, a celebrated Jesuit, and one of the best French historians, was born at Rouen in 1649. He taught polite literature, philosophy, and divinity, among the Jesuits; and was superior of their house at Paris, where he died in 1728. There are a great number of his works published in French, of which the principal are, 1. A History of France, of which he also wrote an abridgement in nine volumes, 12mo. 2. A History of the French Militia, in two vols 4to. 3. An Answer to the Provincial Letters. 4. A Voyage to the World of Descartes. 5. Letters on the doctrines of the Theorists, and on Probability. 6. New difficulties relating to the knowledge of Brutes: And, 7. A Theological treatise on the Efficacy of Grace.

DANMONII, an ancient British nation, supposed to have inhabited that tract of country which is now called *Cornwall* and *Devonshire*, bounded on the south by the British occean, on the west by St George's channel, on the north by the Severn sea, and on the east by the country of the Durotriges. Some other British tribes were also seated within these limits; as the Cossini and Ostidamnii; and, according to Mr Baxter, they were the keepers of their flocks and herds. As the several tribes of the Danmonii submitted without much resistance to the Romans, and never joined in any revolt against them, that people were under no necessity of building many forts, or keeping many garrisons in their country. This is the reason why so few Roman antiquities have been found in that country, and so little mention is made of it and its ancient inhabitants by Roman writers. Ptolemy names a few places, both on the sea coasts and in the inland parts of this country, which were known to, and frequented by, the Romans. The most considerable of these places are the two famous promontories of Bolerium and Ocrinum, now the Land's end and the Lizard; and the towns of Isca Danmoniorum and Tamare, now Exeter and Saltash. As the Danmonii submitted so tamely to the Romans, they might perhaps permit them to live, for some time at least, under their own princes and their own laws; a privilege which we know they granted to some other British states. In the most perfect state of the Roman government in Britain, the country of the Danmonii made a part of the province called Flavia Cæsariensis, and was governed by the president of that province. After the departure of the Romans, kingly government was immediately revived among the Danmonii in the person of Vortigern, who was perhaps descended from the race of their ancient princes, as his name signifies in the British language a chieftain or the head of a family.

DANTE, Aligheri, one of the first poets of Italy, was born at Florence in 1265, of an ancient and honourable family. Boccacio, who lived in the same period, has left a very curious and entertaining treatise, on the life, the studies, and manners of this extraordinary poet, whom he regarded as his master, and for whose memory he professed the highest veneration. This biographer relates, that Dante, before he was nine years old, conceived a passion for the lady whom he has immortalized in his singular poem. Her age was near his own; and her name was Beatrice, the daughter of Folco Portinari, a noble citizen of Florence. The passion of Dante, however, like that of his successor Petrarch, seems to have been of the chaste and platonic kind, according to the account he has himself given of it, in one of his early productions, entitled *Vita Nuova;* a mixture of mysterious poetry and prose; in which he mentions both the origin of his affection and the death of his mistress, who, according to Boccacio, died at the age of 24. The same author asserts, that Dante fell into a deep melancholy in consequence of this event, from which his friends endeavoured to raise him, by persuading him to marriage. After some time he followed their advice, and repented it; for he unfortunately made choice of a lady who bore some resemblance to the celebrated Xantippe. The poet, not possessing the patience of Socrates, separated himself from her with such vehement expressions of dislike, that he never afterwards admitted her to his presence, though she had born him several children. In the early part of his life he gained some credit in a military character; distinguishing himself by his bravery in an action where the Florentines obtained a signal victory over the citizens of Arezzo. He became still more eminent by the acquisition of civil honours; and at the age of 25 he rose to be one of the chief magistrates of Florence, when that dignity was conferred by the suffrages of the people. From this exaltation the poet himself dated his principal misfortunes, as appears from the fragment of a letter quoted by Leonardo Bruni, one of his early biographers, where Dante speaks of his political failure with that liberal frankness which integrity inspires. Italy was at that time distracted by the contending factions of the Ghibellins and the Guelphs: the latter, among whom Dante took an active part, were again divided into the Blacks and the Whites. Dante, says Gravina, exerted all his influence to unite these inferior parties; but his efforts were ineffectual, and he had the misfortune to be unjustly persecuted by those of his own faction. A powerful citizen of Florence, named Corso Donati, had taken measures to terminate these intestine broils, by introducing Charles of Valois, brother to Philip the Fair king of France. Dante, with great vehemence, opposed this disgraceful project, and obtained the banishment of Donati and his partizans. The exiles applied to the pope (Boniface VIII.), and by his assistance succeeded in their design. Charles of Valois entered Florence in triumph, and those who had opposed his admission were banished in their turn. Dante had been dispatched to Rome as the ambassador

dor of his party; and was returning, when he received intelligence of the revolution in his native city. His enemies, availing themselves of his absence, had procured an iniquitous sentence against him, by which he was condemned to banishment, and his possessions were confiscated. His two enthusiastic biographers Boccacio and Manetti, express the warmest indignation against the injustice of his country. Dante, on receiving this intelligence, took refuge in Sienna, and afterwards in Arezzo, where many of his party were assembled. An attempt was made to surprise the city of Florence, by a small army which Dante is supposed to have attended: the design miscarried, and our poet is conjectured to have wandered to various parts of Italy, till he found a patron in the great Candella Scala, prince of Verona, whom he has celebrated in his poem. The high spirit of Dante was ill suited to courtly dependence; and he is said to have lost the favour of his Veronese patron by the rough frankness of his behaviour. From Verona he retired to France, according to Manetti; and Boccacio affirms that he disputed in the theological schools of Paris with great reputation. Bayle questions his visiting Paris at this period of his life; and thinks it improbable, that a man, who had been one of the chief magistates of Florence, should condescend to engage in the public squabbles of the Parisian theologists; but the spirit both of Dante and the times in which he lived sufficiently account for this exercise of his talents; and his residence in France at this season is confirmed by Boccacio, in his life of our poet, which Bayle seems to have had no opportunity of consulting.

The election of Henry count of Luxemburgh to the empire, in November 1308, afforded Dante a prospect of being restored to his native city, as he attached himself to the interest of the new emperor, in whose service he is supposed to have written his Latin treatise *De Monarchia*, in which he asserted the rights of the empire against the encroachments of the Papacy. In the year 1311, he instigated Henry to lay siege to Florence; in which enterprise, says one of his biographers, he did not appear in person, from motives of respect towards his native city. The emperor was repulsed by the Florentines; and his death, which happened in the succeeding year, deprived Dante of all hopes concerning re-establishment in Florence. After this disappointment, he is supposed to have passed some years in roving about Italy in a state of poverty and distress, till he found an honourable establishment at Ravenna, under the protection of Guido Novello da Polenta, the lord of that city, who received this illustrious exile with the most endearing liberality, continued to protect him through the few remaining years of his life, and extended his munificence to the ashes of the poet.

Eloquence was one of the many talents which Dante possessed in an eminent degree. On this account he is said to have been employed on fourteen different embassies in the course of his life, and to have succeeded in most of them. His patron Guido had occasion to try his abilities in a service of this nature, and dispatched him as his ambassador to negotiate a peace with the Venetians, who were preparing for hostilities against Ravenna. Manetti asserts that he was unable to procure a public audience at Venice, and returned to Ravenna by land, from his apprehensions of the Venetian fleet; when the fatigue of his journey, and the mortification of failing in his attempt to preserve his generous patron from the impending danger, threw him into a fever, which terminated in death on the 14th of September 1321. He died, however, in the palace of his friend; and the affectionate Guido paid the most tender regard to his memory. This munificent patron (says Boccacio) commanded the body to be adorned with poetical ornaments, and, after being carried on a bier through the streets of Ravenna by the most illustrious citizens, to be deposited in a marble coffin. He pronounced himself the funeral oration, and expressed his design of erecting a splendid monument in honour of the deceased: a design which his subsequent misfortunes rendered him unable to accomplish. At his request, many epitaphs were written on the poet: the best of them (says Boccacio) by Giovanni del Virgilio of Bologna, a famous author of that time, and the intimate friend of Dante. Boccacio then cites a few Latin verses, not worth transcribing, six of which are quoted by Bayle as the composition of Dante himself, on the authority of Paul Jovius. In 1483 Bernardo Bembo, the father of the celebrated cardinal, raised a handsome monument over the neglected ashes of the poet, with the following inscription:

Exigua tumuli Danthes hic sorte jacebas
Squalenti nulli cognita pæne situ;
At nunc marmoreo subnixus conderis arcu,
Omnibus et cultu splendidiore nites;
Nimirum Bembus, Musis incensus Etruscis,
Hoc tibi, quem in primis hæ coluere, dedit.

Before this period the Florentines had vainly endeavoured to obtain the bones of their great poet from the city of Ravenna. In the age of Leo X. they made a second attempt, by a solemn application to the pope for that purpuse; and the great Michael Angelo, an enthusiastic admirer of Dante, very liberally offered to execute a magnificent monument to the poet. The hopes of the Florentines were again unsuccessful. The particulars of their singular petition may be found in the notes of Codivi's Life of Michael Angelo.

At what time, and in what place, he executed the great and singular work which has rendered him immortal, his numerous commentators seem unable to determine. Boccacio asserts, that he began it in his 35th year, and had finished seven cantos of his *Inferno* before his exile; that in the plunder of his house, on that event, the beginning of his poem was fortunately preserved, but remained for some time neglected, till its merit being accidentally discovered by an intelligent poet named Dino, it was sent to the marquis Marcello Malespina, an Italian nobleman, by whom Dante was then protected. The marquis restored these lost papers to the poet, and intreated him to proceed in a work which opened in so promising a manner. To this incident we are probably indebted for the poem of Dante, which he must have continued under all the disadvantages of an unfortunate and agitated life. It does not appear at what time he completed it; perhaps before he quitted Verona, as he dedicated the Paradise to his Veronese patron. The critics have variously accounted for his having called his poem Comedia. He gave it the title (said one of his sons), be-

Dante, Dantzic.

cause it opens with distress and closes with felicity. The very high estimation in which this production was held by his country, appears from a singular institution. The republic of Florence, in the year 1373, assigned a public stipend to a person appointed to read lectures on the poem of Dante: Boccacio was the first person engaged in this office; but his death happening in two years after his appointment, his comments extended only to the seventeen first cantos of the Inferno. The critical dissertations that have been written on Dante are almost as numerous as those to which Homer has given birth; the Italian, like the Grecian bard, has been the subject of the highest panegyric, and of the grossest invective. Voltaire has spoken of him with that precipitate vivacity, which so frequently led that lively Frenchman to insult the reputation of the noblest writers. In one of his entertaining letters, he says to an Italian abbé, *Je fais grand cas du courage, avec lequel vous avez osé dire que Dante étoit un fou, et son ouvrage un monstre.—Le Dante pourra entrer dans les bibliotheques des curieux, mais il ne sera jamais lu.* But more temperate and candid critics have not been wanting to display the merits of this original poet. Mr Warton has introduced into his last volume on English poetry, a judicious and spirited summary of Dante's performance.

DANTE, *John Baptist*, a native of Perugia, an excellent mathematician, called the *new Dædalus*, from the wings he made himself, and with which he flew several times over the lake Thrasymenus. He fell in one of his enterprises, the iron work with which he managed one of his wings having failed; by which accident he broke his thigh: but it was set by the surgeons, and he was afterwards called to Venice to profess mathematics.

DANTZIC, the capital of Polish Prussia, situated on a branch of the Vistula, about four miles above where it falls into the Baltic; in E. Long. 18. 36. N. Lat. 54. 20. This city is famous in history on many accounts, particularly that of its being formerly at the head of the Hanseatic association, commonly called the *Hanse-towns*. It is large, beautiful, populous, and rich; its houses generally are five stories high; and many of its streets are planted with chesnut-trees. One of the suburbs is called *Scotland;* and the Scots had great privileges, in consequence of their gallant defence of the town, under one of the family of Douglas, when it was besieged by the Poles. It is said there were upwards of 30,000 pedlars of that nation in Poland who travelled on foot, and some with three, four, or five horses. In King Charles II.'s time they were about 53,000: in that reign Sir John Denham and Mr Killigrew were sent to take the number of them, and to tax them by the poll, with the king of Poland's license; which having obtained, they brought home 10,000l. sterling, besides their charges in the journey. Dantzic has a fine harbour; and is still a most eminent commercial city, although it seems to be somewhat past its meridian glory, which was probably about the time that the president de Thou wrote his much esteemed *Historia sui Temporis*, wherein, under the year 1607, he so highly celebrates its commerce and grandeur. It was a republic, claiming a small adjacent territory about 40 miles round it, which was under the protection of the king of Poland; but its privileges have been abridged, if not entirely annihilated, by the king of Prussia. Its magistracy, and the majority of its inhabitants, are Lutherans; although the Romanists and Calvinists be equally tolerated in it. It has 26 parishes, with many convents and hospitals. The inhabitants were once very numerous; but the calamities of war, and the oppressions of foreign powers, have reduced the inhabitants at present to 44,500. Its own shipping is numerous; but the foreign ships constantly resorting to it are more so, whereof 1014 arrived there in the year 1752; in which year also 1288 Polish vessels came down the Vistula, chiefly laden with corn for its matchless granaries; from whence that grain is distributed to many foreign nations, Poland being justly deemed the greatest magazine of corn in all Europe, and Dantzic the greatest port for distributing it everywhere: besides which, Dantzic exports great quantities of naval stores, and a vast variety of other articles. In 1815, an unfavourable year for trade, there arrived only 459 ships, and sailed 377; but in general the number is twice or three times as great. Dr Busching affirms, that it appears from ancient records, as early as the year 997, that Dantzic was a large commercial city, and not a village or inconsiderable town, as some pretend. The inhabitants of Dantzic have often changed their masters, and have sometimes been under the protection of the English and Dutch; but generally have shown a great predilection for the kingdom and republic of Poland, as being less likely to rival them in their trade, or abridge them of their immunities, which reach even to the privilege of coining money. In 1734, the inhabitants discovered a remarkable attachment and fidelity toward Stanislaus king of Poland, not only when his enemies the Russians were at their gates, but even in possession of the city. This city was exempted by the late king of Prussia from those claims which he made on the neighbouring countries; notwithstanding which, his Prussian majesty soon after thought proper to seize on the territories belonging to Dantzic, under pretence of their having been formerly part of Polish Prussia. He then proceeded to possess himself of the port-duties belonging to that city, and erected a customhouse in the harbour, where he laid arbitrary and insupportable duties upon goods exported or imported. To complete the system of oppression, customhouses were erected at the very gates of Dantzic, so that no persons could go in or out of the town without being searched in the strictest manner. Such is the treatment which the city of Dantzic has received from the king of Prussia, though few cities have ever existed which have been comprehended in so many general and particular treaties, and whose rights and liberties have been so frequently secured, and guaranteed by so many great powers, and by such a long and regular succession of public acts, as that of Dantzic has been. In the year 1784, it was blockaded by his troops on various pretences; but by the interposition of the empress of Russia and of the king of Poland, they were withdrawn: and a compromise having taken place, the city was restored to its former immunities. In May 1807, it was taken by the French, after a long siege, attended with the destruction of the suburbs. It was retaken from them in 1814, after an able defence by General Rapp, and came again into the possession of Prussia in 1814.

Dantzic.

DANUBE, the largest and most considerable river in Europe, rising in the Black Forest, near Zunberg; and running north-east through Swabia, by Ulm, the capital of that country; then running east through Bavaria and Austria, passes by Ratisbon, Passau, Ens, and Vienna. It then enters Hungary, and runs south-east from Presburg to Buda, and so on to Belgrade; after which it divides Bulgaria from Wallachia and Moldavia, discharging itself by several channels into the Black sea, in the province of Bessarabia. Towards the mouth, it was called the *Ister* by the ancients; and it is now said, that four of the mouths are choked up with sand, and that there are only two remaining. It begins to be navigable for boats at Ulm, and receives several large rivers as it passes along. It is so deep between Buda and Belgrade, that the Turks and Christians have had men of war upon it; and yet it is not navigable to the Black sea, on account of the cataracts. The Danube was generally supposed to be the northern boundary of the Roman empire in Europe. It was worshipped as a deity by the Scythians.

DAPHNE, a daughter of the river Peneus by the goddess Terra, of whom Apollo became enamoured. This passion had been raised by Cupid; with whom Apollo, proud of his late conquest of the serpent Python, had disputed the power of his darts. Daphne heard with horror the addresses of the god, and endeavoured to remove herself from his importunities by flight. Apollo pursued her, and Daphne, fearful of being caught, intreated the assistance of the gods, who changed her into a laurel. Apollo crowned his head with the leaves of the laurel, and for ever ordered that that tree should be sacred to his divinity. Some say that Daphne was admired by Leucippus, son of Oenomaus king of Pisa, who to be in her company disguised his sex, and attended her in the woods in the habit of a huntress. Leucippus gained Daphne's esteem and love; but Apollo, who was his powerful rival, discovered his sex, and Leucippus was killed by the companions of Diana. Daphne was also the name of a daughter of Tiresias, priestess in the temple of Delphi. She was consecrated to the service of Apollo by the Epigoni, or according to others by the goddess Tellus. She was called *Sibyl*, on account of the wildness of her looks and expressions when she delivered oracles. Her oracles were generally in verse; and Homer, according to some accounts, has introduced much of her poetry in his compositions.

DAPHNE, in *Ancient Geography*, a small village near to, or in the suburbs of, Antiochia of Seleucis in Syria; with a large grove, well watered with springs: In the middle of the grove stood the temple of Apollo and Diana. Its extent was 80 stadia or 10 miles; the distance from the city five miles: A place pleasant and agreeable, from the plenty of water and the temperature of the air, and its soft-breathing breezes. The grove was of bay-trees, intermixed with cypress: which last multiplied so fast, as to occupy the whole of it. Pompey gave some land for enlarging the grove. Antiochus Epiphanes built a very large temple of Daphnæus Apollo. The place at length became so infamous, that people of modesty and character avoided resorting thither; so that *Daphnici mores* became proverbial.

DAPHNE, in *Ancient Geography*, a small district on the lake Samachonites, in the Higher Galilee, very pleasant, and plentifully watered with springs, which feed the Less Jordan; whence its name seems to arise, probably in imitation of that near Antioch of Syria on the river Orontes.

DAPHNE, *Spurge-laurel*; a genus of plants, belonging to the octandria class; and in the natural method ranking under the 31st order, *Vepreculæ*. See BOTANY *Index*.

DAPHNEPHORIA, a festival in honour of Apollo, celebrated every ninth year by the Bœotians. It was then usual to adorn an olive bough with garlands of laurels and other flowers, and place on the top a brazen globe, on which were suspended smaller ones. In the middle was placed a number of crowns, and a globe of inferior size, and the bottom was adorned with a saffron-coloured garment. The globe on the top represented the sun or Apollo. That in the middle was an emblem of the moon, and the others of the stars. The crowns, which were 65 in number, represented the sun's annual revolution. This bough was carried in solemn procession by a beautiful youth of an illustrious family, and whose parents were both living. The youth was dressed in rich garments which reached to the ground, his hair hung loose and dishevelled, his head was covered with a golden crown, and he wore on his feet shoes called *Iphicratidæ*, from Iphicrates an Athenian, who first invented them. He was called Δαφνηφορος, *laurel-bearer*; and at that time he executed the office of a priest of Apollo. He was preceded by one of his nearest relations, bearing a rod adorned with garlands, and behind him followed a train of virgins with branches in their hands. In this order the procession advanced as far as the temple of Apollo, surnamed Ismenius, where supplicatory hymns were sung to the god. This festival owes its origin to the following circumstance.—When an oracle advised the Ætolians who inhabited Arne and the adjacent country, to abandon their ancient possessions, and go in quest of a settlement, they invaded the Theban territories, which at that time were pillaged by an army of Pelasgians. As the celebration of Apollo's festival was near, both nations, who religiously observed it, laid aside all hostilities, and according to custom cut down laurel boughs from Mount Helicon, and in the neighbourhood of the river Melas, and walked in procession in honour of the divinity. The day that this solemnity was observed, Polematas the general of the Bœotian army saw a youth in a dream, that presented him with a complete suit of armour, and commanded the Bœotians to offer solemn prayers to Apollo, and walk in procession with laurel boughs in their hands every ninth year. Three days after this dream, the Bœotian general made a sally, and cut off the greatest part of the besiegers, who were compelled by this blow to relinquish their enterprise. Polematas immediately instituted a novennial festival to the god, who seemed to be the patron of the Bœotians.

DAPIFER, the dignity or office of grand master of a prince's household. This title was given by the emperor of Constantinople to the czar of Russia as a testimony of favour. In France the like officer was instituted by Charlemagne, under the title of *dapiferat*; and the dignity of dapifer is still subsisting in Germany, the elector of Bavaria assuming the title of *arch-dapifer of the empire*, whose office is, at the coronation of the emperor, to carry the first dish of meat to table on horseback.

DAPPLE-BAY, in the manege: When bay horses have marks of a dark bay, they are called *dapple-bays*.

Dapple-Blacks: When a black horse has got spots or marks more black or shining than the rest of his skin, he is called a *dapple-black*.

DARANTASIA, in *Ancient Geography*, called *Forum Claudii* by the Romans; a town of the Centrones in Gallia Narbonensis, situated between Lemincum and Augusta Prætoria. Now *Moustiers*, and *Moustiers en Tarantaise*, in Savoy.

DARAPTI, among logicians, one of the modes of syllogisms of the third figure, whose premises are universal affirmatives, and the conclusion is a particular affirmative: thus,

DAR- Every body is divisible;
AP- Every body is a substance;
TI. Therefore, some substance is divisible.

DARDA, a town and fort of Lower Hungary, built by the Turks in 1686, and taken by the Imperialists the next year, in whose hands it remains. It is seated on the river Drave, 10 miles from its confluence with the Danube, and at the end of the bridge of Esseck. E. Long. 19. 10. N. Lat. 45. 45.

DARDANELLES, two ancient and strong castles of Turkey, one of which is in Romania, and the other in Natolia, on each side of the channel formerly called the *Hellespont*. This keeps up a communication with the Archipelago, and the Propontis or sea of Marmora. The mouth of the channel is four miles and a half over; and the castles were built in 1659, to secure the Turkish fleet from the insults of the Venetians. The ships that come from Constantinople are searched at the castle on the side of Natolia, to see what they have on board.

DARDANIA, in *Ancient Geography*, a district of Mœsia Superior to the south. Now the south part of Servia, towards the confines of Macedonia and Illyricum.—*Dardani* was the name of the people, who seem to have been descendants of the *Dardani* of Troas. Also a small district of Troas, along the Hellespont, (Mela, Virgil); and the ancient name of *Samothracia*, (Pliny), from *Dardanus*, who removed thither.

DARDANUM PROMONTORIUM, (Pliny); *Dardanis*, (Strabo); a promontory of Troas, near Abydos, running out into the Hellespont; with a cognominal town at it, called *Dardanus*, and *Dardanum;* all which gave name to the *Dardanelles*.

DARDANUS, a son of Jupiter and Electra, who, after the death of his brother Jasion, left Samothrace his country, and passed into Asia Minor, where he married Batia, the daughter of Teucer king of Teucria. After the death of his father-in-law he ascended the throne, and reigned 62 years. He built the city of Dardania, and was reckoned the founder of the kingdom of Troy. He was succeeded by Erichthonius. According to some, Corybas, his nephew, accompanied him to Teucria, where he introduced the worship of Cybele. Dardanus taught his subjects to worship Minerva, and he gave them two statues of the goddess, one of which is well known by the name of *Palladium*. According to Virgil, Dardanus was an Italian by origin.

DARE, the same with dace. See DACE, ICHTHYOLOGY *Index*.

DARES, a Phrygian, who lived during the Trojan war, in which he was engaged, and of which he wrote the history in Greek. The history was extant in the age of Ælian; the Latin translation, which is all that is known of it, is generally allowed to be spurious, though it is attributed by some to Cornelius Nepos. This translation first made its appearance A. D. 1477, at Milan. Homer speaks of him, Iliad. v. 10. and 7.

DARFOOR, or DARFUR, a country or kingdom of Africa, which has been visited by no other European traveller excepting Mr Browne. This country is of considerable extent, and in many places covered with wood. During the dry season, the appearance of the open country is sterile and barren, but when the rains commence, the dry sandy soil is soon changed into green fields covered with luxuriant vegetation. Considerable quantities of maize, sesame, beans, and legumens, are raised by the inhabitants for food. There are several species of trees in Darfoor; but the tamarind alone is valuable for its fruit, or rises to a considerable size. The date, which is diminutive, does not appear to be indigenous. Domestic animals are, the camel, the sheep, the goat, and horned cattle, which are numerous. Of the milk of the cow, some of the inhabitants make a kind of cheese, but the process is not generally known. The camel is of an inferior quality; and the horse and the ass are imported from Egypt and Nubia. Their wild animals are, the lion, the leopard, the hyæna, the wolf, and the wild buffaloe. The *termes*, or white ant, abounds; and the cochineal insect is frequently met with, though it has never been applied to any useful purpose in Darfoor. The rocks are chiefly composed of gray granite, but in a few places alabaster and marble are found. Nitre is produced in considerable quantities, fossil salt is found in one district, and sulphur is collected by the pastoral Arabs on the south and west.

The principal towns in Darfoor, are Cobbe, the chief residence of the merchants, situated in N. Lat. 14. 11. Long. E. G. 28. 8. It is above two miles in length, but extremely narrow, containing numerous trees and vacant spaces within its boundaries. Sweini, which commands the northern road to Darfoor, is situated above two journeys to the north of Cobbe. Kourma, a small town, lies 12 or 13 miles to the south-west of Cobbe, and Cubcubia, two and a half journeys to the west. Cubcubia commands the western roads, and has a market twice in the week. Cours lies 14 or 15 miles to the north-west of Cobbe; Ril, about 60 miles to the south-east of Cobbe, is situated in a fertile plain, commands the southern and eastern roads, and was formerly the residence of the kings of Darfoor. Gidid, Gelle, and Shoba, are the only other remarkable towns. The villages are numerous, but their population seldom exceeds a few hundred inhabitants. The population of Darfoor is estimated by Browne at 200,000 persons. It consists of the native tribes of Fur, of a deep black complexion, crisped woolly hair, and features different from those of the negroes; Arabs of the tribes of Mahmid, Mahrea, Beni Fesara, Beni Gerar, &c. some of whom had settled

tled in the country, while others wander on the frontiers, and are very numerous; and a number of emigrants, from the neighbouring states, particularly Dongola, Mahas, Senaar, and Cordofan. Besides these, Darfoor comprehends the inhabitants of various subordinate districts, that are sometimes dependant on Darfoor, and sometimes on the surrounding nations: as Dar Rugda, which is generally subject to Bergoo; Dar Berti, Bego, or Dageou, between Darfoor and Bergoo, the power of which formerly predominated over the Furian tribes; and Zeghawa, formerly an independent kingdom, that was accustomed to raise a thousand cavalry in war, the inhabitants of which are different in their features from the Negroes.

The dialect of Arabic which is vernacular in Darfoor, differs essentially from that spoken in Egypt. The native Furians are more cheerful in their dispositions than the Egyptians; but resemble the Moorish tribes in the violence of their passions, their disregard to truth, their inattention to cleanliness, and their inaccurate ideas of property. As the practice of polygamy is established, their intercourse with the other sex is regulated by no attention to delicacy or decency; and the precepts of Islamism are often infringed, by the relations of brother and sister being exchanged for a closer connection. The sex are, however, subjected to less restraint than in many Mahometan countries. The women appear in public unveiled, make bargains in the markets, and converse with the other sex, without offending their husbands or relations. The most severe labours of the field, and the meanest domestic offices, are performed by the women, who are often seen walking after their husbands, under the pressure of a heavy burden, while these ride before them on their asses, without incumbrance and without concern.

Their houses are built of clay, commonly by the hands of their women, and are covered with a flattish roof of thin boards, coated with clay. Salt is the general medium of exchange in Darfoor, but in some places, small tin rings of arbitrary value, are employed. A caravan passes from Darfoor to Egypt, to traffic in slaves, ivory, gum, camels, &c.; but this commercial intercourse is not regular, and is frequently interrupted. The Dongolese and Nubian settlers in Darfoor, who had been accustomed to the Egyptian trade, originally opened the route; but merchants are frequently interrupted by the Cubba-besh and Bedeiat Arabs; the last of whom are not supposed to be of Arabic origin. The king, or, as he is denominated, the sultan of Darfoor, reigns with absolute authority, and confers the same arbitrary power on his delegates in the provinces. Though the precepts of the Koran are the ostensible rules of decision, in litigation, yet the verdict depends on the will of the judge; and, as none but ecclesiastics dare express their sentiments of his conduct, their opinion is the only check upon his caprice. These judges, however, display considerable ingenuity in developing the most intricate cases that occur in a nation versed in the arts of deceit.

The sultan's revenues consist in the taxes upon merchandise exported and imported; the annual tribute of live stock from the Arabs, and of corn from the towns and villages, with the amount of fines, forfeitures, and presents. The armies of Darfoor are not numerous, as 4000 troops are reckoned a formidable number; neither are these troops remarkable for skill, courage, or perseverance, though they endure hunger, thirst, and fatigue, with great resolution, and use no other camp equipage, but a light mat adapted to the size of the body. The troops of Darfoor, not actually engaged in war, are reviewed at an annual military festival, termed, *The leathering of the kettledrum*, when presents are offered to the sovereign by all the principal people of the country, and various superstitious ceremonies are performed, among which are the sacrifice of a young boy and a girl.

Various superstitious opinions are blended with the Mahometanism of the Furian tribes. The mountaineers sacrifice to the deity of the mountains in order to procure rain. Mahometanism began to prevail in Darfoor, in the reign of Solyman, of the Dageou race, who is supposed by Browne to have lived at some period between 130 and 150 years ago. The Dageou race are reported to have been originally expelled from the vicinity of Tunis, and to have resigned the sceptre to the race of Fur, after being exhausted by intestine dissensions. At the inauguration of every king, they are said to have kindled a fire, which was preserved burning till his death. At the accession of a sultan, the present Furians spread before him various carpets, on which their deceased monarchs used to sit, and from that which obtains the preference, deduce an omen of his future character, which they suppose will resemble its former possessor.

DARIC, in antiquity, a famous piece of gold, first coined by Darius the Mede about 538 years before Christ, probably during his stay at Babylon, out of the vast quantity of gold which had been accumulated in the treasury. From thence it was dispersed over the east, and also in Greece; so that the Persian daric, which was also called *stater*, was the gold coin best known in Athens in ancient times. According to Dr Bernard, it weighed two grains more than one of our guineas; but as it was very fine, and contained little alloy, it may be reckoned worth about 25$^{s.}$ of our money. Plutarch informs us, that the darics were stamped on one side with an archer clothed in a long robe, and crowned with a spiked crown, holding a bow in his left hand and an arrow in his right; and on the other side with the effigies of Darius. All the other pieces of gold of the same weight and value that were coined of the succeeding kings, both of the Persian and Macedonian race, were called *darics*, from Darius in whose reign this coin commenced. Of these there were whole darics and half darics; and they are called in those parts of Scripture written after the Babylonish captivity *adarkonim;* and by the Talmudists *darkonoth.* Greaves says that the daric is still found in Persia; but it is certainly very scarce, and perhaps of doubtful antiquity.

DARIEN, or the ISTHMUS OF PANAMA, is a province between South and North America, being a narrow isthmus or neck of land, which joins them together. It is bounded on the north by the North sea, on the south by the South sea, on the east by the gulf or river of Darien, and on the west by another part of the South sea and the province of Veragua. It lies in the form of a bow, or crescent, about the great bay of Panama in the South sea; and is 300 miles in length, and 60 in breadth. This province is not the richest, but is of the greatest importance to Spain, and has been the scene of more actions than any other in America. The wealth of Peru is brought hither, and from hence exported to Europe. This has induced many enterprising people to make attempts on Panama, Porto-Bello, and other towns of this province, in hopes of obtaining a rich booty.

The Scotch got possession of part of this province in 1699, and attempted to form an establishment, which would have proved one of the most useful and important that ever was projected. Of the rise, progress, and catastrophe, of this well-imagined, but ill-fated, undertaking, Sir John Dalrymple, in the 2d volume of his Memoirs of Great Britain and Ireland, has given a very interesting account, authenticated in every particular by unquestionable documents. The projector and leader of the Darien expedition was a clergyman of the name of *Paterson;* who having a violent propensity to see foreign countries, he made his profession the instrument of indulging it, by going to the new western world, under pretence of converting the Indians to the religion of the old. In his courses there, he became acquainted with Captain Dampier and Mr Wafer, who afterwards published, the one his Voyages, and the other his Travels, in the region where the separation is narrowest between the Atlantic and the South seas; and both of whom, particularly the first, appear by their books to have been men of considerable observation. But he got much more knowledge from men who could neither read nor write, by cultivating the acquaintance of some of the old bucaniers, who, after surviving their glories and their crimes, still, in the extremity of age and misfortune, recounted with transport the ease with which they had passed and repassed from the one sea to the other, sometimes in hundreds together, and driving strings of mules before them loaded with the plunder of friends and of foes. Paterson having examined the places, satisfied himself, that on the isthmus of Darien there was a tract of country running across from the Atlantic to the South sea, which the Spaniards had never possessed, and inhabited by a people continually at war with them; that along the coast, on the Atlantic side, there lay a string of islands called the *Sambaloes*, uninhabited, and full of natural strength and forests, from which last circumstance one of them was called the *island of the Pines;* that the seas there were filled with turtle and the manatee or sea cow; that mid-way between Porto-Bello and Carthagena, but near 50 leagues distant from either, at a place called *Acta*, in the mouth of the Darien, there was a natural harbour, capable of receiving the greatest fleets, and defended from storms by other islands which covered the mouth of it, and from enemies by a promontory which commanded the passage, and by hidden rocks in the passage itself; that on the other side of the isthmus, and in the same tract of country, there were natural harbours, equally capacious and well defended; that the two seas were connected by a ridge of hills, which, by their height, created a temperate climate in the midst of the most sultry latitudes, and were sheltered by forests, yet not rendered damp by them, because the trees grew at a distance from each other, having very little underwood; that, contrary to the barren nature of hilly countries, the soil was of a black mould two or three feet deep, and producing spontaneously the fine tropical fruits and plants, and roots and herbs; that roads could be made with ease along the ridge, by which mules, and even carriages, might pass from the one sea to the other in the space of a day; and consequently this passage seemed to be pointed out by the finger of nature, as a common centre to connect together the trade and intercourse of the universe.

Paterson knew that ships which stretch in a straight line from one point to another, and with one wind, run less risks, and require fewer hands, than ships which pass through many latitudes, turn with many coasts, and require many winds; in evidence of which, vessels of seven or eight hundred tons burden are often to be found in the South seas, navigated by no more than eight or ten hands, because these hands have little else to do than set their sails when they begin their voyage, and to take them in when they end it; that as soon as ships from Britain got so far south as to reach the trade-wind, which seldom varies, that wind would carry them to Darien, and the same wind would carry ships from the bay of Panama, on the opposite side of the isthmus, to the East Indies; that as soon as ships coming from the East Indies to the bay of Panama got so far north as the latitude of 40°, to reach the westerly winds, which, about that latitude, blow almost as regularly from the west as the trade-winds do from the east, these winds would carry them, in the track of the Spanish Acapulco ships, to the coast of Mexico; from whence the land-wind, which blows for ever from the north to the south, would carry them along the coast of Mexico into the bay of Panama. So that in going from Britain, ships would encounter no uncertain winds, except during their passage south into the latitude of the trade-wind: in coming from India to the bay of Panama, no uncertain winds, except in their passage north to the latitude of the westerly winds; and in going from the other side of the isthmus to the east, no uncertain wind whatsoever.—Gold was seen by Paterson in some places of the isthmus; and hence an island on the Atlantic side was called the *Gold island*, and a river on the side to the South sea was called the *Golden river;* but these were objects which he regarded not at that time, because far greater were in his eye; the removing of distances, the drawing nations nearer to each other, the preservation of the valuable lives of seamen, and the saving in freight, so important to merchants, and in time so important to them, and to an animal whose life is of so short duration as that of man.

By this obscure Scotsman, a project was formed to settle, on this neglected spot, a great and powerful colony; not as other colonies have for the most part been settled, by chance, and unprotected by the country from whence they went; but by system, upon foresight, and to receive the ample protection of those governments to whom he was to offer his project. And certainly no greater idea has been formed since the time of Columbus.

Paterson's original intention was to offer his project to England, as the country which had most interest in it, not only from the benefit common to all nations, of shortening the length of voyages to the East Indies, but by the effect which it would have had to connect the interests of her European, West Indian, American, African,

African, and East Indian trade. But Paterson having few acquaintance, and no protection in London, thought of drawing the public eye upon him, and ingratiating himself with moneyed men, and with great men, by assisting them to model a project, which was at that time in embryo, for erecting the Bank of England. But that happened to him which has happened to many in his situation: the persons to whom he applied made use of his ideas, took the honour of them to themselves, were civil to him for a while, and neglected him afterwards. He therefore communicated his project of a colony only to a few persons in London, and these few discouraged him.

He next made offer of his project to the Dutch, the Hamburghers, and the elector of Brandenburgh; because, by means of the passage of the Rhine and Elbe through their states, he thought, that the great additional quantities of East Indian and American goods, which his colony would bring into Europe, would be distributed through Germany. The Dutch and Hamburgh merchants, who had most interest in the subject of his visit, heard him with indifference: The elector, who had very little interest in it, received him with honour and kindness. But court arts and false reports lost him even that prince's favour.

Paterson, on his return to London, formed a friendship with Mr Fletcher of Salton, whose mind was inflamed with the love of public good, and all of whose ideas to procure it had a sublimity in them. Fletcher brought Paterson down to Scotland with him, presented him to the marquis of Tweeddale, then minister for Scotland; and then, with that power, which a vehement spirit always possesses over a diffident one, persuaded the marquis, by arguments of public good and the honour which would redound to his administration, to adopt the project. Lord Stair and Mr Johnston, the two secretaries of state, patronised those abilities in Paterson which they possessed in themselves: and the lord advocate, Sir James Stuart, the same man who had adjusted the prince of Orange's declaration at the Revolution, whose son was married to a niece of Lord Stair, went naturally along with his connexions. These persons, in June 1695, procured a statute from parliament, and afterwards a charter from the crown in terms of it, for creating a trading company to Africa and the new world, with power to plant colonies and build forts, with consent of the inhabitants, in places not possessed by other European nations.

Paterson, now finding the ground firm under him, and that he was supported by almost all the power and talents of his country, the character of Fletcher, and the sanction of an act of parliament and royal charter, threw his project boldly upon the public, and opened a subscription for a company. The frenzy of the Scots nation to sign the solemn league and covenant, never exceeded the rapidity with which they ran to subscribe to the Darien company. The nobility, the gentry, the merchants, the people, the royal burghs without the exception of one, most of the other public bodies, subscribed. Young women threw their little fortunes into the stock; widows sold their jointures, to get the command of money for the same purpose. Almost in an instant 400,000l. were subscribed in Scotland, although it be now known, that there was not at that time above 800,000l. of cash in the kingdom. The famous Mr Law, then a youth, afterwards confessed, that the facility with which he saw the passion of speculation communicate itself from all to all, satisfied him of the possibility of producing the same effect from the same cause, but upon a larger scale, when the duke of Orleans, in the year of the Mississippi, engaged him against his will to turn his bank into a bubble. Paterson's project, which had been received by strangers with fears when opened to them in private, filled them with hopes when it came to them upon the wings of public fame: For Colonel Erskine, son to Lord Cardross, and Mr Haldane of Gleneagles, the one a generous branch of a generous stem, and the other a country gentleman of fortune and character, having been deputed to receive subscriptions in England and on the continent, the English subscribed 300,000l. and the Dutch and Hamburghers 200,000l. more.

In the mean time the jealousy of trade (continues our author), which has done more mischief to the trade of England than all other causes put together, created an alarm in England; and the houses of lords and commons, without previous inquiry or reflection, on the 13th of December 1695, concurred in a joint address to the king, against the establishment of the Darien company as detrimental to the interest of the East India Company. Soon after, the commons impeached some of their own countrymen for being instrumental in erecting the company; and also some of the Scots nation, one of whom was a peer, Lord Belhaven; that is to say, they arraigned the subjects of another country, for making use of the laws of their own. Among 600 legislators, not one had the happy ray of genius to propose a committee of both parliaments, to inquire into the principles and consequences of the establishment; and if these should, upon inquiry, be found, that the benefit of it should be communicated, by a participation of rights, to both nations. The king's answer was, "That he had been ill advised in Scotland." He soon after changed his Scottish ministers, and sent orders to his resident at Hamburgh to present a memorial to the senate, in which he disowned the company, and warned them against all connexions with it. The senate sent the memorial to the assembly of merchants, who returned it with the following spirited answer. "We look upon it as a very strange thing, that the king of Britain should offer to hinder us, who are a free people, to trade with whom we please; but are amazed to think that he would hinder us from joining with his own subjects in Scotland, to whom he had lately given such large privileges, by so solemn an act of parliament." But the merchants, seeing the scheme discouraged by their governments, were soon intimidated: The Dutch, Hamburgh, and London merchants withdrew their subscriptions.

The Scots, not discouraged, were rather animated by this oppression; for they converted it into a proof of the envy of the English, and of their consciousness of the great advantages which were to flow to Scotland from the colony. The company proceeded to build six ships in Holland, from 36 to 60 guns, and they engaged 1200 men for the colony; among whom were younger sons of many of the noble and most ancient families of Scotland, and 60 officers who had been disbanded at the peace, who carried with them such of their private men, generally raised on their own, or the estates of their relations, as they knew to be faithful and brave; and most of those were Highlanders. The Scots parliament, on the 5th August 1698, unanimously addressed the king to support the company. The lord president Sir Hugh Dalrymple, brother to Lord Stair, and head of the bench, and the lord advocate Sir James Stuart, head of the bar, jointly drew memorials to the king, able in point of argument, information, and arrangement; in which they defended the rights of the company upon the principles of constitutional and of public law. And neighbouring nations, with a mixture of surprise and respect, saw the poorest kingdom of Europe sending forth the most gallant and the most numerous colony that had ever gone from the old to the new world.

On the 26th day of July of the year 1698, the whole city of Edinburgh poured down upon Leith, to see the colony depart, amidst the tears and prayers and praises of relations and friends, and of their countrymen. Many seamen and soldiers, whose services had been refused, because more had offered themselves than were needed, were found hid in the ships, and, when ordered ashore, clung to the ropes and timbers, imploring to go without reward with their companions. Twelve hundred men sailed in five stout ships, and arrived at Darien in two months, with the loss of only 15 of their people. At that time it was in their power, most of whom were well born, and all of them hardily bred and inured to the fatigues and dangers of the late war, to have gone from the northmost part of Mexico to the southmost of Chili, and to have overturned the whole empire of Spain in the South seas: But modest, respecting their own and their country's character, and afraid of being accused that they had plunder, and not a settlement in view, they began with purchasing lands from the natives, and sending messages of amity to the Spanish governors within their reach: and then fixed their station at Acta, calling it *New St Andrew*, from the name of the tutelar saint of Scotland, and the country itself *New Caledonia*. One of the sides of the harbour being formed by a long narrow neck of land which ran into the sea, they cut it across so as to join the ocean and the harbour. Within this defence they erected their fort, planting upon it 50 pieces of cannon. On the other side of the harbour there was a mountain a mile high, on which they placed a watch-house, which, in the rarefied air within the tropics, so favourable for vision, gave them an immense range of prospect to prevent all surprise. To this place, it was observed that the Highlanders often repaired, to enjoy a cool air, and to talk of their friends they had left behind in their hills; friends whose minds were as high as their mountains. The first public act of the colony was to publish a declaration of freedom of trade and religion to all nations. This luminous idea originated with Paterson.

But the Dutch East India Company having pressed the king, in concurrence with his English subjects, to prevent the settlement at Darien, orders had been sent from England to the governors of the West Indian and American colonies, to issue proclamations against giving assistance, or even to hold correspondence with the colony; and these were more or less harshly expressed, according to the tempers of the different governors. The Scots trusting to far different treatment, and to the supplies which they expected from those colonies, had not brought provisions enough with them; they fell into diseases from bad food and from want of food. But the more generous savages, by hunting and fishing for them, gave them that relief which fellow Britons refused. They lingered eight months, awaiting, but in vain, for assistance from Scotland; and almost all of them either died out or quitted the settlement. Paterson, who had been the first that entered the ship at Leith, was the last who went on board at Darien.

During the space of two years, while the establishment of his colony had been in agitation, Spain had made no complaint to England or Scotland against it. The Darien council even averred in their papers (which are in the advocates library), that the right of the company was debated before the king, in presence of the Spanish ambassador, before the colony left Scotland. But now, on the 3d of May 1698, the Spanish ambassador at London presented a memorial to the king, which complained of the settlement at Darien as an encroachment on the rights of his master.

The Scots, ignorant of the misfortunes of their colony, but provoked at this memorial, sent out another colony soon after of 1300 men, to support an establishment which was now no more. But this last expedition having been more hastily prepared than the first, was unlucky in its passage. One of the ships was lost at sea, many men died on ship board, and the rest arrived at different times, broken in their health and dispirited, when they heard the fate of those who had gone before them.—Added to the misfortunes of the first colony, the second had a misfortune peculiar to itself: The general assembly of the church of Scotland sent out four ministers, with orders "to take charge of the souls of the colony, and to erect a presbytery, with a moderator, clerk, and record of proceedings; to appoint ruling elders, deacons, overseers of the manners of the people, and assistants in the exercise of church discipline and government, and to hold regular kirk-sessions." When they arrived, the officers and gentlemen were occupied in building houses for themselves with their own hands, because there was no help to be got from others; yet the four ministers complained grievously that the council did not order houses to be immediately built for their accommodation. They had not had the precaution to bring with them letters of recommendation from the directors at home to the council abroad. On these accounts, not meeting with all the attention they expected from the higher, they paid court to the inferior ranks of the colonists, and by that means threw divisions into the colony. They exhausted the spirits of the people, by requiring their attendance at sermon four or five hours at a stretch, relieving each other by preaching alternately, but allowing no relief to their hearers. The employment of one of the days set aside for religious exercise, which was a Wednesday, they divided into three parts, thanksgiving, humiliation, and supplication, in which three ministers followed each other. And as the service of the church of Scotland consists of a lecture with a comment, a sermon, two prayers, three psalms, and a blessing, the work of that day, upon an average of the length of the service of that age,

age, could not take up less than twelve hours: during which space of time the colony was collected, and kept close together in the guard-room, which was used as a church, in a tropical climate, and in a sickly season. They presented a paper to the council, and made it public, requiring them to set aside a day for a solemn fasting and humiliation, and containing their reasons for their requisition; in which, under pretence of enumerating the sins of the people, they poured abuse on their rulers. They damped the courage of the people, by continually presenting hell to them as the termination of life to most men, because most men are sinners. Carrying the presbyterian doctrine of predestination to extremes, they stopped all exertions, by showing that the consequence of them depended not on those by whom they were made. They converted the numberless accidents to which soldiers and seamen are exposed into immediate judgments of God against their sins. And having resolved to quit the settlement, they, in excuse for their doing so, wrote bitter letters to the general assembly against the characters of the colonists, and the advantages of the colony itself.

One of them, in a kind of history of the colony which he published, with a savage triumph exulted over the misfortunes of his countrymen in the following words;—"They were such a rude company, that I believe Sodom never declared such impudence in sinning as they. An observant eye might see, that they were running the way they went; hell and judgment was to be seen upon them, and in them, before the time: Their cup was full; it could hold no more: They were ripe; they must be cut down with the sickle of the wrath of God."

The last party that joined the second colony at Darien, after it had been three months settled, was Captain Campbell of Finab with a company of the people of his own estate, whom he had commanded in Flanders, and whom he carried to Darien in his own ship. On their arrival at New St Andrew, they found intelligence had been lately received, that a Spanish force of 1600 men, which had been brought from the coast of the South sea, lay encamped at Tubucantee, waiting there till a Spanish squadron of eleven ships which was expected should arrive, when they were jointly to attack the fort. The military command was offered to Captain Campbell, in compliment to his reputation and to his birth, who was descended from the families of Breadalbane and Athole. In order to prevent a joint attack, he resolved to attack first; and therefore on the second day after his arrival, he marched with 200 men to Tubucantee, before his arrival was known to the enemy, stormed the camp in the night-time, dissipated the Spanish force with much slaughter, and returned to the fort the fifth day: But he found the Spanish ships before the harbour, their troops landed, and almost all hope of help or provision cut off; yet he stood a siege near six weeks, till almost all the officers were dead, the enemy by their approaches had cut off his wells, and his balls were so far expended, that he was obliged to melt the pewter dishes of the garrison into balls. The garrison then capitulated, and obtained not only the common honours of war and security for the property of the company, but, as if they had been conquerors, exacted hostages for performance of the conditions. Captain Campbell alone desired to be excepted from the capitulation, saying he was sure the Spaniards could not forgive him the mischief which he so lately had done them. The brave, by their courage, often escape that death which they seem to provoke: Captain Campbell made his escape in his vessel, and, stopping nowhere, arrived safely at New York, and from thence to Scotland, where the company presented him with a gold medal, in which his virtue was commemorated, to inflame his family with the love of heroic actions. And the Lord Lyon King at Arms, whose office it is in Scotland (and such offices should be everywhere) to confer badges of distinction according to the rules of heraldry upon honourable actions, gave him a Highlander and an Indian for supporters to his coat of arms.

A harder fate attended those whom Captain Campbell left at Darien. They were so weak in their health as not to be able to weigh up the anchors of the Rising Sun, one of their ships, which carried 60 guns: But the generous Spaniards assisted them. In going out of the harbour she ran aground: The prey was tempting, and to obtain it, the Spaniards had only to stand by and look on: but showed that mercy to the Scots in distress, which one of the countrymen of those Scots, General Elliot, returned to the posterity of the Spaniards at the end of the late conflagration at the siege of Gibraltar. The Darien ships being leaky and weakly manned, were obliged in their voyage to take shelter in different ports belonging to Spain and England. The Spaniards in the new world showed them kindness; the English governments showed them none; and in one place one of their ships was seized and detained. Of these only Captain Campbell's ship and another small one were saved: The Royal Sun was lost on the bar of Charlestown; and of the colony, not more than 30, saved from war, shipwreck, or disease, ever saw their country again.

Paterson, who had stood the blow, could not stand the reflection of misfortune. He was seized with a lunacy in his passage home after the ruin of the first colony: But he recovered in his own country, where his spirit, still ardent and unbroken, presented a new plan to the company, founded on the idea of King William, that England should have the joint dominion of the settlement with Scotland.

He survived many years in Scotland, pitied, respected, but neglected. After the union of the two kingdoms, he claimed reparation of his losses from the equivalent-money given by England to the Darien Company, but got nothing: because a grant to him from a public fund would have been only an act of humanity, not a political job.

Thus ended the colony of Darien. Men look into the works of poets for subjects of satire; but they are more often to be found in the records of history. The application of the Dutch to King William against the Darien Company, affords the surest of all proofs, that it was the interest of the British islands to support it. England, by the imprudence of ruining that settlement, lost the opportunity of gaining and continuing to herself the greatest commercial empire that probably ever will be upon earth. Had she treated with Scotland, in the hour of the distress of the company, for a joint possession of the settlement, or adopted the union of the kingdoms, which the sovereign of both proposed to them, that possession could certainly have been obtained. Had she treated with Spain to relinquish an imaginary right, or at least to give a passage across the isthmus, upon receiving duties so high as to overbalance all the chance of loss by a contraband trade, she had probably obtained either the one or the other. Had she broke with Spain for the sake of gaining by force one of those favours, she would have lost far less than she afterwards did by carrying a war into that country for many years, to force a king upon the Spaniards against their will. Even a rupture with Spain for Darien, if it had proved successful, would have knit the two nations together by the most solid of ties, their mutual interest: for the English must then have depended upon Spain for the safety of their caravans by land, and the Spaniards upon England for the safety of their fleets by sea. Spain and England would have been bound together as Portugal and England have long been; and the Spanish treasures have sailed, under the wings of English navies, from the Spanish main to Cadiz, in the same manner as the treasures of Portugal have sailed under the same protection, sacred and untouched, from the Brazils to Lisbon.

It has been made a question, whether King William behaved with his ordinary sincerity and steadiness, in the assurances of favour which he gave more than once to the company during their distresses. The following anecdote makes it probable, that there was a struggle in his breast between the part which he was obliged to act to please his English and Dutch, at the expence of his Scots subjects, and his own feelings. A provision ship of the first colony, in which were 30 gentlemen passengers, and some of them of noble birth, having been shipwrecked at Carthagena, the Spaniards, believing or pretending to believe that they were smugglers, cast them into a dungeon, and threatened them with death. The company deputed Lord Basil Hamilton from Scotland to implore King William's protection for the prisoners. The king at first refused to see him, because he had not appeared at court when he was last in London. But when this difficulty was removed by explanation, an expression fell from the king, which showed his sense of the generous conduct of another, although, influenced by the English and Dutch East India Companies, he could not resolve to imitate it in his own. For Lord Basil's audience having been put off from time to time, but at last fixed to be in the council chamber after a council was over, the king, who had forgotten the appointment, was passing into another room, when Lord Basil placed himself in the passage, and said, "That he came commissioned by a great body of his majesty's subjects to lay their misfortunes at his feet; that he had a right to be heard, and would be heard:" The king returned, listened with patience, gave instant orders to apply to Spain for redress; and then turning to those near him, said, "This young man is too bold, if any man can be too bold in his country's cause." I had this anecdote from the present earl of Selkirk, grandson to Lord Basil.

King William's desertion of a company erected upon the faith of his own charter, and the English oppressions of it, were the reasons why so many of the Scots, during four successive reigns, disliked the cause of the Revolution and of the Union. And that dislike, joined to English discontents, brought upon both countries two rebellions, the expenditure of many millions of money, and (which is a far greater loss) the downfall of many of their noblest and most ancient families. —*Sir John Dalrymple's Memoirs of Great Britain and Ireland*, vol. ii.

DARII, in *Logic*, one of the modes of syllogism of the first figure, wherein the major proposition is an universal affirmative, and the minor and conclusion particular affirmatives: thus,

DA- Every thing that is moved, is moved by another;
RI- Some body is moved;
I, Therefore, some body is moved by another.

DARIORIGUM, in *Ancient Geography*, a town of the Veneti in Gallia Celtica; called in the Notitia Lugdunensis, *Civitas Venetum*, after the manner of the lower age. Now *Vannes*, or *Vennes*, in Britanny. W. Long. 2. 37. Lat. 47. 40.

DARIUS, the name of several kings of Persia. See *(History of)* PERSIA.

DARKING, a market-town of Surrey in England, situated ten miles east of Guilford. The market is noted for corn and provisions. Population 3259 in 1811. W. Long. 0. 15. N. Lat. 51. 18.

DARKNESS, the absence, privation, or want of natural light. "Darkness was upon the face of the deep." (Gen. i. 2.); that is to say, the chaos was plunged in thick darkness, because hitherto the light was not created. One of the most terrible sorts of darkness was that which Moses brought upon Egypt as a plague to the inhabitants of it. The Septuagint, our translation of the Bible, and indeed most others, in explaining Moses's account of this darkness, render it, "a darkness which may be felt:" and the Vulgate has it "palpable darkness;" that is, a darkness consisting of black vapours and exhalations, so condensed that they might be perceived by the organs of feeling or seeing: but some commentators think that this is carrying the sense too far, since in such a medium as this mankind could not live an hour, much less for the space of three days, as the Egyptians are said to have done, during the time this darkness lasted; and therefore they imagine, that instead of a darkness that may be felt, the Hebrew phrase may signify a darkness wherein men went groping and feeling about for every thing they wanted. Le Clerc is of this opinion, and thinks that Philo, in his life of Moses, understood the passage in its right sense. "For in this darkness (says he), whoever were in bed, durst not get up; and such as their natural occasions compelled to get up, went feeling about by the walls, or any thing they could lay hold on, as if they had been blind." What it was that occasioned this darkness, whether it was in the air or in the eyes; whether it was a suspension of light from the sun in that country, or a black thick vapour which totally intercepted it, there is reason to think that the description which the author of the book of Wisdom (xvi. 1, 2, 3, &c.) gives us of their inward terrors and consternation, is not altogether conjectural, viz. that they were not only prisoners of darkness, and fettered with the bonds of a long night, but were horribly astonished likewise, and troubled with strange apparitions;

paritions; for while over them was spread an heavy night, they were to themselves more grievous than darkness.

During the last three hours that our Saviour hanged upon the cross, a darkness covered the face of the earth, to the great terror and amazement of the people present at the execution. This extraordinary alteration in the face of nature (says Dr Macknight, in his *Harmony of the Gospels*), was peculiarly proper, whilst the Sun of righteousness was withrawing his beams from the land of Israel and from the world; not only because it was a miraculous testimony borne by God himself to his innocence: but also because it was a fit emblem of his departure and its effects, at least till his light shone out anew with additional splendour in the ministry of his apostles. The darkness which now covered Judea and the neighbouring countries, beginning about noon, and continuing till Jesus expired, was not the effect of an ordinary eclipse of the sun: for that can never happen but at the new moon; whereas now it was full moon; not to mention, that the total darkness occasioned by eclipses of the sun never continues above twelve or fifteen minutes; wherefore it must have been produced by the divine power, in a manner we are not able to explain. Accordingly, Luke (xxiii. 44, 45.), after relating that there was darkness over all the earth, adds, "and the sun was darkened;" which perhaps may imply, that the darkness of the sun did not occasion, but proceeded from, the darkness that was over all the land. Farther, the Christian writers, in their most ancient apologies to the Heathens, affirm, that as it was full moon at the passover when Christ was crucified, no such eclipse could happen by the course of nature. They observed also, that it was taken notice of as a prodigy by the Heathens themselves.

DARLINGTON, a town of the county of Durham, situated on a flat on the river Skerne, which falls into the Tees. It is a pretty large place, has several streets, and a spacious market-place. It gives title of earl to the Vane family. W. Long. 1. 15. N. Lat. 54. 30.

DARMSTADT, a town of Germany, in the circle of the Upper Rhine, and capital of the grand duchy of Hesse, with a handsome castle, where its own prince generally resides. It is seated on a river of the same name, in E. Long. 8. 40. N. Lat. 49. 5c.

DARNEL. See LOLIUM, BOTANY *Index*.

DARNLEY, LORD. See *(History of)* SCOTLAND.

DARTFORD, a town of the county of Kent in England, seated on the river Darent, not far from its influx into the Thames. Population 3177 in 1811. E. Long. 0. 16. N. Lat. 51. 25.

DARTMOUTH, a sea-port town in Devonshire, seated on the river Dart, near its fall into the sea. It is a well frequented and populous place, having a commodious harbour, and a considerable trade by sea. The town is large and well built; but the streets are narrow and bad, though all paved. It sends two members to parliament. Population 3595 in 1811. W. Long. 4. 0. N. Lat. 50. 25.

DARTOS, in *Anatomy*, one of the coats which form the scrotum. It is called the *dartos muscle;* but Dr Hunter says, that no such muscle can be found, and Albinus takes no notice of it in his tables.

DARWIN, ERASMUS, a physician, a poet, and medical writer, was born at Elston, near Newark, in Nottinghamshire, on the 12th December 1731. He was the fourth son of Robert Darwin, Esq. He received the early part of his education at Chesterfield school, under the reverend Mr Burrows, of whom he always spoke with great respect. He was entered, with two of his elder brothers, at St John's college, Cambridge; and, being intended for the practice of medicine, took the degree of M. B. in 1755, defending in his *thesis* an opinion, that the motion of the heart and arteries is produced by the immediate stimulus of the blood. During his residence in Cambridge, Mr Darwin was elected to one of Lord Exeter's scholarships, worth about 16l. per annum, which, from the meagreness of his father's income at that time, was esteemed a desirable acquisition. After having prepared himself for his future profession, by an attendance on the lectures of Dr Hunter, in London, and by a severe course of study at Edinburgh, he contemplated the metropolis as the proper theatre for his exertions. Deterred, however, by the want of an immediate introduction, and the improbability of obtaining immediate patronage, Dr Darwin thought it altogether more adviseable to settle in the country. The first place to which he went, in the capacity of a physician, was Nottingham, where he was entirely disappointed in his hopes of practice; he removed, therefore, to Litchfield, with letters of introduction to Lady Gresley and the reverend Mr Seward. Here his great capacity and various acquirements were most justly appreciated: he resided at Litchfield during a great number of years, in the enjoyment of a very extensive reputation, and a very profitable practice, the foundation of which is supposed to have been laid by his success in restoring to health a gentleman of fortune in the neighbourhood, whose recovery was despaired of by a numerous circle of friends and acquaintances.

In the year 1757 Dr Darwin married Miss Mary Howard, daughter of Charles Howard, Esq. by his wife, Elizabeth Foley: she died in 1770. By this lady he had five children, two of whom died in their infancy: the eldest son, Charles, he educated to his own profession, but he died in the 20th year of his age, very soon after he had finished his course of studies at Edinburgh, where he gained considérable reputation, by endeavouring to furnish a criterion for distinguishing *pus* from *mucus*.

Soon after the decease of his wife, Dr Darwin commenced his laborious work, the *Zoonomia*, which, however, he did not think proper to publish till about eight years since.

In 1778 he obtained a lease of a picturesque spot of ground, about a mile from Litchfield, where a cold bath was erected by Sir John Flayer, an eminent physician in the beginning of the last century: there is a grotto, surrounded by projecting rocks, from the edges of which trickles a perpetual shower of water. This place became his favourite retreat and amusement: here he formed a botanic garden, and began his poem on the "Loves of the Plants," the scenery of which, "as adapted to love-scenes, and being thence a proper residence for the modern goddess of Botany," is taken from these sequestered shades :—

And if with thee some hapless maid should stray,
Disastrous Love companion of her way,
Oh lead her timid steps to yonder glade,
Whose arching cliffs depending alders shade :
There as meek Evening wakes her temperate breeze,
And moonbeams glimmer through the trembling trees,
The rills, that guggle round, shall soothe her ear ;
The weeping rocks shall number tear for tear, &c. &c.
Canto I. line 25.

In 1780, Dr Darwin was called to attend Colonel Sacheveral Pole, of Radbourne-hall, four miles from Derby ; and a few months after the decease of the colonel, he married his relict, Mrs Pole, with a jointure of 600l. per annum. The marriage of Dr Darwin occasioned his immediate removal from Litchfield to Radbourne, where he resided two years, till he got accommodated with a house in Derby. In this last situation he remained till about two months before his death, when he removed to Breadwall Priory about three miles from Derby, which was a commodious and peaceful retirement for his old age.

During the last few years, Dr Darwin was much subject to inflammation in his breast and lungs ; and had a very serious attack of this disease in the course of the spring of 1801, from which, after repeated bleedings, he with difficulty recovered. On the 10th of April 1802, he was attacked with a severe shivering fit, followed by a correspondent hot one, and accompanied with symptoms of inflammation in his lungs: his surgeon, Mr Hadley, took from him, in the course of the day, 25 ounces of blood. The fever was removed, and in two or three days he became, to all appearance, quite well. On the 17th as he was walking in his garden with Mrs Darwin, and a lady of about his own age, the latter remarked, that he would have sufficient employment for ten years in bringing all his plans about the place to perfection. "You madam (he replied) have as good a prospect as any body I know, of your age, of living ten years ; I have not." Mrs Darwin remarked his good looks, spirits, and strength. He said, "I always appear particularly well immediately before I become ill." He sat with his family in the evening, conversing with his usual cheerfulness ; went to bed, and rose at six on the following morning ; wrote some letters till after seven, when he was seized with a chilly fit, which increased, and was attended with thirst. He then sat down by the kitchen fire and drank a considerable quantity of butter-milk ; but feeling himself much indisposed, he lay down on a sofa, when becoming more cold and torpid, he was raised up, and placed in an arm-chair, where, without pain or any emotion, he expired a little before nine, in the 71st year of his age.

Dr Darwin left a widow and six children, three boys and three girls, by his last marriage. There was also another child, who died an infant. Besides these, he left two natural daughters, whom he had established in a school at Ashbourne, and for whose instruction and assistance he composed and published his "Treatise on Female Education."

During the whole of his life, Dr Darwin was remarkable for great benevolence of disposition, and it was particularly conspicuous in the care he took even of the lowest animals. The keenness of his feelings on this subject has been attributed to the strong impression made upon his mind by a representation of the tortures of the inquisition, which was shewn to him at an early age. He had frequently expressed a strong desire, that the termination of his existence might be without pain, having always looked upon death as the less evil of the two. He was of a middle stature, in person gross and corpulent ; his features were coarse, and his countenance heavy ; if not wholly void of animation, it certainly was by no means expressive. In his gait and dress he was rather clumsy and slovenly, and frequently walked with his tongue hanging out of his mouth.

His conversation abounded with very unequal sallies of wit : when he found himself engaged with a powerful antagonist in argument, he had sometimes recourse to ridicule, a weapon which he did not always handle with dexterity, for he was affected with an impediment in his speech which rendered his enunciation scarcely intelligible.

About the age of twenty-one, Dr Darwin was seized with a fit of the gout ; in consequence of which he totally abstained from all fermented liquors, not even tasting small beer, or a drop of any kind of wine; but he ate plentifully of flesh-meat, and all kinds of vegetables and fruit, using for his drink, at meals, chiefly water alone, or cream and water, with tea and coffee between them, as usual. By this abstinence from fermented liquors, he kept quite free from gout for 15 years, and from some other complaints to which he had been subject. He then indulged himself occasionally with a little wine and water ; cyder and water, &c. but was speedily admonished into his former temperance, by a paroxysm of the gout. He was in the habit of eating a large quantity of food, and his stomach possessed a strong power of digestion. His advice frequently was, "Eat, or be eaten ;" but he took every opportunity to impress a dread of all fermented liquors on the minds of his patients, whose diseases he was too ready to represent as originating in the frequent use of them. In the "Botanic Garden," he has also taken an opportunity to express his strong antipathy against fermented and spirituous liquors, by comparing their effects to that of the Promethean fire : "The ancient story of Prometheus, who concealed in his bosom the fire he had stolen, and afterwards had a vulture perpetually gnawing his liver, afford so apt an allegory for the effects of drinking spirituous liquors, that one should be induced to think the art of distillation, as well as some other chemical processes (such as calcining gold) had been known in times of great antiquity, and lost again. The swallowing drams cannot be better represented in hieroglyphic language, than by taking fire into one's bosom ; and certain it is, that the general effect of drinking fermented or spirituous liquors is an inflamed, schirrous, or paralytic liver, with its various critical or consequential diseases, as leprous eruptions on the face, gout, dropsy, epilepsy, and insanity."

Darwin.

The various productions of Dr Darwin's fanciful and philosophical pen, have long since been exposed to public criticism, and received an ample share, as well of obloquy as applause. Still, however, he has claims to celebrity from the literary lustre which adorns his character, as a medical philosopher, a philosophical agricultor, and a poet.

The pretensions of Dr Darwin to high rank as a medical philosopher will, of course, substantiate themselves in the merits, numerous and solid as they are, of the "Zoonomia." In whichever point of view this work shall be considered, whether as a mere repository of curious natural and medical facts, or as a scheme and system of pathological and physiological disquisition, is probably matter of trifling import, so far as the reputation of its author is concerned. By either mode of appreciation, it is, unquestionably, a noble effort of human labour or of human wit; and though its illustrious author may have sometimes erred from excess of ingenuity, and been occasionally blinded by too great a love of system, the Zoonomia will ever be considered as a production of transcendent merit.

As a philosophical agricultor Dr Darwin must ever be entitled to the highest consideration. In order to profit by the multitudinous experiments of Hales, Grew, Malpighi, Bonnet, Du Hamel, Buffon, Spallanzani, Priestley, &c. collected in the "Phytologia," it is not necessary to take possession of the air-built theory of vegetation which is there constructed, and securely inhabit it as an edifice whose solidity is equal to its elegance. Whether the analogy is in fact so close between the parts and functions of animal and vegetable beings;—whether the anatomy of the one so strictly corresponds with that of the other, as to induce a belief that the latter are in reality an inferior order of the former, possessed of a brain, uterus, muscles, and complete nervous system, is an inquiry, which, however curious, must surely be subordinate in comparison with those grand and indisputable discoveries which the application of chemistry to agriculture has brought to light. A small portion only of the Phytologia is devoted to this fanciful system of vegetable physiology: the second part, divided into three sections, treats on the economy of vegetation; and the third, on agriculture and horticulture, is divided into six sections.

Dr Darwin, in his character as a poet, does not stand very high in the estimation of some. The ear is fascinated and seduced by the mellifluence of his numbers, but there is a harlotry in his embellishments which is unchaste. His cadences are not sufficiently varied for a poem of such length as the "Botanic Garden;" indeed there is an evident mechanism in the construction of his lines which it is by no means pleasant to detect. But an imagination of unrivalled richness; a felicity of allusion to whatever can throw lustre on his subject, to ancient mythology and modern discoveries, to the works of nature and of art; if these are some of the essentials of poetry, Dr Darwin may certainly claim them as his own. No man, perhaps, was ever happier in the selection and composition of his epithets, had a more imperial command of words, or could elucidate with such accuracy and elegance the most complex and intricate machinery. Who but Dr Darwin would have thought of describing a porcelain manufactory in verse; the powers and construction of a steam engine; the mechanism of a watch; and the complexity of a cotton-mill? These, and many similar descriptions, to be found in the Botanic Garden, are inimitable in their way. In some of his minor effusions he is particularly happy: the beautiful little song "to May," is exquisitely finished; and it would be difficult to find thirty lines in the Botanic Garden to rival in dignity and pathos the "Address to Swilcar's Oak," introduced in the Phytologia.

Darwin.

As a prose writer, Dr Darwin was incorrect; his grammatical errors are numerous, and he was even deficient in orthography. In the year 1758, he published, in the Philosophical Transactions, "An attempt to confute the opinion of Henry Earl, concerning the ascent of vapour;" and "An account of the cure of a periodical hæmoptoë, by keeping the patient awake." This was followed by "Experiments on animal fluids in the exhausted receiver." He inserted in the Derby Mercury, an elegy writen at Matlock, and addressed to Mrs Darwin; another piece occasioned by the appearance of a most fatal distemper among horned cattle, at Calke, near Derby; and a third article on occasion of the earthquake, which several years ago was felt at Derby, and in the surrounding country. In 1782, the Botanical Society of Litchfield published a translation of Linnæus's *Systema Vegetabilium*, the execution of which was principally confided to Dr Darwin. His other works have already been mentioned in the course of this biographical sketch. He left a poem entitled "The Temple of Nature," which was published after his death.

Next to medicine, mechanics, and almost every branch of natural history, engaged his attention. He not only pursued these studies with great ardour and diligence himself, but also embraced every opportunity of cultivating and encouraging them among his numerous connexions and acquaintance. Very soon after he settled in Derby, he instituted and established a philosophical society and library, both of which were in a flourishing state at the time of his decease. He also took pleasure in encouraging works in natural history.

But though the learning, taste, and genius of Dr Darwin, were eminently displayed in these pursuits, yet there was one great end, to the attainment of which all his talents and views were directed. He did not hesitate openly and repeatedly to declare, that the acquisition of wealth was the leading object of all his literary undertakings.

However, he was by no means insensible to the value of reputation. During the last years of his life, the love of fame was a passion which had a great power over his mind; and the incense of praise was so pleasant to him, that flattery was found to be the most successful means of gaining his notice and favour.

There are reasons for suspecting that Dr Darwin was not a believer in Divine Revelation. A few days before his death, a gentleman endeavoured to discover whether he entertained a belief and expectation of a future state of existence; the doctor was observed to speak with a considerable degree of sedateness on the subject, and remarked, that it was natural to extend our wishes and views beyond the present scene, and

that

that it was right to pursue such measures as are likely to secure our happiness in another world; "but," he added, "let us not hear any thing about hell."

DASYPUS, the ARMADILLO or *Tatou*, a genus of quadrupeds belonging to the order of *Bruta*. See MAMMALIA *Index*.

DATA, among mathematicians, a term for such things or quantities as are given or known, in order to find other things thereby that are unknown. The *data* of Euclid is the first in order of the books that have been written by the ancient geometricians, to facilitate and promote the method of resolution or analysis. In general, a thing is said to be given which is either actually exhibited, or can be found out, that is, which is either known by hypothesis, or that can be demonstrated to be known: and the propositions in the book of Euclid's data shew what things can be found out or known, from those that by hypothesis are already known: so that in the analysis or investigation of a problem, from the things that are laid down as given or known, by the help of these propositions, it is demonstrated that other things are given, and from these last that others again are given, and so on, till it is demonstrated that that which was proposed to be found out in the problem is given; and when this is done, the problem is solved, and its composition is made and derived from the compositions of the data which were employed in the analysis. And thus the data of Euclid are of the most general and necessary use in the solution of problems of every kind.

Marinus, at the end of his preface to the data, is mistaken in asserting that Euclid has not used the synthetical, but the analytical method in delivering them: for though in the analysis of a theorem, the thing to be demonstrated is assumed in the analysis; yet in the demonstrations of the data, the thing to be demonstrated, which is, that something is given, is never once assumed in the demonstration; from which it is manifest, that every one of them is demonstrated synthetically; though indeed if a proposition of the data be turned into a problem, the demonstration of the proposition becomes the analysis of the problem. *Simpson's Preface to his edition of the Data.*

From the primary use of the word *data* in mathematics, it has been transplanted into other arts; as philosophy, medicine, &c. where it expresses any quantity, which, for the sake of a present calculation, is taken for granted to be such, without requiring an immediate proof for its certainty; called also the *given* quantity, number, or power. And hence also such things as are known, from whence, either in natural philosophy, the animal mechanism, or the operation of medicine, we come to the knowledge of others unknown, are now frequently in physical writers called *data*.

DATE, an addition or appendage in writings, acts, instruments, letters, &c. expressing the day and month of the year when the act or letter was passed or signed; together with the place where the same was done. The word is formed from the Latin *datum*, "given," the participle of *do*, "I give."

Our ancient deeds had no dates, but only the month and year, to signify that they were not made in haste, or in the space of a day, but upon longer and more mature deliberation. The king's grants began with these words, *Præsentibus et futuris*, &c. but the grants of private persons with *Omnibus, præsentes literas inspecturis*, &c.

A deed is good, though it mentions no date or hath a false date; or even if it hath an impossible date, as the 30th of February: provided the real day of its being dated or given, that is, delivered, can be proved. *Blackst. Com.* vol. ii. p. 304.

DATE, the fruit of the great palm-tree. See PHOENIX, BOTANY *Index*.

DATI, CARLO, professor of polite learning at Florence. His native country became very famous, as well on account of his works, as of the eulogies which have been bestowed on him by learned men. The chief work to which Dati applied himself, was *Della Pittura Antica*, on which he published an essay in the year 1667. He died in 1675, much lamented, as well for his humanity and amiable manners as for his parts and learning.

DATISCA, a genus of plants belonging to the diœcia class; and in the natural method ranking under the 54th order, *Miscellaneæ*.

DATISI, in *Logic*, a mode of syllogisms in the third figure, wherein the major is an universal affirmative, and the minor and conclusion particular affirmative propositions. For example,

DA- All who serve God are kings;
TI- Some who serve God are poor;
SI. Therefore some who are poor are kings.

DATIVE, in *Grammar*, the third case in the declension of nouns: expressing the state or relation of a thing to whose profit or loss some other thing is referred. See GRAMMAR.

It is called *dative*, because usually governed by a verb, implying something to be given to some person. As, *commodare Socrati*, "to lend to Socrates;" *utilis reipublicæ*, "useful to the commonwealth;" *perniciosus ecclesiæ*, "pernicious to the church."

In English, where we have properly no cases, this relation is expressed by the sign *to* or *for*.

DATUM, or DATUS, in *Ancient Geography*, a town of Thrace, situated between Neapolis and the river Nestus: A colony of Thracians, according to Eustathius; who places it on the sea-coast, near the Strymon, in a rich and fruitful soil, famous for ship-building and mines of gold; hence the proverb Δατος Αγαθων, denoting property and plenty (Strabo.) Apian describes it as seated on a steep eminence, the whole of which it covered. It was taken by Philip of Macedon, who changed its name to Philippi, being originally called Crenides on account of its springs. It was afterwards famous for the defeat of Brutus and Cassius, by Augustus and Antony.

DATURA, the THORN-APPLE: a genus of plants belonging to the pentandria class; and in the natural methed ranking under the 28th order, *Luridæ*. See BOTANY *Index*.

DAUBENTON, LOUIS JEAN MARIE, a distinguished naturalist, was born at Montbar, in the department of the Côte d'Or, in France, on the 29th of May 1716. His father, Jean Daubenton, was a notary in that place, and his mother's name was Marie Pichenot. In his youth he distinguished himself by the sweetness of his temper, and by his diligent application

tion to his studies. The Jesuits of Dijon, under whose tuition he was first placed, noticed, him in a peculiar manner. Having gone through a course of what was called *philosophy*, under the Dominicans of Dijon, his father, who destined him for the church, and who had made him assume the ecclesiastical dress at the age of twelve, sent him to Paris to study theology. But his predilection for natural history induced him privately to study medicine. Accordingly he attended the lectures of Baron, Martinenq, and Col de Villars, and likewise those of Winslow, Hunault, and Antoine de Jussieu in the botanic garden. The death of his father in 1736 enabled him to follow his inclination without constraint. Accordingly he took a degree at Rheims in 1741, and returned to his own country with the intention of following the practice of medicine. But fortune destined him for a more brilliant career.

Montbar had given birth, about the same time, to another man of a very different character, who, though possessed of an independent fortune, a robust constitution, and actuated by a violent passion for pleasure, had determined notwithstanding to devote himself to the cultivation of the sciences. This man was Buffon. Hesitating for some time what branch of physics he should make his peculiar study, he tried by turns geometry, mechanical philosophy, and agriculture. At last his friend Dufay, who during his short superintendence had raised the botanic garden from that state of neglect in which former naturalists had left it, and who had procured for Buffon the reversion of his office, dying, and leaving him his place, Buffon's choice was fixed on natural history, and he saw before him that wide field which he afterwards traversed with so much reputation.

Natural history was at that time little else than a dry catalogue of names, destitute of that methodical arrangement, of that precision, of those interesting details which have since distinguished it. It occupied a very low station among the sciences, and instead of being a fashionable study, was degraded into the drudge of medicine and surgery. Buffon formed the bold plan of giving life to this dry and apparently steril mass, of painting nature as she is, always young, always active; of pointing out the harmony of all her parts, and the laws by which they are combined into one system, and of giving his picture all the glow, all the freshness, all the charms of nature herself. But to secure success it was necessary to make truth the basis of his system. Every thing must be collected, revised, and examined. The forms and dimensions of animals must be compared, and their internal structure ascertained. The ardent and impatient spirit of Buffon could ill brook a task so tedious and painful, and the imperfection of his sight rendered him unqualified for it. He looked about, therefore, for a man possessed of sufficient judgment, patience, and neatness of hand for his purpose, and at the same time modest enough to submit willingly to act a secondary part. He found such a man in Daubenton, the companion of his infancy.

The character of these two philosophers was almost opposite in every respect. Buffon was violent, impatient, rash; Daubenton was all gentleness, patience, and caution: Buffon wished to divine the truth rather than to discover it: Daubenton believed nothing which he had not himself seen and ascertained. Buffon suffered his imagination to lead him from nature; Daubenton, on the contrary, discarded from his writings every expression which was calculated to mislead. They were thus happily fitted to correct each others's faults. Accordingly the history of quadrupeds, which appeared while they laboured together, is the most exempt from error of any of the divisions which constitute Buffon's natural history.

Buffon drew Daubenton to Paris about 1742: procured for him the place of demonstrator of the cabinet of natural history, at first with a salary of only 500 francs, but which was gradually increased to 2000. He furnished him likewise with a lodging, and neglected nothing to secure his comfort and convenience. Daubenton on his side devoted himself to second the views of his benefactor. The cabinet of natural history, which was arranged, and in a great measure collected by his means, was of immense service. In the history of quadrupeds, he gave the description and dissection of 182 species of quadrupeds. These details contained a vast number of new facts, and arranged in such a manner that the most curious results are often obtained merely by comparing them together. This work procured for Daubenton a very high reputation, and drew upon him the envy of Reaumur, who at that time considered himself at the head of natural history. But the credit and reputation of Buffon was sufficient to prevent his friend from falling a victim to the attack of this formidable antagonist.

In the subsequent parts of his natural history, Buffon was persuaded to separate himself from Daubenton. This injured the precision and value of these parts excessively; while it deprived Daubenton of 12,000 francs a year. Afterwards the intimacy between them revived, and continued till the death of Buffon.

The number of dissertations on natural history which Daubenton published in the Memoirs of the French Academy, is so great, that even a list of them would be too long for this place. Descriptions of different animals, dissections, comparisons between the forms of different animals, anatomical examinations of fossil bones, to determine the animals to which they had belonged, the physiology of vegetables, and different parts of mineralogy, successively occupied him; not to mention his experiments on agriculture and rural economy, which, however, were of more service to him afterwards than all the rest of his labours, on account of the reputation among the populace which they had procured him.

In the year 1794, when the dregs of the people were masters of France, Daubenton was under the necessity of applying to the section of Sans-culottes for a certificate of civism, to enable him to retain his place in the garden of plants, which he had filled with honour for 52 years. A professor and academician would scarcely have obtained it; but it was readily granted to Shepherd Daubenton, under which title it had been fortunately presented. The following is a translation of this certificate;

SECTION OF THE SANS-CULOTTES.

Copy of the extract of the deliberations of the General Assembly of the sitting of the fifth of the first decade *of the 3d month of the 2d year of the French Republic one and indivisible.*

It appears, that after the report made to the fraternal society of the section of the *sans-culottes* concerning the good civism and acts of humanity which the Shepherd Daubenton has always testified, the General Assembly unanimously decree to give him a certificate of civism, and the president followed by several members of the said assembly give him the fraternal hug, with all the acclamations due to a true model of humanity, which has been testified by several renewals of the hug.

(Signed) R. G. DARDEL, President.

Besides his publications, Daubenton was of great service to science as a lecturer. From 1775 he gave lectures on natural history in the college of medicine. In 1783 he lectured on rural economy. He was appointed professor of mineralogy by the convention at the garden of plants, and he gave lectures during the ephemeral existence of the Normal school. He was likewise one of the editors of the Journal des Sçavans, and contributed to both the Encyclopedias. As a lecturer he was extremely popular, and what is uncommon, he retained his popularity to the last.

Notwithstanding the feebleness of his constitution, he arrived at a very advanced age without much disease or loss of his faculties. This may be, in some measure, ascribed to the gentleness of his temper, and his remarkable resignation. He was temperate and moderate even in his studies. Part of his time was spent in reading romances with his wife.

In the year 1799 he was appointed one of the members of the conservative senate, and he resolved to attend the meeting of it. This obliged him to alter his regimen. The season was severe. At the first meeting that he attended he fell from his seat in an apoplectic fit. The most speedy assistance was procured, and by its means he was restored to his senses. With the utmost calmness he pointed out with his fingers the progress of the paralysis in different parts of his body, and died, on the first of January 1800, without a struggle.

DAUCUS, the CARROT, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 45th order, *umbellatæ*. See BOTANY and AGRICULTURE *Index*.

DAVENANT, Sir WILLIAM, an eminent poet of the 17th century, was born at Oxford in 1606. After some stay at the university, he entered into the service of Frances first duchess of Richmond, and afterwards of Fulke Grevil, Lord Brooke; who having an excellent taste for poetry, was much charmed with him. He got great esteem by writing poems and plays; and upon the death of Ben Johnson was created poet-laureat. He wrote his poem Gondibert at Paris. He formed a design for carrying over a considerable number of artificers, especially weavers, to Virginia, by the encouragement of Henrietta Maria, the queen-mother of England, who obtained leave for him of the king of France. But he and his company were seized by some parliament ships, and he carried prisoner first to the isle of Wight, and then to the tower of London; but, by the mediation of Milton and others, he got his liberty as a prisoner at large. At this time tragedies and comedies being prohibited, he contrived to set up an opera, to be performed by declamations and music. This Italian opera began in Rutland-house in Charter-house-yard, 1656; but was afterwards removed to the Cockpit in Drury-Lane, and was much frequented for many years. In 1648, his Madagascar, with other poems, was printed. He died in 1668.

DAVENANT, *Dr Charles*, an eminent civilian and writer, eldest son of the preceding, and educated at Cambridge: he wrote several political tracts, and likewise plays. He was (1685) empowered, with the master of the revels, to inspect the plays designed for the stage, that no immoralities might be presented. His Essays on Trade are in high esteem, and were reprinted in 5 vols 8vo, in 1771. Dr Davenant was inspector-general of exports and imports; and died in 1712.

DAVENTRY, or DAINTRY, a handsome town of Northamptonshire in England, situated on the side of a hill, on the great road to Chester and Carlisle. W. Long. 1. 15. N. Lat. 52. 12.

DAUGHTER, (*filia*), a female child. See the article CHILDREN.

Daughters, among the ancients, were more frequently exposed than sons, as requiring greater charge to educate and settle them in the world. See EXPOSING *of Children*. Those who had no legitimate sons were obliged, by the Athenian laws, to leave their estates to their daughters, who were confined to marry their nearest relations, otherwise to forfeit their inheritance; as we find to have been practised likewise among the Jews, many of whose laws seem to have been transcribed by Solon.

If an heiress happened to be married before her father's death, this did not hinder the nearest relation to claim the inheritance, and even to take the woman from her husband; which is said to have been a common case.

DAVID, king of Israel, and Hebrew poet, was born at Bethlehem 1085, and died 1014 years B. C. His history is particularly recorded in the sacred writings.

ST DAVID'S, an episcopal town in Pembrokeshire, in S. Wales; but has neither market nor fair. It is seated in a barren soil on the river Ilen, not a mile from the sea-shore. It was once a considerable place, and had walls, which are now demolished; but it is small at present, and thinly inhabited: the cathedral is a pretty good structure. From the cape, near this place, there is a prospect of Ireland. Population 1816, in 1811. W. Long. 5. 20. N. Lat. 52. 0.

ST DAVID'S, a town and fort of Asia, in the peninsula on this side the Ganges, and on the coast of Coromandel, 80 miles south of Fort St George. E. Long. 79. 55. N. Lat. 11. 30. On the taking of Madras by the French in 1746, the presidency of all the English settlements on the Coromandel coast was removed to Fort St David, and continued there till about the year 1752, when it was removed back to Madras. In June 1758, the fort was taken and demolished by the French, and has never been rebuilt since.

DAVIDISTS, DAVIDICI, or DAVID-GEORGIANS, a sect of heretics, the adherents of David George, a native of Delft, who, in 1525, began to preach a new doctrine; publishing himself to be the true Messiah;

and that he was sent thither to fill heaven, which was quite empty for want of people to deserve it. He is likewise said to have denied the existence of angels, good and evil, of heaven and hell, and to have rejected the doctrine of a future judgment. He rejected marriage, with the Adamites; held, with Manes, that the soul was not defiled by sin; and laughed at the self-denial so much recommended by Jesus Christ. Such were his principal errors. He made his escape from Delft, and retired first to Friesland, and then to Basil, where he changed his name, assuming that of John Bruck, and died in 1556.

He left some disciples behind him, to whom he promised, that he would rise again at the end of three years. Nor was he altogether a false prophet herein; for the magistrates of that city, being informed, at the three years end, of what he had taught, ordered him to be dug up and burnt, together with his writings, by the common hangman.

There are still some remains of this ridiculous sect in Holstein, Friesland, and other countries, whose temper and conduct seem to discredit the exaggerated accounts which some writers have given of their founder. He was probably a deluded fanatic and mystic.

DAVILA, Henry Catharine, a celebrated historian, was the youngest son of Antonio Davila, grand constable of Cyprus, who on the taking of that island by the Turks in 1570, had been obliged to retire into Spain, whence this family supposed they had derived their name and origin. From Spain Antonio repaired to the court of France, and settled his son Louis and two daughters under the patronage of Catharine of Medicis; whose name he afterwards gave to the young historian, born 1576, at an ancient castle in the territories of Padua, though generally called a native of Cyprus. The little Davila was brought early into France; and at the age of 18 he signalized himself in the military scenes of that country. His last exploit there was at the siege of Amiens, where he fought under Henry IV. and received a wound in the knee, as he relates himself in his history. After peace was established in France, he withdrew into Italy, and entered into the service of the Venetians. Davila, while he was at Venice, wrote his admirable history of the civil wars in France, which contains every thing worth notice that passed from the death of Henry II. in 1539, to the peace of Vervins in 1598. He continued to serve the republic of Venice with great reputation, till a most unfortunate adventure put an end to his life in 1631. Passing through Verona with his wife and family on his way to Crema, which he was appointed to defend, and demanding, according to the usual custom of persons in his station, a supply of horses and carriages for his retinue, a brutal Veronese, called *Il Turco*, entered the room where he and his family were at supper, and being mildly reprimanded for his intrusion by Davila, discharged a pistol at the historian, and shot him dead on the instant. His accomplices also killed the chaplain of Davila, and wounded most of his attendants. But his eldest son Antonio, a youth of 18, revenged the death of his father, by killing the murderer on the spot. All the confederates were secured next morning, and publicly executed at Verona. It is very remarkable, that Davila passed no censure on the massacre of St Bartholomew. His character of the queen-mother has that partiality, which it was natural for him to show to the patroness of his family; but his general veracity is confirmed by the great authority of the first duke of Epernon, who (to use the words of Lord Bolingbroke) "had been an actor, and a principal actor too, in many of the scenes that Davila recites." Girard, secretary to the duke, and no contemptible biographer, relates that this history came down to the place where the old man resided in Gascony, a little before his death; that he read it to him; that the duke confirmed the truth of the narration of it; and seemed only surprised by what means the author could be so well informed of the most secret councils and measures of those times.

DAVIS, Sir John, an eminent lawyer and poet, born about the year 1570. He first distinguished himself by his poem *Nosce Teipsum*, on the Immortality of the Soul. He became attorney-general, and speaker of the house of commons in Ireland; and afterwards was appointed lord chief justice of the court of King's Bench in England, but died before his installation, in 1626. He published many law tracts; but was esteemed more as a scholar and a wit than as a lawyer.

Davis, *John*, a famous navigator in the 16th century, was born at Sandridge, near Dartmouth in Devonshire; and distinguished himself by making three voyages to the most northern parts of America, in order to discover a north-west passage to the East Indies; in which he discovered the straits which bear his name. He afterwards performed five voyages to the East Indies; in the last of which he was slain in a desperate fight with some Javanese, near the coast of Malacca, on the 27th of December 1605. He wrote an account of his second voyage for the discovery of the north-west passage; a voyage to the East Indies; and other tracts.

Davis's Straits. See *New Britain.*

DAVIT, in a ship, a long beam of timber, represented by *a*, *a*, Plate CLXIX. and used as a crane whereby to hoist the flukes of the anchor to the top of the bow, without injuring the sides of the ship as it ascends; an operation which, by mariners, is called *fishing the anchor.* The anchors being situated on both the bows, the davit may be occasionally shifted so as to project over either side of the ship, according to the position of that anchor on which it is employed. The inner end of the davit is secured by being thrust into a square ring of iron *b*, which is bolted to the deck, and forelocked under the beams. This ring, which is called the *span-shackle*, exhibited at large by fig. 9. is fixed exactly in the middle of the deck, and close behind the foremast. Upon the outer end of the davit is hung a large block *c*, through which a strong rope traverses, called the *fish-pendant*, *d;* to whose foremost end is fitted a large iron hook *e*, and to its after-end a tackle or complication of pulleys, *f;* the former of which is called the *fish-hook*, and the latter the *fish-tackle.*

The davit, therefore, according to the sea phrase, is employed to *fish the anchor;* which being previously *catted*, the fish-hook is fastened upon its flukes; and the efforts of the tackle being transmitted to the hook, by means of the fish-pendant, draws up that part of the anchor sufficiently high upon the bow to fasten it, which is done by the *shank-painter*. See that article. —There is also a davit of a smaller kind, occasionally fixed in the long-boat, and employed to weigh the anchor therein.

DAUPHIN, is a title which was given to the eldest son of the royal family of France, and presumptive heir of the crown; on account of the province of Dauphiné, which in 1343 was given to Philip de Valois, on this condition, by Humbert dauphin of the Viennois. The dauphin, in his letters patent, styled himself, *By the grace of God, eldest son of France, and dauphin of Viennois*.

DAUPHIN was anciently the title or appellation of the prince of Viennois in France.

Most authors who have sought the origin of the name *Dauphin* and *Dauphine*, seem to have given too much loose to conjecture. Du Chesne is of opinion, that it was the grandson of Guy the Fat who first bore the dame of *dauphin*. Chorier observes, that William, canon of Notre Dame at Grenoble, who has written the life of Margaret, daughter of Stephen earl of Burgundy, married with Guy, son of Guy the Fat, calls the latter simply Guy the Old, and the former always Count Dauphin; and adds, that no record or monument ever attributes the title of dauphin to Guy the Fat, or any of his predecessors: so that it must necessarily have taken its rise in his son, all whose successors so constantly assumed it, that it became the proper name of the family. He died in 1142, in the flower of his youth; so that it must be about the year 1120 that the title commenced; and without doubt, adds he, on some illustrious occasion. He observes farther, that this prince was of a military disposition, and delighted in nothing but war: and again, that it was the custom of the cavaliers to deck their casques, coats of arms, and the housing of their horses, with some figure or device peculiar to themselves, whereby they were distinguished from all others engaged in the same combat or tournament. From all these circumstances he conjectures that this Guy chose the dolphin for his signature; that this was the crest of his helmet; and that he bore it on his coat in some notable tournament or battle, wherein he distinguished himself. And this, Chorier makes no doubt, is the real origin of the appellation. Nothing was more common in those times than to make proper names become the names of families or dignities. Witness the Ademars, Arthands, Aynards, Atlemans, Berengers, and many others; who all owe their names to some one of their ancestors, from whom it has been transmitted throughout the family.

The seigneurs or lords of Auvergne have likewise born the appellation of *dauphin*; but the dauphins of Auvergne had it not till a good while after those of the Viennois, and even received it from them. The manner was this: Guy VIII. dauphin of Viennois, had by his wife Margaret, daughter of Stephen earl of Burgundy, a son and two daughters. The son was Guy IX, his successor. Beatrix, one of the daughters, was married to the count d'Auvergne, who, according to Blondel, was William V. or rather, as Chorier and others hold, Robert VI. father of William V. This prince lost the greatest part of the county of Auvergne, which was taken from him by his uncle William, assisted by Louis the Young: and was only left master of the little canton whereof Vodable is the capital. He had a son whom he called Dauphin, on account of Guy, or Guignes, his uncle by the mother's side. From his time his successors, holding the same petty canton of Auvergne, styled themselves *dauphins of Auvergne*, and bore a dolphin for their arms.

DAUPHINS, or *Delphins*, in literary history, a name given to the commentators on the ancient Latin authors, who were employed by Louis XIV. of France for the benefit of the prince, under the care and direction of M. de Montausier his governor, and Bossuet and Huet his preceptors. They were 39 in number.

DAUPHINY, a late province of France, bounded on the west by the Rhone, on the north by the Rhone and Savoy, on the south by Provence, and on the east by the Alps; and now forming the departments of Drome, Isere, and Upper Alps. In some places it is very fertile; and produces corn, wine, olives, woad, copperas, silk, iron, crystal, and copper. But the greatest part of the province is barren, and the inhabitants are obliged to go into other countries for subsistence. The mountains abound in game of all sorts: and here are fir-trees proper for masts. The principal rivers are, the Rhone, the Durance, the Isere, and the Drome. There is a great number of mineral springs; and Grenoble is the capital town.

DAURAT, JOHN, an eminent French poet, born in 1507. In the reign of Henry II. he was preceptor to the king's pages, and Charles IX. who took great delight in his conversation, honoured him with the title of his poet; but his generosity and want of management placed him in that class of learned men who have been very near starving. Conformable to the taste of the age, he had so much skill in making anagrams, that several illustrious persons gave him their names to anagrammatize: he also undertook to explain the Centuries of Nostradamus. Making verses was a disease in him: for no book was printed, nor did any person of consequence die, but Daurat made some verses on the occasion; as if he had been poet ordinary, or his muse had been a hired mourner to the whole kingdom. Scaliger tells us, that he spent the latter part of his life in endeavouring to find all the bible in Homer. He died in 1588.

DAY, according to the most natural and obvious sense of the word, signifies that space of time during which it continues to be light; in contradistinction to night, which is that portion of time wherein it is dark: but the space of time in which it is light, being somewhat vague and indeterminate, the time between the rising and the setting of the sun is usually looked on as the day; and the time which lapses from its setting to its rising again, the night.

The word *day* is often taken in a large sense, so as to include the night also; or to denote the time of a whole apparent revolution of the sun round the earth; in which sense it is called by some a natural day, and by others an artificial one: but, to avoid confusion, it is usual to call it in the former sense simply the *day*, and in the latter a *nychthemeron*: by which term that acceptation of it is aptly denoted, as it implies both day and night.

The nychthemeron is divided into twenty-four parts, called *hours;* which are of two sorts, equal, and unequal or temporary. See the article HOUR.

Different nations begin their day at a different hour. Thus the Egyptians begin their day at midnight; from whom Hippocrates introduced that way of reckoning into astronomy, and Copernicus and others have followed him: but the greatest part of astronomers reckon the day to begin at noon, and so count twenty-four hours, till the noon of the next day; and not twice twelve, according to the vulgar computation. The method of beginning the day at midnight prevails in Britain, France, Spain, and most parts of Europe.

The Babylonians began their day at sunrising: reckoning the hour immediately before its rising again, the twenty-fourth hour of the day; from whence the hours reckoned in this way are called the *Babylonic*. In several parts of Germany, they begin their day at sunsetting, and reckon on till it sets next day, calling that the *twenty-fourth hour:* these are generally termed *Italian hours*. The Jews also began their nychthemeron at sunsetting: but then they divided it into twice twelve hours as we do; reckoning twelve for the day, be it long or short, and twelve for the night; so that their hours continually varying with the day and night, the hours of the day were longer than those of the night for one half year, and the contrary the other; from whence their hours are called temporary: those at the time of the equinoxes became equal, because then those of the day and night are so. The Romans also reckoned their hours after this manner, as do the Turks at this day.

This kind of hours is called *planetary*, because the seven planets were anciently looked upon as presiding over the affairs of the world, and to take it by turns each of these hours, according to the following order; Saturn first, then Jupiter, Mars, the Sun, Venus, Mercury, and last of all the Moon: hence they denominated each day of the week from that planet whose turn it was to preside the first hour of the nychthemeron. Thus, assigning the first hour of Saturday to Saturn, the second will fall to Jupiter, the third to Mars, and so the twenty-second of the same nychthemeron will fall to Saturn again, and therefore the twenty-third to Jupiter, and the last to Mars: so that on the first hour of the next day, it will fall to the sun to preside; and by the like manner of reckoning, the first hour of the next will fall to the Moon; of the next to Mars; of the next to Mercury; of the next to Jupiter; and of the next to Venus: hence the days of the week came to be distinguished by the Latin names of *Dies Saturni, Solis, Lunæ, Martis, Mercurii, Jovis*, and *Veneris;* and among us, by the names of Saturday, Sunday, Monday, &c.

Day-Coal, in *Natural History*, a name given by the miners of England, and the common people who live in coal countries, to that seam or stratum of the coal which lies uppermost in the earth. The same vein or stratum of coal usually runs a great way through the country, and dips and rises in the earth at different places; so that this upper stratum, or day-coal, is in the various parts of the same stratum, sometimes near the surface, and sometimes many fathoms deep. The subterranean fires found in some of our coal countries feed principally on this coal; and are nearer to or farther from the surface as it rises or sinks.

Day-Fly. See EPHEMERIS, ENTOMOLOGY *Index*.

Day-Net, among fowlers. See NET.

Days of Grace, are those granted by the court at the prayer of the defendant or plaintiff, in whose delay it is.

Days of Grace, in commerce, are a customary number of days allowed for the payment of a bill of exchange, &c. after the same becomes due.

Three days of grace are allowed in Britain; ten in France and Dantzic; eight at Naples; six at Venice, Amsterdam, Rotterdam, and Antwerp; four at Francfort; five at Leipsic; twelve at Hamburgh; six in Portugal; 14 in Spain; 30 in Genoa, &c.

In Britain the days of grace are given and taken as a matter of course, the bill being only paid on the last day: but in other countries, where the time is much longer, it would be reckoned dishonourable for a merchant to take advantage of it; bills are therefore paid on the very day they fall due.

Day's-Man, in the north of England, an arbitrator or person chosen to determine an affair in dispute.

Intercalary Days. See *INTERCALARY Days*.

Day's-Work, among seamen, the reckoning or account of the ship's course during 24 hours, or between noon and noon, according to the rules of trigonometry. See *Dead-Reckoning*.

DAZE, in *Natural History*, a name given by our miners to a glittering sort of stone, which often occurs in their works; and, as it is an unprofitable substance, is one of those things they call *weeds*. The word *daze* takes in, with them, every stone that is hard and glittering: and therefore it comprehends the whole genus of the telangia or stony nodules, which have the flakes of talc in their substance: these according to the colour of the stony matter they are bedded in, and their own colour, give the names of *black daze, white, red*, and *yellow daze*, to these stones.

DEACON, (*Diaconus*), a person in the lowest degree of holy orders, whose business is to baptize, read in the church, and assist at the celebration of the eucharist. The word is formed from the Latin *Diaconus*, of the Greek διακονος, minister, servant. Deacons were instituted seven in number, by the apostles, *Acts* chap. vi. which number was retained a long time in several churches. Their office was to serve in the Agapæ, and to distribute the bread and wine to the communicants. Another part of the office of deacons was to be a sort of monitors and directors to the people in the exercise of their public devotions in the church; for which purpose they made use of certain known forms of words, to give notice when each part of the service began. Whence they are sometimes called *eirokerukes*, "the holy cryers of the church."

Deacons had, by license and authority from the bishop, a power to preach, to reconcile penitents and grant them absolution, and to represent their bishops in general councils. Their office out of the church was to take care of the necessitous, such as orphans, widows, prisoners, and all the poor and sick who had any title to be maintained out of the revenues of the church; to inquire into the morals and conversation of the people, and to make their report thereof to the bishop. Whence, on account of the variety of business, it was usual to have several deacons in the same church.

In the Romish church it is the deacon's office to incense the officiating priest or prelate; to lay the corporal on the altar; to receive the patten or cup from the subdeacon, and present them to the person officiating; to incense the choir; to receive the pix from the officiating prelate, and carry it to the subdeacon; and at the pontifical mass, when the bishop gives the blessing, to put the mitre on his head, and to take off the archbishop's pall and lay it on the altar. In England, the form of ordaining deacons, declares that it is their office to assist the priest in the distribution of the holy communion: in which, agreeably to the practice of the ancient church, they are confined to the administering the wine to the communicants. A deacon in England is not capable of any ecclesiastical promotion; yet he may be a chaplain to a family, curate to a beneficed clergyman, or lecturer to a parish-church. He may be ordained at 23 years of age, *anno currente;* but it is expressly provided, that the bishop shall not ordain the same person a priest and deacon in the same day. Deacons, according to St Paul, should be chaste, sincere, and blameless; neither great drinkers, nor given to filthy lucre: they should hold the mystery of the faith in a pure conscience; and should be well approved before they are admitted to the ministry. In the church of Scotland, the deacon's office is only to take care of the poor.

DEACONESS, *a female deacon;* an order of women who had their distinct offices and services in the primitive church. This office appears as ancient as the apostolical age: for St Paul calls Phebe a servant of the church of Cenchrea. The original word is διακονος, answerable to the Latin word *ministra.* Tertullian calls them *viduæ,* "widows," because they were commonly chosen out of the widows of the church; and, for the same reason, Epiphanius, and the council of Laodicea, call them πρεσβυτιδας, elderly women, because none but such were ordinarily taken into this office. For, indeed, by some ancient laws, these four qualifications are required in every one that was to be admitted into this order. 1. That she should be a widow. 2. That she should be a widow that had born children. 3. A widow that was but once married. 4. One of a considerable age, 40, 50, or 60 years old. Though all these rules admitted of exceptions. Concerning their ordination, whether it was always performed by imposition of hands, the learned are much divided in their sentiments. Baronius and Valesius think they were not, and made no other account of them than as mere lay persons. But the author of the constitutions, speaking of their ordination, requires the bishop to use imposition of hands, with the form of prayer which is there recited. We are not, however, to imagine, that this ordination gave them any power to execute any part of the sacerdotal office. They were only to perform some inferior services of the church, and those chiefly relating to the women for whose sakes they were ordained. One part of their office was to assist the minister at the baptizing of women, to undress them for immersion, and to dress them again, that the whole ceremony might be performed with all the decency becoming so sacred an action. Another part of their office was to be private catechists to the women-catechumens who were preparing for baptism. They were likewise to attend the women that were sick and in distress; to minister to martyrs and confessors in prison; to attend the women's gate in the church: and lastly, to assign all women their places in the church, regulate their behaviour, and preside over the rest of the widows; whence in some canons they are styled προκαθεμεναι, "governesses." This order, which since the 10th or 12th century has been wholly laid aside, was not abolished everywhere at once, but continued in the Greek church longer than in the Latin, and in some of the Latin churches longer than in others.

DEACONRY, Diaconate, the order or ministry of a deacon or deaconess. See Deacon and Deaconess.

Deaconry, (*Diaconia,*) is also a name still reserved to the chapels and oratories in Rome, under the direction of the several deacons, in their respective regions or quarters.

To the deaconries were annexed a sort of hospitals or boards for the distribution of alms, governed by the regionary deacons, called *cardinal deacons,* of whom there were seven, answering to the seven regions, their chief being called the *archdeacon.*

The hospital adjoining to the church of the deaconry had an administrator for the temporal concerns, called the *father of the deaconry,* who was sometimes a priest and sometimes a layman.

At present there are fourteen of these deaconries or hospitals at Rome, which are reserved to the cardinals. Du Cange gives us their names: as, the deaconry of St Maria in the Broad-way, the deaconry of St Eustachio near the Pantheon, &c.

DEAD languages. See Philology, chap. ii.

Preservation of Dead Bodies. See Embalming.

Feast of the Dead. See *Feast of the Dead.*

Dead-Lights, certain wooden ports which are made to fasten into the cabin windows, to prevent the waves from gushing into the ship in a high sea. As they are made exactly to fit the windows, and are strong enough to resist the waves, they are always fixed in on the approach of a storm, and the glass lights taken out, which must otherwise be shattered to pieces by the surges, and suffer great quantities of water to enter the vessel.

Dead-Mens-Eyes, in the sea-language, a kind of blocks, with many holes in them, but no sheevers, whereby the shrouds are fastened to the chains: the crow-feet reeve also through these holes; and, in some ships, the main-stays are set tight in them: but then they have only one hole, through which the lanyards are passed several times. See Plate CLXIX.

Dead's Part. See Law *Index.*

Dead Reckoning, in *Navigation,* the judgment or estimation which is made of the place where a ship is situated, without any observation of the heavenly bodies. It is discovered by keeping an account of the distance she has run by the log, and of her course steered by the compass; and by rectifying these data by the usual allowance for drift, lee-way, &c. according to the ship's known trim. This reckoning, however, is always to be corrected, as often as any good observation of the sun can be obtained.

Dead-Sea, in *Geography,* a lake of Judea, into which the river Jordan discharges itself; being about 70 miles long and 20 broad. See Asphaltites.

Dead-Tops, a disease incident to young trees, and cured by cutting off the dead parts close to the next good twig or shoot, and claying them over as in grafting.

Dead-Water, at sea, the eddy-water just astern of a ship; so called because it does not pass away so swift as the water running by her sides does. They say that a ship makes much dead-water when she has a great eddy following her stern.

DEADLY-carrot. See Thapsia.

Deadly-Feud, in English law-books, a profession of irreconcileable enmity, till a person is revenged by the death of his enemy. The word *feud* is derived from the German *Feud;* which, as Hottoman observes, signifies *modo bellum, modo capitales inimicitias*[*]. Such enmity and revenge were allowed by law in the time of the Saxons, viz. If any man was killed, and a pecuniary satisfaction was not made to the kindred, it was lawful for them to take up arms and revenge themselves on the murderer; which was called *deadly feud.* And this probably was the original of an Appeal.

DEAFNESS, the state of a person who wants the sense of hearing; or the disease of the ear, which prevents its due reception of sounds. See Medicine *Index*.

Deafness generally arises either from an obstruction or a compression of the auditory nerve; or from some collection of matter in the cavities of the inner ear; or from the auditory passage being stopped up by some hardened excrement; or, lastly, from some excrescence, a swelling of the glands, or some foreign body introduced within it.

Those born deaf are also dumb, as not being able to learn any language, at least in the common way. However, as the eyes, in some measure serve them for ears, they may understand what is said by the motion of the lips, tongue, &c. of the speaker; and even accustom themselves to move their own, as they see other people do, and by this means learn to speak.—Thus it was that Dr Wallis taught two young gentlemen born deaf to know what was said to them, and to return pertinent answers. Digby gives us another instance of the same within his own knowledge; and there was a Swiss physician in Amsterdam, one John Conrad Amman, who reduced the thing to a fixed art or method, which he published in his *Surdus Loquens*, Amstelod. 1692, and *de Loquela*, ibid. 1700. See an account of methods employed in the education of this class of persons, in the article Deaf and Dumb, in the Supplement.

In the Phil. Trans. N° 312. we have an account by Mr Waller, R. S. Secr. of a man and his sister, each about 50 years old, born in the same town with Mr Waller, who had neither of them the least sense of hearing; yet both of them knew, by the motion of the lips only, whatever was said to them, and would answer pertinently to the question proposed. It seems they could both hear and speak when children, but lost their hearing afterwards: whence they retained their speech, which, though uncouth, was yet intelligible.

Such another instance is that of Mr Goddy's daughter, minister of St Gervais in Geneva, related by Bishop Burnet. "At two years old they perceived she had lost her hearing; and ever since, though she hears great noises, yet hears nothing of what is said to her. But by observing the motions of the mouth and lips of others, she acquired so many words, that out of these she has formed a sort of jargon, in which she can hold conversation whole days with those that can speak her language. She knows nothing that is said to her, unless she see the motion of their mouths that speak to her, so that in the night they are obliged to light candles to speak to her. One thing will appear the strangest part of the whole narration: she has a sister, with whom she has practised her language more than with any body else; and in the night, by laying her hand on her sister's mouth, she can perceive by that what she says, and so can discourse with her in the dark." *Burnet. Let.* IV. p. 248[†].

It is observable, that deaf persons, and several others thick of hearing, hear better and more easily if a loud noise be raised at the time when you speak to them; which is owing, no doubt, to the greater tension of the ear-drum on that occasion. Dr Wallis mentions a deaf woman, who if a drum were beat in the room could hear any thing very clearly; so that her husband hired a drummer for a servant, that by this means he might hold conversation with his wife. The same author mentions another, who, living near a steeple, could always hear very well if there was a ringing of three or four bells, but never else.

DEALS, a thin kind of fir-planks, of great use in carpentry. They are formed by sawing the trunk of a tree into a great many longitudinal divisions, of more or less thickness according to the purposes they are intended to serve.

A very good method of seasoning planks of deal and fir is to throw them into salt water as soon as they are sawed, and keep them there three or four days, frequently turning them: in this case they will be rendered much harder, by drying afterwards in the air and sun: but neither this, nor any other method yet known, will prevent them from shrinking.

Rods of deal expand gradually, or cross the grain, in moist weather, and contract again in dry; and thence have been found to make an useful hygrometer.

DEAL, a town of Kent in England, lying between Dover and Sandwich, in E. Long. 1. 20. N. Lat. 51. 16. is supposed to be the *Dola* of Nennius, and is situated on a flat and level coast. This town, according to Dr Campbell, justifies an observation he had made in favour of situations of this kind, viz. that they are less liable than others to be injured by the sea. The town of Deal, as far as we are able to judge, except it may be the sea's sinking a little from it, is in much the same condition in which it ever was, even from the earliest accounts. The learned Dr Halley has proved, *Miscellanea Curiosa*, vol. iii. p. 426. that Julius Cæsar landed here, August 26th, the year before the coming of Christ 55.—The great convenience of landing has been of infinite service to the place: so that it is large and populous, divided into the upper and lower towns, and is in effect the principal place in the Downs. Population 3420 in 1811.

DEAN, an ecclesiastical dignitary in cathedral and collegiate churches, and head of the chapter.

Rural-Dean, called also *Arch-Presbyter*, originally exercised jurisdiction over ten churches in the country, and afterwards became only the bishop's substitute, to

[*] See Feuds.

[†] See farther the article *Dumbness*.

grant letters of administration, probate of wills, &c.; to convocate the clergy; and to signify to them sometimes by letter the bishop's will, and to give induction to the archdeacon. Their office is not lost in that of the archdeacons and chancellors.

Dean of a Monastery, was a superior established under the abbot, to ease him in taking care of ten monks; whence he was called *decanus*.

Dean and Chapter, are the council of the bishop, to assist him with their advice in affairs of religion, and also in the temporal concerns of his see. When the rest of the clergy were settled in the several parishes of each diocese, these were reserved for the celebration of divine service in the bishop's own cathedral; and the chief of them, who presided over the rest, obtained the name of *decanus* or *dean*, being probably at first appointed to superintend ten canons or prebendaries.

All ancient deans are elected by the chapter by *conge d'elire* from the king, and letters missive of recommendation, in the same manner as bishops: but in those chapters that were founded by Henry VIII. out of the spoils of the dissolved monasteries, the deanery is donative, and the installation merely by the king's letters patent. The chapter, consisting of canons or prebendaries, are sometimes appointed by the king, sometimes by the bishop, and sometimes elected by each other.

The dean and chapter are the nominal electors of a bishop. The bishop is their ordinary and immediate superior; and has, generally speaking, the power of visiting them, and correcting their excesses and enormities. They had also a check on the bishop at common law; for till the statute 32 Hen. VIII. c. 28. his grant or lease would not have bound his succesors, unless confirmed by the dean and chapter.

Dean of Guild. See Law *Index*.

DEANERY, the office of a DEAN.—Deaneries and prebends may become void like a bishopric, by death, by deprivation, or by resignation either to the king or bishop. If a dean, prebendary, or other spiritual person, be made a bishop, all the preferments of which he was before possessed are void: and the king may present to them in right of his prerogative royal. But they are not void by the election, but only by the consecration.

DEATH, is generally considered as the separation of the soul from the body; in which sense it stands opposed to life, which consists in the union thereof.

Physicians usually define death by a total stoppage of the circulation of the blood, and a cessation of the animal and vital functions consequent thereon; as respiration, sensation, &c.

An animal body, by the actions inseparable from life, undergoes a continual change. Its smallest fibres become rigid; its minute vessels grow into solid fibres no longer pervious to the fluids; its greater vessels grow hard and narrow; and every thing becomes contracted, closed, and bound up; whence the dryness, immobility, and extenuation, observed in old age. By such means the offices of the minuter vessels are destroyed; the humours stagnate, harden, and at length coalesce with the solids. Thus are the subtilest fluids in the body intercepted and lost, the concoction weakened, and the reparation prevented; only the coarser juices continue to run slowly through the greater vessels, to the preservation of life, after the animal functions are destroyed. At length, in the process of these changes, death itself becomes inevitable, as the necessary consequence of life. But it is rare that life is thus long protracted, or that death succeeds merely from the decays and impairments of old age. Diseases, a long and horrid train, cut the work short.

The signs of death are in many cases very uncertain. If we consult what Winslow or Bruchier have said on this subject, we shall be convinced, that between life and death the shade is so very undistinguishable, that even all the powers of art can scarcely determine where the one ends and the other begins. The colour of the visage, the warmth of the body, and suppleness of the joints, are but uncertain signs of life still subsisting; while, on the contrary, the paleness of the complexion, the coldness of the body, the stiffness of the extremities, the cessation of all motion, and the total insensibility of the parts, are but uncertain marks of death begun. In the same manner also, with regard to the pulse and breathing; these motions are so often kept under, that it is impossible to perceive them. By bringing a looking-glass near to the mouth of the person supposed to be dead, people often expect to find whether he breathes or not. But this is a very uncertain experiment; the glass is frequently sullied by the vapour of the dead man's body; and often the person is still alive, though the glass is no way tarnished. In the same manner, neither burning nor scarifying, neither noises in the ears nor pungent spirits applied to the nostrils, give certain signs of the discontinuance of life; and there are many instances of persons who have endured them all, and afterwards recovered without any external assistance, to the astonishment of the spectators. This ought to be a caution against hasty burials, especially in cases of sudden death, drowning, &c.

Death, in *Law*. In law, there is a natural death and civil death: natural, where nature itself expires; civil, where a person is not actually dead, but adjudged so by law. Thus, if any person, for whose life an estate is granted, remains beyond sea, or is otherwise absent, seven years, and no proof made of his being alive, he shall be accounted naturally dead.

Brothers of Death, a denomination usually given to the religious of the order of St Paul, the first hermit. They are called *brothers of death*, *fratres à morte*, on account of the figure of a death's head which they were always to have with them, in order to keep perpetually before them the thoughts of death. This order, by its constitutions made in 1620, does not seem to have been established long before Pope Paul V. Louis XIII. in 1621, permitted them to settle in France. The order was probably suppressed by Pope Urban VIII.

Law of Death-Bed. See Law *Index*.

Death-Watch, in *Natural History*, a little insect famous for a ticking noise, like the beat of a watch, which the vulgar have long taken for a presage of death in the family where it is heard: whence it is also called *pediculus fatidicus*, *mortisaga*, *pulsatorius*, &c.

There are two kinds of death-watches. Of the first we have a good account in the Phil. Trans. by Mr Allen. It is a small beetle, 5-16ths of an inch long, of a dark brown colour, spotted; having pellucid wings

Death-watch.

under the vagina, a large cap or helmet on the head, and two antennæ proceeding from beneath the eyes, and doing the office of proboscides. The part it beats withal, he observed, was the extreme edge of the face, which he chooses to call the upper-lip, the mouth being protracted by this bony part, and lying underneath out of view.

This account is confirmed by Dr Derham; with this difference, that instead of ticking with the upper lip, he observed the insect to draw back its mouth, and beat with its forehead. That author had two death-watches, a male and a female, which he kept alive in a box several months; and could bring one of them to beat whenever he pleased, by imitating its beating. By this ticking noise he could frequently invite the male to get up upon the other in the way of coition. When the male found he got up in vain, he would get off again, beat very eagerly, and then up again: Whence the ingenious author concludes those pulsations to be the way whereby these insects woo one another, and find out and invite each other to copulation.

The second kind of death-watch is an insect in appearance quite different from the first. The former only beats seven or eight strokes at a time, and quicker: the latter will beat some hours together without intermission; and his strokes are more leisurely, and like the beat of a watch. This latter is a small grayish insect, much like a louse when viewed with the naked eye.

It is very common in all parts of the house in the summer months: it is very nimble in running to shelter, and shy of beating when disturbed; but will beat very freely before you, and also answer the beating, if you can view it without giving it disturbance, or shaking the place where it lies, &c. The author cannot say whether they beat in any other thing, but he never heard their noise except in or near paper. As to their noise, the same person is in doubt whether it be made by their heads, or rather snouts, against the paper; or whether it be not made after some such manner as grashoppers and crickets make their noise. He inclines to the former opinion. The reason of his doubt is, that he observed the animal's body to shake and give a jerk at every beat, but could scarce perceive any part of its body to touch the paper. But its body is so small and near the paper, and its motion in ticking so quick, that he thinks it might be, yet he not perceive it. The ticking, as in the other, he judges to be a wooing act; as having observed another, after much beating, come and make offers to the beating insect, who, after some offers, left off beating, and got upon the back of the other. When they were joined, he left off again; and they continued some hours joined tail to tail, like dog and bitch in coition. Whether this insect changes its shape, and becomes another animal or not, he cannot say; though he has some cause to suspect that it becomes a sort of fly. It is at first a minute white egg, much smaller than the nits of lice; though the insect is near as big as a louse. In March it is hatched, and creeps about with its shell on. When it first leaves its shell, it is even smaller than its egg; though that be scarcely discernible without a microscope. In this state it is perfectly like the mites in cheese. From the mite state they grow gradually to their mature perfect state. When they become like the old ones, they are at first very small, but run about much more swiftly than before.

Death-watch
||
Debruized.

DEBENTURE, a term of trade used at the customhouse for a kind of certificate signed by the officers of the customs, which entitles a merchant exporting goods to the receipt of a bounty or draw-back. All merchandises that are designed to be taken on board for that voyage being entered and shipped, and the ship being regularly cleared out, and sailed out of port on her intended voyage, debentures may be made out from the exporter's entries, in order to obtain the draw-backs, allowances, bounties, or premiums; which debentures for foreign goods are to be paid within one month after demand. And in making out these debentures, it must be observed, that every piece of vellum, parchment, or paper, containing any debenture for drawing back customs or duties, must, before writing, be stamped, and pay a duty of 8d.

The forms of debentures vary according to the merchandise exported. In the execution of debentures for tobacco, it must be particularly observed, 1. That debentures for the same quantity may be made on one or more parchments. 2. That the exporter's oath must be printed, specifying whether he acts for himself or on commission. 3. If exported to any other foreign ports than Ireland, the word *Ireland* must be added to the oath after *Great Britain.* 4. That as no tobacco may be consumed on board of ships of war in Europe but what has paid full duties, and been manufactured in Great Britain, no drawback is to be allowed for tobacco exported in any man of war. 5. That the eight pounds per hogshead of 350 pounds, or more, allowed for draught at importation, must not be deducted on exportation. 6. That debentures for tobacco exported to Ireland must not be paid till a certificate be produced, testifying the landing thereof. 7. That no persons may swear to the exportation but such as are permitted to swear to debentures for other goods. In debentures for all other foreign goods, no person may be admitted to swear to the exportation but the true exporter, either as a proprietor, or who, being employer by commission, is concerned in the direction of the voyage. All kinds of debentures, before delivered or paid to the exporters, are entered into a separate book kept for that purpose by the collector and comptroller of the customs.

DEBITA FUNDI. See LAW *Index*.

DEBITA Fructuum. See LAW *Index*.

DEBILITY, among physicians, a relaxation of the solids, occasioning oftentimes weaknesses and faintings.

DEBIR, in *Ancient Geography*, a sacerdotal city of Palestine, near Hebron; but neither distance, nor point of the compass on which it lies, can be determined. It was anciently called *Kariath-sepher* or *Kirjath-sepher*, and *Kirjath-sanna* (Joshua).—Another *Debir* in the tribe of Gad, beyond Jordan.

DEBRECHEN, a town of Upper Hungary, about 77 miles east of Buda. E. Long. 21. 10. N. Lat. 47. 45.

DEBRUIZED, in *Heraldry*, a term peculiar to the English, by which is intimated the grievous restraint of any animal, debarred of its natural freedom, by any of the ordinaries being laid over it.

DEBT, in *Law*, any thing due to another, whether it be money, goods, or services; or the action brought for recovering the same.

National DEBT. See FUNDS and *NATIONAL Debt*.

DEBTOR, a person who owes any thing to another; in contradistinction to creditor, which is he to whom the debt is owing.

DEBTOR, in merchants accounts. See BOOK-KEEPING.

DECADE, a word used by some old writers for the number ten, and *decades* for an enumeration by tens. The word is formed from the Latin *decas*, which is derived from a Greek word of the same import. The word has been more peculiarly appropriated to the number of books, q. d. *decades*, into which the Roman History of Titus Livius is divided. Hence also came *decadal* arithmetic, the Decameron of Boccacio, &c.

DECAGON, in *Geometry*, a plain figure with ten sides and ten angles.

DECAGYNIA (from δεκα, *ten*, and γυνη, a *woman*), the name of an order, or secondary division, in the class decandria, of the sexual method, consisting of plants whose flowers are furnished with ten stamina and the same number of styles; which last are considered by Linnæus and the sexualists as the female organs of generation in plants. Neurada and American nightshade furnish examples.

DECALOGUE, the ten precepts or commandments delivered by God to Moses, after engraving them on two tables of stone.

The Jews, by way of excellence, call these commandments the *ten words*, from whence they had afterwards the name of *decalogue*: but it is to be observed, that they joined the first and second into one, and divided the last into two. They understand that against stealing to relate to the stealing of men, or kidnapping; alleging, that the stealing one another's goods or property is forbidden in the last commandment.

The emperor Julian objected to the decalogue, that the precepts it contained (those only excepted which concern the worship of false gods, and the observation of the sabbath) were already so familiar to all nations, and so universally received, that they were unworthy, for that very reason, to be delivered by so great a legislator, to so peculiar a people. The church of Rome has struck the second commandment quite out of the decalogue; and to make their number complete, hath split the tenth into two: the reason of which may be easily conceived.

DECAN, a kingdom of Asia, in the peninsula on this side the Ganges, bounded on the south by the kingdom of Bisnagar, on the west by the ocean, on the north by Mogulistan, and on the east by the mountains which separate it from Golconda.

DECANDRIA, (δεκα, *ten*, and ανηρ, a *husband*), Linnæus's tenth class, comprehending those hermaphrodite plants which bear flowers with ten stamina. See BOTANY *Index*.

DECANTATION, among chemists, &c. the gently pouring off a liquor from its fæces, by inclining the lip or canthus of the vessel; whence the name.

DECANUS, in Roman antiquity, an officer who presided over the other ten officers, and was head of the contubernium, or serjeant of a file of soldiers.

DECAPOLIS, in *Ancient Geography*, a district beyond Jordan, almost all of it belonging to the half tribe of Manasseh; before the captivity, called *Bethsan*; but after occupied by the heathen, who could not be driven out. It comprised, as the name denotes, ten principal cities on the other side the Jordan, if we except Scythopolis, which stood on this side, but its territory on the other.

DECAPROTI, DECEMPRIMI, in Roman antiquity, officers for gathering the tributes and taxes.

The decaproti were also obliged to pay for the dead, or to answer to the emperor for the quota parts of such as died, out of their own estates.

DECASPERMUM, a genus of plants belonging to the icosandria class. See BOTANY *Index*.

DECASTYLE, in the ancient architecture, a building with an ordnance of ten columns in front, as the temple of Jupiter Olympius was.

DECEIT, in *Law*, a subtile trick or device, to which may be added all manner of craft and collusion, or underhand practice, used to defraud another, by any means whatever.

DECEMBER, the last month of the year, wherein the sun enters the tropic of Capricorn, and makes the winter solstice.

In Romulus's year, December was the 10th month, whence the name, viz. from *decem*, "ten:" for the Romans began their year in March.

The month of December was under the protection of Vesta. Romulus assigned it 30 days, Numa reduced it to 29, which Julius Cæsar increased to 31.

Under the reign of Commodus, this month was called, by way of flattery, *Amazonius*, in honour of a courtesan whom that prince passionately loved, and had got painted like an Amazon: but it only kept the name during that emperor's life.

At the latter end of this month they had the *juveniles ludi*; and the country people kept the feast of the goddess Vacuna in the fields, having then gathered in their fruits and sown their corn; whence seems to be derived our popular festival called *harvest-home*.

DECEMPAGI, in *Ancient Geography*, a town of Belgica: Now *Dieuse*, in Lorrain, on the rivulet Seille or Selna, near the lake Lindre, about seven German miles to the north-east of Nancy.

DECEMPEDA, Δεκαπους, *ten-feet rod*, an instrument used by the ancients in measuring.

The decempeda was a rule or rod divided into ten feet; whence its name, from *decem*, "ten," and *pes*, *pedis*, "foot." The foot was subdivided into twelve inches, and each inch into ten digits. The decempeda was used both in measuring of land, like the chain among us; and by architects to give the proper dimensions and proportions to the parts of their buildings, which use it still retains. Horace, lib. ii. od. 15. blaming the magnificence and delicacy of the buildings of his time, observes, that it was otherwise in the times of Romulus and Cato; that in the houses of private persons there were not then known any porticoes measured out with the decempeda, nor turned to the north to take the cool air.

DECEMVIRI, ten magistrates of absolute authority among the Romans. The privileges of the patricians raised dissatisfaction among the plebeians; who, though freed from the power of the Tarquins, still saw that the administration of justice depended upon the will and caprice of their superiors, without any written statute to direct them, and convince them that they were governed with equity and impartiality. The tribunes complained to the senate, and demanded that a code of laws might be framed for the use and benefit of the Roman people. The petition was complied with; and three ambassadors were sent to Athens and all the other Grecian states, to collect the laws of Solon and of all the other celebrated legislators of Greece. Upon the return of the commissioners it was universally agreed, that ten new magistrates called *Decemviri* should be elected from the senate to put the project into execution. Their power was absolute, all other offices ceased after their election, and they presided over the city with regal authority. They were invested with the badges of the consul, in the enjoyment of which they succeeded by turns, and only one was preceded by the fasces, and had the power of assembling the senate and confirming decrees. The first decemvirs were Appius Claudius, T. Genutius, P. Sextus, Sp. Veturius, C. Julius, A. Manlius, Ser. Sulpitius, Pluriatius, T. Romulus, Sp. Posthumius, in the year of Rome 302. Under them the laws, which had been exposed to public view, that every citizen might speak his sentiments, were publicly approved of as constitutional, and ratified by the priests and augurs in the most solemn and religious manner. They were ten in number, and were engraved on tables of brass; two were afterwards added, and they were called the laws of the twelve tables, *leges duodecim tabularum*, and *leges decemvirales.* The decemviral power, which was beheld by all ranks of people with the greatest satisfaction, was continued: but in the third year after their creation the decemvirs became odious on account of their tyranny; and the attempt of Ap. Claudius to ravish Virginia totally abolished that office. The people were so exasperated against them, that they demanded them from the senate to burn them alive. Consuls were again appointed, and tranquillity re established in the state. There were other officers in Rome called decemvirs, who were originally appointed in the absence of the prætor to administer justice. Their appointment became afterwards necessary, and they generally assisted at sales, called *subhastationes*, because a spear, *hasta*, was fixed at the door of the place where the goods were exposed to sale. They were called *decemviri litibus judicandis.* The officers whom Tarquin appointed to guard the Sibylline books were also called *decemviri.* They were originally two in number, called *duumviri*, till the year of Rome 388, when their number was increased to ten, five of which were chosen from the plebeians and five from the patricians. Sylla increased their number to fifteen, called *quindecemvirs.*

DECENNALIA, ancient Roman festivals, celebrated by the emperors every tenth year of their reign, with sacrifices, games, and largesses for the people. The emperor Augustus first instituted these solemnities, in which he was imitated by his successors. At the same time the people offered up vows for the emperor, and for the perpetuity of the empire; which were therefore called *vota decennalia.* Augustus's view in establishing the decennalia was to preserve the empire and the sovereign power without offence or restraint to the people. For during the celebration of this feast, that prince used to surrender up all his authority into the hands of the people; who filled with joy, and charmed with the goodness of Augustus, immediately delivered it him back again.

DECHALES, CLAUDIUS FRANCES MILLIET, an excellent mathematician, mechanic, and astronomer, descended from a noble family, and born at Chamberry in 1611. His principal performances are an edition of Euclid's Elements of Geometry, in which the unserviceable propositions are rejected, and the uses of those retained annexed; a discourse on fortification; and another on navigation. These with others have been collected, first in 3 vols folio, and afterwards in 4, under the title of *Mundus Mathematicus:* being indeed a complete course of mathematics. He died in 1678, professor of mathematics in the university of Turin.

DECIATES, or *Deciatii*, in *Ancient Geography*, a people of Gallia Narbonensis, next the borders of Italy, on the Mediterranean. Now the diocese of Grace and Antibes. *Deciatum oppidum*, was a town situated between Antibes and Nice.

DECIDUOUS, an appellation chiefly used in respect of plants: thus, the calyx or cup of a flower is said to be *deciduous*, when it falls along with the flower-petals; and, on the contrary, it is called *permanent*, when it remains after they are fallen. Again, deciduous leaves are those which fall in autumn; in contradistinction to those of the evergreens, which remain all the winter. See DEFOLIATION.

DECIL, in *Astronomy*, an aspect or position of two planets, when they are distant from each other a tenth part of the zodiac.

DECIMAL ARITHMETIC, the art of computing by decimal fractions. See ARITHMETIC.

CIRCULATING **DECIMALS**, called also *recurring* or *repeating decimals*, are those in which a figure or several figures are continually repeated. They are distinguished into *single* and *multiple*, and these again into *pure* and *mixed.*

A *pure single* circulate is that in which one figure only is repeated; as ·222, &c. and is marked thus $\cdot\dot{2}$.

A *pure multiple* circulate is that in which several figures are continually repeated; as ·232323, &c. marked $\cdot\ddot{2}3$; and ·524524, &c. marked $\cdot\dot{5}2\dot{4}$.

A *mixed single* circulate is that which consists of a terminate part, and a single repeating figure; as 4·222, &c. or $4.\dot{2}$. And

A *mixed multiple* circulate is that which contains a terminate part with several repeating figures; as $45\cdot\dot{5}2\dot{4}$.

That part of the circulate which repeats is called the *repetend;* and the whole repetend, supposed infinitely continued, is equal to a vulgar fraction, whose numerator is the repeating number or figures, and its denominator the same number of nines: so $\cdot\dot{2}$ is$=\frac{2}{9}$; and $\cdot\ddot{2}3$ is$=\frac{23}{99}$; and $\cdot\dot{5}2\dot{4}$ is$=\frac{524}{999}$.

Dr Wallis, it appears, was the first who distinctly considered or treated of infinite circulating decimals, as he himself informs us in his Treatise of Infinites. Since his time many other authors have treated on this part of arithmetic; the principal of those, however, to whom the art is mostly indebted, are Messrs Brown, Cunn, Martin, Emerson, Malcom, Donn, and Henry Clarke; in whose writings the nature and practice of this art may be fully seen, especially in the last-mentioned ingenious author. *Hutton's Math. Dict.*

DECIMATION, a punishment inflicted by the Romans, on such soldiers as quitted their posts, or behaved themselves cowardly in the field. The names of the guilty were put into an urn or helmet, and as many were drawn out as made the tenth part of the whole number, and those were put to the sword, and the others saved. This was called *decimare;* a word of the ancient Roman militia, who, to punish whole legions when they had failed in their duty, made every tenth soldier draw lots, and put him to death for an example to the others.

As the Romans had their *decimatio*, they had also the *vicesimatio*, and even *centesimatio*, when only the 20th or 100dth man suffered by lot.

DECIPHERING, the art of finding the alphabet of a cipher. For the art both of Ciphering and Deciphering, see the article CIPHER.

DECIUS MUS, a celebrated Roman consul, who, after many glorious exploits, devoted himself to the gods manes for the safety of his country in a battle against the Latins, about 340 years before the Augustan age. His son Decius imitated his example, and devoted himself in like manner in his fourth consulship, when fighting against the Gauls and Samnites. His grandson also did the same in the war against Pyrrhus and the Tarentines. This action of devoting one's self was of infinite service to the state. The soldiers were animated by the example, and induced to follow with intrepidity a commander who, arrayed in an unusual dress, and addressing himself to the gods with solemn invocation, rushed into the thickest part of the enemy to meet his fate.

DECIUS, *Cn. Metius, Q. Trajanus*, a native of Pannonia, sent by the emperor Philip to appease a sedition in Mœsia. Instead of obeying his master's command, he assumed the imperial purple, and soon after marched against him, and at his death became the only emperor. He signalized himself against the Persians; and, when he marched against the Goths, he pushed his horse into a deep marsh, from which he could not extricate himself, and he perished with all his army by the darts of the barbarians, A. D. 251, after a reign of two years.

DECK *of a* SHIP (from *decken*, Dan. to cover); the planked floors of a ship, which connect the sides together, and serve as different platforms to support the artillery and lodge the men, as also to preserve the cargo from the sea in merchant vessels. As all ships are broader on the lower deck than on the next above it, and as the cannon thereof are always heaviest, it is necessary that the frame of it should be much stronger than that of the others; and for the same reason the second or middle deck ought to be stronger than the upper deck or forecastle.

Ships of the first and second rates are furnished with three whole decks, reaching from the stem to the stern, besides a forecastle and a quarter-deck, which extends from the stern to the mainmast; between which and the forecastle a vacancy is left in the middle, opening to the upper deck, and forming what is called the *waist*. There is yet another deck above the hinder or aftmost part of the quarter-deck, called the *poop*, which also serves as a roof for the captain's cabin or couch.

The inferior ships of the line of battle are equipped with two decks and a half; and frigates, sloops, &c. with one gun-deck and a half, with a spar-deck below to lodge the crew.

The decks are formed and sustained by the beams, the clamps, the water-ways, the carlings, the ledges, the knees, and two rows of small pillars called *stanchions*, &c. See those articles.

That the figure of the deck, with its corresponding parts, may be more clearly understood, we have exhibited a plan of the lower-deck of a 74 gun ship in Plate CLXIX. And as both sides of the deck are exactly similar, the pieces by which it is supported appear on one side, and on the other side the planks of the floor of which it is composed, as laid upon those upper pieces.

A, the principal or main hatch-way.

B, the stern-post.

C, the stern.

D, the beams, composed of three pieces, as exhibited by D, in one of which the dotted lines show the arrangement of one of the beams under the other side of the deck.

E, part of the vertical or hanging knees.

F, the horizontal or lodging knees, which fasten the beams to the sides.

G, the carlings, ranging fore and aft from one beam to another.

H, the gun-ports.

I, the pump-dales, being large wooden tubes, which return the water from the pumps into the sea.

K, the spurs of the beams, being curved pieces of timber serving as half-beams to support the decks, where a whole beam cannot be placed on account of the hatchways.

L, the wing-transom, which is bolted by the middle to the stern-post, and whose ends rest upon the fashion-pieces.

M, the hulk-head or partition which incloses the manger, and prevents the water which enters at the hawse-holes from running aft between decks.

NN, the fore hatchway.

OO, the after hatchway.

P, the drum-head of the great capstern.

P*p*, the drum-head of the main capstern.

Q, the wing-transom knee.

R, one of the breast-hooks under the gun-deck.

S, the breast-hook of the gun-deck.

TT, the station of the chain-pumps.

V, the breadth and thickness of the timbers at the height of the gun-deck.

UU, scuttles leading to the gunner's store-room, and the bread-room.

W, the station of the fore-mast.

X, the station of the main-mast.

Y, the station of the mizen-mast.

Z, the ring-bolts of the decks, used to retain the cannon whilst charging.

a a, The ring-bolts of the sides whereon the tackles are hooked that secure the cannon at sea.

c a a d, The water-ways, through which the scupper holes are pierced, to carry the water off from the deck into the sea.

b b, Plan of the foremost and aftmost cable bits, with their cross-pieces *g g*, and their standards *e e*.

Thus we have represented on one side all the pieces which sustain the deck with its cannon; and on the other side the deck itself, with a tier of 32 pounders planted in battery thereon. In order also to show the use of the breeching and train-tackle, one of the guns is drawn in as ready for charging.

The number of beams by which the decks of ships are supported, is often very different, according to the practice of different countries, the strength of the timber of which the beams are framed, and the services for which the ship is calculated.

As the deck which contains the train of a fire-ship is furnished with an equipage peculiar to itself, the whole apparatus is particularly described in the article *Fire-Ship*.

Flush-Deck, implies a continued floor laid from stem to stern, upon one line, without any stops or intervals.

Half-Deck, a space under the quarter-deck of a ship of war, contained between the foremost bulk-head of the steerage and the fore-part of the quarter-deck. In the colliers of Northumberland the steerage itself is called the *half deck*, and is usually the habitation of the crew.

DECLAMATION, a speech made in public, in the tone and manner of an oration, uniting the expression of action to the propriety of pronunciation, in order to give the sentiment its full impression upon the mind. According to the manners and customs of the present age, public harangues are made only, 1. In the pulpit. 2. In the senate, in council, or other public assembly. 3. By public professors. 4. On the theatre.

I. With regard to the declamation of the pulpit, the dignity and sanctity of the place, and the importance of the subject, require the preacher to exert the utmost powers of his voice to produce a pronunciation that is perfectly distinct and harmonious, and that he observe a deportment and action which is expressive and graceful. No man, therefore, who is destitute of a voice, should ascend the pulpit, and there act the part of a pantomime before his audience. The preacher should not, however, roar like a common crier, and rend the ear with a voice of thunder; for such kind of declamation is not only without meaning and without persuasion, but highly incongruous with the meek and gentle expressions of the gospel. He should likewise take particular care to avoid a monotony; his voice should rise from the beginning, as it were by degrees, and its greatest strength should be exerted in the application. Each inflection of the voice should be adapted to the phrase, and to the meaning of the words; and each remarkable expression should have its peculiar inflexion. The dogmatic requires a plain, uniform tone of voice only; and the menaces of the gospel demand a greater force than do its promises and rewards; but the latter should not be pronounced in the soft tone of a flute, nor the former with the loud sound of a trumpet. The voice should still retain its natural tone in all its various inflexions. Happy is that preacher, to whom nature has given a voice that is at once strong, flexible, and harmonious.

An air of complacency and benevolence, as well as devotion, should be constantly visible in the countenance of the preacher. But every appearance of affectation must be carefully avoided; for nothing is so disgustful to an audience as even the semblance of dissimulation. Eyes constantly rolling, turned towards heaven, and streaming with tears, rather denote a hypocrite, than a man possessed of the real spirit of religion, and that feels the true import of what he preaches. An air of affected devotion infallibly destroys the efficacy of all that the preacher can say, however just and important it may be. On the other hand, he must avoid every appearance of mirth or raillery, or of that cold unfeeling manner which is so apt to freeze the hearts of his hearers.

The body should be in general erect, and in a natural and easy attitude. The perpetual movement or contortion of the body has a ridiculous effect in the pulpit, and makes the figure of a preacher and a harlequin much too similar, But, on the other hand, he ought not to remain constantly upright and motionless like a speaking statue.

The motions of the hands give a strong expression to a discourse; but they should be constantly decent, grave, noble, and expressive. The preacher who is incessantly in action, who is perpetually clasping his hands, or who menaces with a clenched fist, or counts his arguments on his fingers, will only excite mirth among his auditory. In a word, declamation is an art that the sacred orator should study with the utmost assiduity. The design of a sermon is to convince, to affect, and to persuade. The voice, the countenance, and the action, which are to produce this triple effect, are therefore the objects to which the preacher should particularly apply himself.

II. The declamation of a minister or statesman in the senate, in council, or other public assembly, is of a more unconfined nature. To persuade, to move the passions, and gain an ascendency in a public assembly, the orator should himself feel the force of what he says, and the declamation should only express that internal sensation. But nothing should be carried to excess. A suavity in the tone of voice, a dignity of deportment, a graceful action, and a certain tranquillity of countenance, should constantly accompany the statesman when he speaks in public, even when he is most earnestly engaged in debate, or when he is addressing his sovereign in person. A pleasing tone of voice and a distinct pronunciation, prejudice the hearers greatly in the speaker's favour. A young man may improve these to a surprising degree. Demosthenes, who had a natural impediment in his speech, was accustomed to go to the sea shore, and partly filling his mouth with pebbles, he declaimed with a loud voice. The stones by degrees gave a volubility to his tongue, and the roaring of the waves reconciled him insensibly to the noise of the multitude.

III. The principal object of a public professor is the instruction of the studious youth; for which purpose he is to convince and persuade. Every tone of voice, every expression of the countenance, or action of the body, which can produce this effect by enforcing the words, should therefore be employed by those who are to teach the science. There is, moreover, one very essential reflection which every professor ought to make, and which is, that the chair from which he harangues is surrounded by young students, naturally possessed with vivacity, not unfrequently ludicrous; and for the most part previously instructed in the preparatory sciences. They are therefore constantly inclined to criticise, to jest, and to ridicule; for which reason, the professor should endeavour to inspire them with respect and attention, by a grave, commanding, and venerable countenance, and carefully avoid all appearance of grimace in his action, and every kind of affectation in his discourse, that he may not afford the least opportunity of pleasantry.

IV. We now come to *theatric declamation*. 1. This was very different among the ancients from what it is, and ought to be, with us, from the nature of the thing itself, and from the difference of circumstances. Numberless passages in Quintilian, and other ancient historians, critics, grammarians, and commentators, evidently prove, that the ancient dramatic declamation was subservient to the rules of the musical rhythmus; and by this, according to Aristides *, their action, as well as recital, was regulated. But to explain this seeming paradox, it will be necessary to make here some preliminary remarks. The ancients gave a much more extensive signification than we do to the word *music* (*musica*), which they derived from the muses, or at least from some of them. It is for this reason that the same Aristides and Quintilian defined it to be "An art that teaches all that relates to the use of the voice, and the manner of performing all the motions of the body with grace:" *Ars decoris in vocibus et motibus*. Therefore poetry, declamation, dancing, pantomimes, and many other gestures and exercises, were subservient to this art.

2. That part of general music which taught the art of declamation and gesture according to the rules of an established method (and which we perform by instinct, or at most by the aid of common sense), was distinguished by the name *hypocritic music;* and this musical art was called by the Greeks *orchesis*, and by the Romans *saltatio*. It was, however, so far from being an advantage to the ancients to have had this art, which we have not, that it was, on the contrary, a mark of great imperfection. For, in the first place, it was an instance of high absurdity to represent a tragedy, or comedy, before an audience of twenty thousand people, the far greatest part of whom could neither hear nor see what passed to any good purpose, unless they were possessed of organs which we have not. The theatres of London and Paris may conveniently contain about a thousand persons; and that is found sufficient in the most populous cities, where there are several places of entertainment on the same day, and where the people are reasonable enough to succeed each other in their diversions. As the features of the face could not be distinguished at so great a distance, and still less the alteration of countenance; in order to represent the different passions, they were obliged to have recourse to *masks*, a wretched childish invention, that destroyed all the strength and variety of expression. Their action became extravagant, and at the same time subservient to a regular mechanism; which prevented all the refinement, and all the pleasure of surprise, in the performance, and must have had an effect horribly disagreeable to those who were placed near the stage.

3. The egregious imperfection of their language likewise, which consisted of syllables long and short, whose duration was determined by a set measure of time, and their manner of tuning these syllables, after the method of the orchesis of the Greeks, was another disadvantage. For by this means they determined by notes or characters placed after the long and short syllables, not only the nature, but the duration, of each action. Now, nothing could be more affected, more constrained and disgustful, than such a method of declaiming. How far superior in this respect are the moderns, who consult nature alone in their theatric declamation; who can make the audience hear each sigh; who can accompany it with a proper attitude; who can incessantly vary their action; who can seize the lucky moment, and make the countenance fully express the sensations of the mind! Nature does all here; and art, infinitely inferior to nature, did all among the ancients. Modern declamation cannot be subservient to a musical rhythmus, seeing we speak rapidly, and without affectation. Our actors learn their art without art, from nature itself, assisted by reflection; and they arrive at a degree of excellence infinitely greater than that of the ancients, by a method far more simple, and by efforts incomparably more easy.

4. We do not, moreover, precisely know what the theatric declamation of the ancients was; nor what were the musical instruments which accompanied that declamation. The title to the Eunuch of Terence says, for example, "that Flaccus, the freedman of Claudius, made the music of that piece, in which he employed the two flutes, the right and the left." These flutes, it is likely, gave the tone to the actor, which must have had a very odd effect on the audience. Most of the ancient pieces have similar titles. They who would be particularly informed of the art of declaiming among the Greeks and Romans, may read to advantage the Critical Reflections on Poetry and Painting by the Abbé du Bos. The third part of that work consists entirely of learned researches and ingenious reflections on this silly practice of the ancients. But as this art has happily no place in modern declamation, and can at best serve only to make a parade of erudition, we shall say no more of it, but pass to matters of real utility,

5. We think there is good reason to believe, moreover, that the most polished nations of modern Europe do not accompany their discourses in general with so many gesticulations, as did the Greeks, the Romans, and other inhabitants of warm climates. They appear to have found the method of animating a discourse, and giving it an expression, by the simple inflections of the voice, and by the features of the countenance; which is far more decent, more just and rational, than all those contortions which perpetually derange the natural attitude of the body and its members, and give the speaker the air of a harlequin.

6. *Expression*, therefore, forms at once the essence and the end of declamation: and the means of producing it consists, in a pronunciation that is sonorous, distinct, and pleasing, supported by an action that is decent and proper to the subject. If the best dramatic poet has need of a good declaimer or actor to make his

---

* *De Musica*, lib. i.

his writings produce their proper effect, the actor has likewise need of a good poet to enable him to please and affect by the action; for it is to little purpose that he endeavours to charm his auditory by uniting, with nature, all the powers of art, if the poet has not furnished him with sentiments that are rational and affecting.

7. The actor, in studying his part before a large mirror, where he can see his whole figure, in order to determine the most proper expressions for every thought, should consult nature, and endeavour to imitate her. But in this imitation, he should take care not to make too servile a copy. He has this to observe, in common with his colleagues, the masters in all the polite arts: The theatre is intended to exhibit an imitation of nature, and not nature itself. Tragedy and comedy form pictures of human life; but these pictures are also pieces of perspective, which require strokes somewhat stronger than nature, that they may be discerned at a distance. The actor is elevated to a considerable height from the ground; he is surrounded by scenery, he is separated from the audience by the orchestra, and he speaks in verse; all this is not natural; but the spectator is to accede to this necessary illusion, in order to promote his own pleasure, which would not be so great as it is were all these matters otherwise disposed. Declamation, therefore, should somewhat exceed, but never lose sight of, nature.

8. The tone of the actor's voice should be natural, but regulated by the extent of the theatre; sufficiently loud to be heard by all the audience, but not so violent as to rend their ears. A pure and graceful pronunciation, without any provincial accent, is likewise a great merit in an actor; and he should also habituate himself to speak in a manner perfectly distinct. It is a capital point in the pronouncing of verse, not to separate the two hemistichs, by resting too long on the *cæsura* in the middle, or dwelling on the end of each hemistich: for, by so doing, the actor falls into a monotony, an insufferable uniformity of cadence, in a piece that consists of some thousand verses. The gradations of the voice demand also a very judicious observance. The speaker, who begins in a high tone, will find it very difficult to sustain it through the whole piece; and he, who clamours incessantly, will find his lungs fail him in those parts where the vehemence of passion requires the strongest efforts. If we may be allowed the expression, the strongest touches, the boldest figures, will not there stand out from the picture in a striking manner.

9. The deportment of an actor should be constantly graceful, decent, and proper to the character he represents. An old man has a different position of body from a young petit-maitre; an aged queen from a young princess; a noble gallant from a valet de chambre. A rational observance of nature, and an imitation of the best actors, are here the surest guides. The same may be said of the action of the hands, the theatric step, &c. An inanimated figure, a body in the position of a statue, and hands immoveable, are as displeasing in the scene, as a player whose incessant gesticulation resembles the action of a puppet.

10. Every actor who aspires to make his art something more than merely mechanical, will begin by enabling himself readily to repeat his part, that the defect of his memory may not embarrass his action. When he is so far a master of it, he will make it the subject of serious reflection in his closet; endeavour to seize the true sense of the author; and to find out that expression of each sentiment and passion, which is the most natural, the most striking, and best adapted to the stage; and which he will cultivate by repeated essays, till he is able to render it in its full force.

DECLARATORY ACTION. See LAW *Index*.

DECLINATION, in *Grammar*, an inflection of nouns, according to their divers cases; as nominative, genitive, dative, &c. See GRAMMAR.

DECLINATION, in *Astronomy*, the distance of any celestial object from the equinoctial, either northward or southward. It is either true or apparent, according as the real or apparent place of the object is considered. See ASTRONOMY *Index*.

DECLINATION of the Sea Compass or *Needle*, is its variation from the true meridian of any place.

DECLINATION of a Plane or *Wall*, in *Dialing*, is the horizontal arch contained between the plane and the prime vertical circle, if you reckon from east to west; or between the meridian and the plane, reckoning from north to south. Many ways are used for finding this declination: but the most easy and practicable is by a declinator. See DECLINATOR.

DECLINATOR, or DECLINATORY, an instrument chiefly used in practical dialing, for taking the declinations, inclinations, or reclinations of the planes on which the dials are to be delineated. See DIALING, N° 24, 25.

DECLINATURE *of* JUDGES. See LAW *Index*.

DECLIVITY denotes the reverse of ACCLIVITY.

DECOCTION, usually signifies either the action of boiling a substance in water, or the water itself in which the substance has been boiled. It is only applicable to matters containing some principles soluble in water: such particularly are animal and vegetable matters. Decoction ought not to be used with such substances as contain any volatile principles, as they would be dissipated in the air during the process. But it may be safely used, nay even becomes necessary, when the matters to be treated are solid, and of a close and compact texture; because then the water could not extract its principles without a boiling heat. Most soft animal matters, as flesh, skin, tendons, may be conveniently boiled in water; because they contain no principle volatile with a boiling heat. Water extracts from them nothing but a gelatinous substance, and some oily parts which float on the surface of the water. All vegetable matters which are inodorous, and particularly those which are hard, as roots, barks, &c. are generally boiled, when an extraction of their principles by water is required.—To this rule, however, there are some exceptions. Peruvian bark, for instance, gives its strength to cold water better than to such as is boiling hot. Many other vegetables also have the same property of yielding less to boiling than to cold water. And therefore a general rule may be established, that decoction ought not to be employed but when absolutely necessary; that is, when the same principles, or the same quantities of those principles, cannot be obtained by an infusion, and that without heat, if it can be so done, considering that the proximate principles of vegetables are generally so delicate, and so susceptible of change and decomposition, that frequently the most gentle heat changes much their nature and properties.

DECOLLATION, Beheading, a term seldom used but in the phrase *decollation* of St John Baptist: which denotes a painting, wherein is represented the Baptist's head struck off from his trunk; or the feast held in honour of that martyr.

DECOMPOSITION, in *Chemistry*, usually signifies the disunion or separation of the constituent parts of bodies.—It differs from mere mechanical division; for when a body is chemically decomposed, the parts into which it is resolved are essentially different from the body itself: and though a mechanical force be applied to it ever so long, or with ever so much violence, the minutest particles into which the body may be reduced still retain their original nature.—Thus, for example, though we suppose nitre, or any other salt, to be reduced to ever so fine powder, each particle retains the nature of nitre, as much as the largest unpounded mass; but if sulphuric acid be applied, a decomposition takes place, and one of the component parts of the nitre, namely the nitric acid, rises in the form of fumes, which lay hid in the mild neutral salt. See Decomposition, Chemical, Supplement.

DECORATION, in *Architecture*, any thing that adorns and enriches a building, church, triumphal arch, or the like, either without side or within.

The orders of architecture contribute greatly to the decoration; but then the several parts of those orders must have their just proportions, characters, and ornaments; otherwise the finest order will bring confusion rather than richness. See Architecture.

Decorations in churches are paintings, vases, festoons, &c. occasionally applied to the walls; and with so much conduct and discretion, as not to take off any thing from the form of the architecture: as is much practised in Italy at the solemn feasts.

Decoration is more particularly applied to the scenes of theatres.

In operas, and other theatrical performances, the decorations must be frequently changed conformably to the subject.

The ancients had two kinds of decorations for their theatres; the first, called *versatiles*, having three sides, or faces, which were turned successively to the spectators: the other called *ductiles*, showing a new decoration by drawing or sliding another before it. This latter sort is still used, and apparently with much greater success than among the ancients, who were obliged to draw a curtain whenever they made a change in the decorations; whereas on our stage the change is made in a moment, and almost without being perceived.

DECORUM, in *Architecture*, is the suitableness of a building, and the several parts and ornaments thereof, to the station and occasion.

DECOUPLE, in *Heraldry*, the same as uncoupled; thus a chevron decouple is a chevron wanting so much of it towards the point, that the two ends stand at a distance from one another, being parted and uncoupled.

DECOY, in naval affairs, a stratagem employed by a ship of war to betray a vessel of inferior force into an uncautious pursuit, till she has drawn her within the range of her cannon, or what is called within *gun-shot*. It is usually performed by painting the stern and sides in such a manner as to disguise the ship, and represent her either much smaller and of inferior force, or as a friend to the hostile vessel, which she endeavours to ensnare, by assuming the emblems and ornaments of the nation to which the stranger is supposed to belong. When she has thus provoked the adversary to chase, in hopes of acquiring a prize, she continues the decoy, by spreading a great sail, as endeavouring to escape; at the same time that her course is considerably retarded by an artful alteration of her trim till the enemy approaches. Decoying is also performed to elude the chase of a ship of a superior force in a dark night, by throwing out a lighted cask of pitch into the sea, which will burn for a considerable time and misguide the enemy. Immediately after the cask is thrown out, the ship changes her course, and may easily escape, if at any tolerable distance from the foe.

Decoy, among fowlers, a place made for catching wild-fowl. A decoy is generally made where there is a large pond surrounded by a wood, and beyond that a marshy and uncultivated country: if the piece of water is not thus surrounded, it will be attended with the noise and other accidents which may be expected to frighten the wild-fowl from a quiet haunt, where they mean to sleep, during the day-time, in security. If these noises or disturbances are wilful, it hath been held that an action will lie against the disturber.—As soon as the evening sets in, the decoy rises (as they term it), and the wild fowl feed during the night. If the evening is still, the noise of their wings, during their flight, is heard at a very great distance, and is a pleasing though rather melancholy sound. This rising of the decoy in the evening, is in Somersetshire called *radding*.

The decoy-ducks are fed with hempseed, which is thrown over the skreens in small quantities, to bring them forwards into the pipes or canals, and to allure the wild fowl to follow, as this seed is so light as to float.

There are several *pipes*, as they are called, which lead up a narrow ditch that closes at last with a funnel-net. Over these pipes (which grow narrower from their first entrance) is a continued arch of netting suspended on hoops. It is necessary to have a pipe or ditch for almost every wind that can blow, as upon this circumstance it depends which pipe the fowl will take to; and the decoy-man always keeps on the leeward side of the ducks, to prevent his effluvia reaching their sagacious nostrils. All along each pipe, at certain intervals, are placed skreens made of reeds, which are so situated, that it is impossible the wild-fowl should see the decoy-man, before they have passed on towards the end of the pipe, where the purse-net is placed. The inducement to the wild-fowl to go up one of these pipes is, because the decoy-ducks trained to this lead the way, either after hearing the whistle of the decoy-man, or enticed by the hemp-seed; the latter will dive under water whilst the wild-fowl fly on, and are taken in the purse.

It often happens, however, that the wild-fowl are in such a state of sleepiness and dozing, that they will not follow the decoy-ducks. Use is then generally made

made of a dog, who is taught his lesson; he passes backwards and forwards between the reed skreens (in which are little holes, both for the decoy-man to see, and the little dog to pass through); this attracts the eye of the wild-fowl, who, not choosing to be interrupted, advance towards the small and contemptible animal, that they may drive him away. The dog all the time, by the direction of the decoy-man, plays among the skreens of reeds, nearer and nearer the purse-net: till at last, perhaps the decoy-man appears behind a skreen, and the wild-fowl not daring to pass by him in return, nor being able to escape upwards on account of the net-covering, rush on into the purse-net. Sometimes the dog will not attract their attention, if a red handkerchief, or something very singular, is not put about him.

The general season for catching fowls in decoy, is from the latter end of October till February: the taking of them earlier is prohibited by an act 10 Geo. II. c. 32. which forbids it from June 1st to October 1st, under the penalty of five shillings for each bird destroyed within that space.

The Lincolnshire decoys are commonly set at a certain annual rent, from 5 to 20 pounds a-year: and there is one in Somersetshire that pays 30l. The former contribute principally to supply the markets in London. Amazing number of ducks, widgeons, and teal, are taken: by an account sent us * of the number caught a few winters past, in one season, and in only ten decoys, in the neighbourhood of Wainfleet, it appeared to amount to 31,200, in which are included several other species of ducks; it is also to be observed, that, in the above particular, widgeon and teal are reckoned but as one, and consequently sell but at half price of the ducks. This quantity makes them so cheap on the spot, that we have been assured, several decoy-men would be content to contract for years to deliver their ducks at Boston, for 10d. per couple. The account of the numbers here mentioned, relates only to those that were sent to the capital.

It was customary formerly to have in the fens an annual *driving* of the young ducks before they took wing. Numbers of people assembled, who beat a vast tract, and forced the birds into a net placed at the spot where the sport was to terminate. A hundred and fifty dozens have been taken at once: but this practice being supposed to be detrimental, has been abolished by act of parliament.

DECREE, an order made by a superior power for the regulation of an inferior.

Decree, in the civil law, is a determination which the emperor pronounces upon hearing a particular cause between the plaintiff and defendant.

Decrees of Councils, are the laws made by them, to regulate the doctrine and policy of the church.

Decrees in Chancery, are the determination of the lord-chancellor, upon a full hearing of the merits of a cause.

DECREET, in the *Law of Scotland*, a final decreet of judgment of the lords of session, from which an appeal only lies to parliament.

Decreet-Arbitral, in *Scots Law*, the sentence or judgment of one to whom parties voluntarily submit the determination of any question betwixt them. See Law *Index*.

DECREMENT, in *Heraldry*, signifies the wane of the moon from the full to the new. The moon in this state is called *moon decrescent* or in *decours*; and when borne in coat armour, faces to the left side of the escutcheon, as she does to the right side when in the increment.

DECREPITATION, in *Chemistry*, signifies the quick separation of the parts of a body, occasioned by a strong heat, and accompanied with a crackling noise. This effect is most frequently produced by water contained betwixt the parts of the decrepitating body, when these parts have a certain degree of adhesion together. This water being quickly reduced into vapour by the heat suddenly applied to it, rarefies and bursts with noise the parts which compress it. The bodies most subject to decrepitation are certain salts, such as common salt, sulphate of potash, nitrate of lead, &c. the decrepitation of all which proceeds from the water of their crystallization. Clays which are not perfectly dry, and flints, are also subject to decrepitation.

DECREPITUDE, in *Medicine*, the consequence of the infirmities of old age; which by degrees leads to death. See Death.

DECRETAL, in the canon law, a letter of a pope, determining some point or question in the ecclesiastical law. The decretals compose the second part of the canon law. The first genuine one, acknowledged by all the learned as such, is a letter of Pope Siricius, written in the year 385, to Himerus bishop of Tarragona, in Spain, concerning some disorders which had crept into the churches of Spain. Gratian published a collection of decretals, containing all the ordinances made by the popes till the year 1150. Gregory IX. in 1227, following the example of Theodosius and Justinian, formed a constitution of his own, collecting into one body all the decisions and all the causes which served to advance the papal power; which collection of decretals was called the *pentateuch*, because it contains five books.

DECUMARIA, a genus of plants belonging to the dodecandria class, and in the natural method ranking under those of which the order is doubtful.

DECUMATES agri, tithed fields, or granted on a tithe, as appears from Tacitus, to that rabble of Gauls who succeeded the Marcomanni, that had till then proved a check to the Roman conquests up the Rhine; and hence probably their name, people living on the marches or limits of the empire. In Cicero we have Ager Decumans, which is of the same import with the Ager Decumas of Tacitus.

DECUPLE proportion, that of ten to one.

DECURIO, a subaltern officer in the Roman armies. He commanded a decuria, which consisted of ten men, and was the third part of a turma, or the 30th part of a legio of horse, which was composed of 580 men. There were certain magistrates in the provinces, called *decuriones municipales*, who formed a body to represent the Roman senate in free and corporate towns. They consisted of ten, whence the name; and their duty extended to watch over the interests of their fellow citizens, and to increase the revenues of the commonwealth. Their court was called *curia decurionum* and *minor senatus*; and their decrees, called *decreta decurionum*, were marked with two D. D. at the top. They generally styled themselves *civitatum patres curiales*,

---

* Pennant's Brit. Zool. ii. 595.

les, and *honorati municipiorum senatorum*. They were elected with the same ceremonies as the Roman senators; they were to be at least 25 years of age, and to be possessed of a certain sum of money. The election happened in the kalends of March.

DECURRENT LEAF. See BOTANY *Index*.

DECURY, ten persons ranged under one chief or leader, called the *decurio*.

The Roman cavalry was divided into decuries, which were subdivisions of a century, each century containing ten decuries.

DECUSSATION, a term in geometry, optics, and anatomy, signifying the crossing of two lines, rays, or nerves, when they meet in a point, and then go on separately from one another.

DECUSSORIUM, a surgeon's instrument, which, by pressing gently on the dura mater, causes an evacuation of the pus collected between the cranium and the before-mentioned membrane, through the perforation made by the trepan.

DEDHAM, a town of Essex in England, containing 1432 inhabitants in 1811. The streets are not paved, but very clean, occasioned by their lying pretty high. It has one large old church, remarkable for a fine Gothic steeple, with a great deal of carved work about it, but much injured by time. E. Long. 1. 10. N. Lat. 52. 5.

DEDICATION, the act of consecrating a temple, altar, statue, palace, &c. to the honour of some deity.

The use of dedications is very ancient both among the worshippers of the true God and among the heathens; the Hebrews call it חמכה *hhanuchah*, "imitation;" which the Greek translators render Εγκαινια and Εγκαινισμος, "renewing."

In the Scripture we meet with dedications of the tabernacle, of altars, of the first and second temple, and even of the houses of private persons. There are also dedications of vessels, and garments of the priests and Levites, and even of the men themselves.

The heathens had also dedications of temples, altars, and images of their gods, &c. Nebuchadnezzar held a solemn dedication of his statue, *Dan.* iii. 2. Pilate dedicated gilt bucklers at Jerusalem to Tiberius, *Philo de legat.* Petronius would have dedicated a statue to the emperor in the same city, *ibid.* p. 791. Tacitus, *Hist.* lib. iv. c. 53. mentions the dedication of the capitol, upon rebuilding it by Vespasian, &c.

The Jews celebrated the anniversary of the dedication of their temple every year for eight days. This was first enjoined by Judas Maccabeus, and the whole synagogue, in the year of the Syro-Macedonian era 148, i. e. 164 years before Christ. The heathens had the like anniversaries, as that of the dedication of the temple of Parthenope, mentioned by Lycophron. Under Christianity, dedication is only applied to a church: and is properly the consecration thereof, performed by a bishop, with a number of ceremonies prescribed by the church.

The Christians finding themselves at liberty under Constantine, in lieu of their ruinous churches built new ones in every place, and dedicated them with much solemnity. The dedication was usually performed in a synod; at least they assembled a number of bishops to assist at the service. We have the description of those of the churches at Jerusalem and Tyre in Eusebius, and many others in later writers.

DEDICATION, in literature, is an address prefixed to a book, soliciting patronage, or testifying respect for the person to whom it is made. The dedication of the fourth part of Mr Edwards's History of Birds, is curious: *To* GOD! *the* ONE *eternal! the incomprehensible, the omnipresent, omniscient, and almighty Creator of all things that exist! from orbs immeasurably great, to the minutest points of matter!—this Atom is dedicated and devoted, with all possible gratitude, humiliation, and worship, and the highest adoration both of body and mind, by his most resigned, low, and humble creature,* G. E.

DEE, JOHN, a famous mathematician and astrologer, was born (July 1527) in London, where his father was a wealthy vintner. In 1542, he was sent to St John's college, Cambridge. After five years close application to mathematical studies, particularly astronomy, he went to Holland, in order to visit several eminent mathematicians on the continent. Having continued abroad near a year, he returned to Cambridge, and was there elected one of the fellows of Trinity college, then first erected by King Henry VIII. In 1548, he took the degree of master of arts; and, in the same year, left England a second time; his stay at home being rendered uneasy to him, by the suspicions that were entertained of his being a conjuror; arising partly from his application to astronomy, but especially on account of a piece of machinery in the Ειρηνη of Aristophanes, which he exhibited to the university, and in which he represented the scarabeus flying up to Jupiter, with a man and a basket of victuals on its back. These suspicions he could never after shake off; nor did his subsequent conduct, as we shall see, tend to clear him of the imputation; for if he was not actually a conjuror, it was not for want of endeavours.

Upon leaving England, he went to the university of Louvain; where he was much esteemed, and visited by several persons of high rank. Here he resided about two years, and then set out for France; where, in the college of Rheims, he read lectures of Euclid's elements with vast applause. In 1551, he returned to England, and was introduced by the secretary Cecil to King Edward, who assigned him a pension of 100 crowns, which he afterwards relinquished for the rectory of Upton upon Severn: but soon after the accession of Queen Mary, having some correspondence with the lady Elizabeth's servants, he was accused of practising against the queen's life by enchantment. On this account he suffered a tedious confinement, and was several times examined; till, in the year 1555, he obtained his liberty by an order of council.

When Queen Elizabeth ascended the throne, our astrological Dee was consulted by Lord Dudley, concerning a propitious day for her majesty's coronation. He was on this occasion introduced to the queen, who made him great promises, which were never performed, though she condescended to receive his instructions relative to the mystical interpretation of some of his unintelligible writings, which he published about this time. In 1564, he made another voyage to the continent; in order to present a book which he had dedicated to the emperor Maximilian. He returned to England in the same year: but in 1571, we find him in Lorrain; where, being dangerously ill, the queen sent over two physicians

physicians to his relief. Having once more returned to his native country, he settled at Mortlake in Surrey, where he continued his studies with unremitting ardour, and collected a considerable library of curious books and manuscripts, and a variety of instruments; most of which were afterwards destroyed by the mob, as belonging to one who dealt with the devil. In 1578, the queen being much indisposed, Mr Dee was sent abroad to consult with German physicians and philosophers (astrologers no doubt) on the occasion. We now behold him again in England, where he was soon after employed in a more rational service. Her majesty, desirous to be informed concerning her title to those countries which had been discovered by her subjects, commanded Mr Dee to consult the ancient records, and furnish her with proper geographical descriptions. Accordingly, in a short time he presented to the queen, in the gardens at Richmond, two large rolls, in which the discovered countries were geographically described and historically illustrated. These rolls are preserved in the Cotton library, *Augustus* I. His next employment was the reformation of the kalendar, on which subject he wrote a rational and learned treatise, preserved in the Ashmolean library at Oxford.

Hitherto the extravagancies of our eccentrical philosopher seem to have been counterpoised by a tolerable proportion of reason and science; but henceforward we consider him as a mere necromancer and credulous alchymist. In the year 1581, he became acquainted with one Edward Kelly, by whose assistance he performed diverse incantations, and maintained a frequent imaginary intercourse with spirits. He was particularly intimate, it seems, with the angels Raphael and Gabriel. One of them made him a present of a black speculum, in which his angels and demons appeared as often as he had occasion for them; they answered his questions, and Kelly's business was to record their dictates:

> Kelly did all his feats upon
> The devil's looking-glass, a stone.
> HUDIB. Part II. Canto iii. 631.

In 1583, they were both introduced to a certain Polish nobleman, then in England, named *Albert Laski*, palatine of Siradia, a person equally addicted to the same ridiculous pursuits. He was so charmed with Dee and his companion, that he persuaded them to accompany him to his native country. They embarked for Holland in Sept. 1583; and travelling over land, arrived at the town of Laski in February following. Their patron, however, finding himself abused by their idle pretensions, persuaded them to pay a visit to Rodolph king of Bohemia; who, though a credulous man, was soon disgusted with their nonsense. They were afterwards introduced to the king of Poland, but with no better success. Soon after this, they were invited by a rich Bohemian nobleman to his castle of Trebona, where they continued for some time in great affluence: owing, as they asserted, to their art of transmutation by means of a certain powder in the possession of Kelly.

Dee, now quarrelling with his companion in iniquity, quitted Bohemia, and returned to England, where he was once more graciously received by the queen; who, in 1595, made him warden of Manchester college, in which town he resided several years. In 1604, he returned to his house at Mortlake, where he died in the year 1608, aged 81; leaving a large family, and many works behind him.—The black stone into which Dee used to call his spirits, was in the collection of the earls of Peterborough, whence it came to Lady Elizabeth Germaine. It was next the property of the late duke of Argyle, and is now Mr Walpole's. It appears upon examination to be nothing but a polished piece of cannel coal.—That Dee was a man of considerable acquirements, is beyond a doubt; his mathematical knowledge is generally allowed: but, unless we suppose him a wicked impostor, which is by no means improbable, we must transmit him to posterity as one of the most foolish superstitious necromancers of his time. Nevertheless, the celebrated Dr Hook, many years after Dee's death, took it into his head to prove that his journal, published by Casaubon, was entirely cryptographical, concealing his political transactions, and that he was employed by Queen Elizabeth as a spy.

DEE, the name of several rivers in Scotland and England; as those whereon the cities of Chester in England, and New Aberdeen in Scotland, are situated. The river Dee in Aberdeenshire rises in the mountains of Mar forest, and falls into the German ocean at Aberdeen. It abounds with salmon, so as to form a considerable salmon fishing. Over this river there is a fine bridge of seven arches, built by a bishop of Aberdeen, who left a revenue for its support.

DEED, an instrument written on paper or parchment, comprehending some contract, bargain, or agreement between the parties thereto, in relation to the matter therein contained.

DEEMSTERS, or DEMSTERS (from the Saxon *dema*, judge or umpire). All controversies in the isle of Man are decided without process, writings, or any charges, by certain judges, chosen yearly from among themselves, called *deemsters*; there being two of them for each division of the island: they sit judges in all courts, either for life or property; and with the advice of 24 keys, declare what is law in uncommon emergencies.

DEEPING, a town of Lincolnshire in England, seated in a fenny ground, on the river Weland, six miles east from Stamford. W. Long. 0. 20. N. Lat. 52. 35.

DEER, in *Zoology*. See CERVUS.—The method of hunting deer in the island of Ceylon is very particular. The huntsmen go out in the night, and only two usually go together; the one of these carries upon his head an earthen vessel, in which there is some fire burning and flaming; the ingredients are generally small sticks cut into pieces, and common rosin. Of this the other man carries a supply about him to replenish the pot when it grows low. The person who has the fire upon his head, carries in one hand a staff, on which there are fixed eight bells; and the larger these are, the better. This man goes first into the woods, and the other follows close behind with a spear in his hand. As soon as the deer hears the noise of the bells, he turns towards the place whence the sound comes; and seeing the fire, he eagerly runs up to it, and stands gazing at a small distance: the second man has then nothing to do but to kill him with the spear; for he sees neither of them. Not only deer, but even elks and hares, are thus taken; for they gaze at the fire, and never see the men. The profits of this sort of hunting are very large; and the danger nothing; for though there are numbers of tygers, elephants, and wild boars, in these woods, the huntsmen are in no danger from them while the fire burns, for they all run away from it.

De Facto, something actually in fact, or existing; in contradistinction to *de jure*, where a thing is only so in justice, but not in fact: as a king *de facto*, is a person who is actually in possession of a crown, but has no legal right to the same; and a king *de jure*, is the person who has a just right to the crown, though he is out of possession thereof.

DEFAMATION, the speaking slanderous words of another; for which the slanderer is punishable, according to the nature of his offence, either by action upon the case at common law, or by statute in the ecclesiastical court.

DEFAULT, in *Law*, is generally taken for non-appearance in court, at a day assigned; but imports any omission of that which we ought to do, for which judgment may be given against the defaulter.

DEFEASANCE, or Defeisance, in *Law*, a condition relating to some certain deed, which being performed, the deed is defeated and rendered void, as if it had never been made. The difference between a common condition and a defeasance is, that the condition is annexed to, or inserted in, the deed; and a defeasance is a deed by itself concluded and agreed on between the parties, and having relation to another deed.

DEFECATE, in *Chemistry*, a term applied to a body freed and purged from fæces and impurities.

DEFECTION, the act of abandoning or relinquishing a party or interest a person had been engaged in. The word is formed of the Latin *deficio*, to fall off.

DEFECTIVE, in general, an appellation given to things which want some of the properties that naturally they ought to have. Thus,

Dfeective or *Deficient Nouns*, in *Grammar*, are such as want either a whole number, a particular case, or are totally indeclinable. See Noun.

The term *defective* is also applied to a verb that has not all its moods and tenses. See Verb, Mood, &c.

DEFENCE, in *Fortification*, all sorts of works that cover and defend the opposite posts, as flanks, casements, parapets, and faussebrays. See Fortification.

Line of Defence, a supposed line drawn from the angle of the curtain, or from any other part in the curtain, to the flanked angle of the opposite bastion.

DEFEND, in general, signifies much the same with protecting or keeping off injuries offered to any person either by enemies or otherwise.

Defend, in our ancient laws and statutes, signifies to prohibit or forbid: as *Usuarios* defendit *quoque rex Edwardus ne remanerent in regno.* L. L. Edw. Conf. c. 38. & 5 Rich. II. c. 7. In which sense Chaucer also uses it in the following passage:

> "Where can you say in any manner age,
> "That ever God *defended* marriage."

In 7 Edw. I. there is a statute entitled, "*Statutum de* defensione *portandi arma*," &c. And "it is defended by law to distrain on the highway." *Coke on Littl.* fol. 161.

DEFENDANT, in *Law*, the person sued in an action personal; as *tenant* is he who is sued in an action real. See Action.

DEFENDER *of the* Faith (*Fidei Defensor*), a peculiar title belonging to the king of England; as *Catholicus* to the king of Spain, and *Christianissimus* to the king of France, &c. These titles were given by the popes of Rome. That of *Fidei Defensor* was first conferred by Leo X. on King Henry VIII. for writing against Martin Luther; and the bull for it bears date *quinto idus Octob.* 1521. It was afterwards confirmed by Clement VII. But the pope, on Henry's suppressing the houses of religion at the time of the Reformation, not only deprived him of his title, but deposed him from his crown also: though in the 35th year of his reign, his title, &c. was confirmed by parliament; and hath continued to be used by all succeeding kings to this day. Chamberlayne says, the title belonged to the king of England before that time; and for proof hereof appeals to several charters granted to the university of Oxford. So that Pope Leo's bull was only a renovation of an ancient right.

DEFENDERS, were anciently notable dignitaries both in church and state, whose business was to look to the preservation of the public weal, to protect the poor and helpless, and to maintain the interests and causes of churches and religious houses. See Protector. The council of Chalcedon, can. 2. calls the defender of a church Εκδικος. Codin, *de officiis aulæ Const.* makes mention of defenders of the palace. There were also a defender of the kingdom, *defensor regni*; defenders of cities, *defensores civitatis*; defenders of the people, *defensores plebis*; of the poor, fatherless, widows, &c.

About the year 420, each patriarchal church began to have its defender; which custom was afterwards introduced into other churches, and continued to later days under other names; as those of *Advocate* and *Advowee.*

In the year 407, we find the council of Carthage asked the emperor, for defenders, of the number of *Scholastici*, i. e. advocates who were in office; and that it might be allowed them to enter and search the cabinets and papers of the judges and other civil magistrates, whenever it should be found necessary for the interest of the church.

DEFERENS, or Deferent, in the ancient astronomy, an imaginary circle, which, as it were, carries about the body of a planet, and is the same with the eccentric; being invented to account for the eccentricity, perigee, and apogee of the planets.

DEFILE, in *Fortification*, a straight narrow passage, through which a company of horse or foot can pass only in file, by making a small front.

DEFINITE, in *Grammar*, is applied to an article that has a precise determinate signification; such as the article *the* in English, *le* and *la* in French, &c. which fix and ascertain the noun they belong to, to some particular; as *the king, le roy*: whereas, in the quality *of king, de roy*, the articles *of* and *de* mark nothing precise, and are therefore indefinite.

DEFINITION, in general, a short description of a thing by its properties; or, in logic, the explication of the essence of a thing by its kind and difference.

DEFINITIVE, a term applied to whatever terminates a process, question, &c. in opposition to provisional and interlocutory.

DEFLAGRATION, in *Chemistry*, the kindling or setting fire to a salt or mineral, &c. either alone, or mixed for that purpose with a sulphureous one, in order to purify it.

This short process has been often recommended to the world as of great use in trying the strength of brandies and other vinous spirits, and has been greatly improved in this respect by Mr Geoffroy.

The common way of trying spirits by deflagration, is to measure out any quantity of it, then to heat it, and set it on fire. If, after it will no longer burn, the remainder is half as much as the quantity measured out for the trial was, then the spirit tried is found to consist of half water, and half totally inflammable spirit; that is, it is somewhat below what we understand by the term *perfect proof*.—This method is much more certain than that by the crown of bubbles which arises upon shaking the spirit in a phial. Mons. Geoffroy's method is this: Take a cylindric vessel two inches high, and as much in diameter, consisting of thin plate silver, that metal being much less liable to rust than copper; this vessel must be fitted with a little rectangular gage exactly graduated into lines, half lines, &c. then the vessel being set level upon a copper case made to contain it, a parcel of the brandy to be examined is poured in, to the height of 16 lines. This height is to be exactly hit by pouring in more than enough at first, and then sucking out the overplus with a very small tube. Then the vessel being heated a little, so as just to make the liquor fume, it is to be set on fire and left to go out of itself; at the instant when the flame expires, the gage is plunged perpendicularly into the vessel, and the lines and quarters exactly noted which the liquor wants of its former height: this difference gives the precise quantity of alcohol or pure spirit contained in the liquor. Thus, if eight lines of phlegm are found remaining, this being the half of the 16 lines of the original filling, it is plain that the liquor contained one half spirit, or was something below proof. If only four lines remained, it was nearly double proof, or of a middle nature betwixt alcohol and common proof-spirit.

DEFLECTION, the turning any thing aside from its former course by some adventitious or external cause. The word is often applied to the tendency of a ship from her true course by reason of currents, &c. which turn her out of her right way. It is likewise applied by astronomers to the tendency of the planets from the line of their projection, or the tangent of their orbit.

Deflection of the Rays of Light, a property which Dr Hook observed in 1675, and read an account of before the Royal Society, March 18th the same year. He says he found it different both from reflection and refraction, and that it was made towards the surface of the opaque body, perpendicularly. This is the same property which Sir Isaac Newton calls inflection.

DEFLORATION, or Deflowering, the act of violating or taking away a woman's virginity. See Virginity.—Death or marriage are decreed by the civil law in case of defloration.

The ancients had so much respect for virgins, that they would not put them to death till they had first procured them to be deflowered. It is said, the natives of the coast of Malabar pay strangers to come and deflower their brides.

In Scotland and the northern parts of England, it was a privilege of the lords of the manor, granted them by King Ewen, that they should have the first night's lodging with their tenants wives. King Malcolm III. allowed the tenants to redeem this service at a certain rate, called *marcheta*, consisting of a certain number of cows: Buchanan says it was redeemed with half a mark of silver. The same custom had place in Wales, Flanders, Friesland, and some parts of Germany.

DEFLUXION, in *Medicine*; the fall of the humours from a superior to an inferior part of the body.

DEFOE, Daniel, a writer famous for politics and poetry, was bred a hosier; which profession however he soon forsook, and became one of the most enterprising authors that any age produced. When discontents ran high at the Revolution, and King William was obliged to dismiss his Dutch guards, Defoe, who had true notions of civil liberty, ridiculed the enemies of government in his well-known poem, called the True-Born Englishman, which had a prodigious sale. The next satire he wrote was entitled Reformation of Manners; aimed at some persons of high rank, who rendered themselves a disgrace to their country. When the ecclesiastics in power breathed too much of a spirit of persecution, Defoe wrote a tract called the Shortest Way with the Dissenters: for which he was called to account, and explained himself with great firmness. He was afterwards sentenced to the pillory for attacking some public measures; which so little intimidated him, that, in defiance of their usage, he wrote a Hymn to the Pillory. It would be endless to enumerate all his publications; but the following are the principal: the History of the Plague in 1665; a novel entitled the History of Colonel Jack; a new Voyage round the World by a Company of Merchants, printed for Betesworth, 1725; the History of Roxana; Memoirs of a Cavalier; the History of Moll Flanders; a book entitled Religious Courtship, which has undergone upwards of 20 editions; and the Life and Adventures of Robinson Crusoe, an admirable performance of which there have been editions without number, but concerning which there is an anecdote that does the author of it no credit as to the better part of a writer's character, honesty. When Captain Woodes Rogers touched at the island of Juan Fernandez, in the South sea, he brought away Alexander Selkirk, a Scotch sailor, who had been left ashore there, and had lived on that desolate place above four years. When Selkirk came back to England, he wrote a narrative of his adventures, and put the papers into the hands of Defoe, to digest for publication; who ungenerously converted the materials into the History of Robinson Crusoe, and returned Selkirk his papers again! A fraud for which, in a humane view, the distinguished merit of that romance can never atone. Daniel Defoe died at Islington, in 1731. All his productions of the romantic

Defoe, Defoliation.

mantic species, but especially the two last mentioned, are much in vogue among country readers; and on account of their moral and religious tendency, may very probably in some measure counteract the pernicious effects produced by the too general circulation of modern novels, those occasional vehicles of impiety and infidelity.

DEFOLIATION, (from *de*, and *folium* "a leaf"); the fall of the leaves. A term opposed to *frondescentia*, the annual renovation of the leaves, produced by the unfolding of the buds in spring. See FRONDESCENTIA.

Most plants in cold and temperate climates shed their leaves every year: this happens in autumn, and is generally announced by the flowering of the common meadow saffron. The term is only applied to trees and shrubs; for herbs perish down to the roots every year, losing stem, leaves, and all.

All plants do not drop their leaves at the same time. Among large trees, the ash and walnut, although latest in unfolding, are soonest divested of them: the latter seldom carries its leaves above five months.

On the oak and hornbeam, the leaves die and wither as soon as the colds commence; but remain attached to the branches till they are pushed off by the new ones, which unfold themselves the following spring. These trees are doubtless a kind of evergreens: the leaves are probably destroyed only by cold; and perhaps would continue longer on the plant, but for the force of the spring sap, joined to the moisture.

In mild and dry seasons, the lilach, privet, yellow jessamine of the woods, and maple of Crete, preserve their leaves green until spring, and do not drop them till the new leaves are beginning to appear. The fig-tree, and many other trees that grow between the tropics, are of this particular class of evergreens. The trees in Egypt, says Doctor Hasselquist, cast their leaves in the latter end of December and beginning of January, having young leaves ready before all the old ones are fallen off; and, to forward this operation of nature, few of the trees have buds; the sycamore and willow, indeed, have some, but with few and quite loose *stipulæ* or scales. Nature did not imagine buds so necessary in the southern as in the northern countries: this occasions a great difference between them.

Lastly, some trees and shrubs preserve their leaves constantly through the whole year; and are not in the least influenced by the clemency or inclemency of seasons. Such are the firs, juniper, yew, cedar, cypress, and many other trees, hence denominated *evergreens*. These preserve their old leaves a long time after the formation of the new, and do not drop them at any determinate time. In general, the leaves of evergreens are harder, and less succulent, than those which are renewed annually. The trees are generally natives of warm climates; as the alaternuses of France and Italy, the evergreen oak of Portugal and Suabia.

Some herbaceous perennials, as the house-leeks and navel-worts, enjoy the same privilege with the evergreen trees, and resist the severities of winter: some even can dispense with the earth for some time; being replete with juices, which the leaves imbibe from the humidity of the atmosphere, and which, in such plants, are of themselves sufficient for effecting the purposes of vegetation. It is for this reason, that, unless in excessive hot weather, gardeners are seldom wont to water fat succulent plants, as the aloes, which rot when they are moistened, if the sun does not quickly dry them up.

Defoliation.

The leaves of all the evergreen shrubs and trees have a thin compact skin or cover over their surface; as is easily discovered by macerating them in water, in order to separate the parenchyma, or pulp, from the vessels of the leaves; which cannot be effected in any of these evergreens till a thin parchment-like colour is taken off. These trees and shrubs are found by experiment to perspire but little, when compared with others which shed their leaves; and it is, perhaps, principally owing to this close covering, as also to the small proportion of moisture contained in their vessels, that they retain their verdure, and continue through the winter on the trees. The nutritive juices of these plants always abound, more or less, with an oily quality, which secures them from being injured by severe frosts; so that many of these evergreen trees are adapted to grow in the coldest parts of the habitable world.

With respect to deciduous trees, the falling off of the leaves seems principally to depend on the temperature of the atmosphere, which likewise serves to hasten or retard the appearance in question. An ardent sun contributes to hasten the dropping of the leaves. Hence in hot and dry summers the leaves of the lime-tree and horse-chesnut turn yellow about the first of September; whilst in other years, the yellowness does not appear till the beginning of October. Nothing, however, contributes more to hasten the fall of the leaves than immoderate cold or moist weather in autumn; moderate droughts, on the other hand, serve to retard it. As a proof of this position, Mr Adanson relates, that in the year 1759, the leaves of the elm-tree, which generally fall off about the 25th of November, continued in verdure and vigour at Paris, where the autumn was remarkably dry, till the 10th of the following month.

The following table, respecting the mean times in which different trees shed their leaves is founded upon observation.

Gooseberry-tree and bladder-sena,	Generally quit their leaves about	October 1st.
Walnut and ash,		—— 15th.
Almond-tree, horse-chesnut, and lime-tree,		—— 20th.
Maple, hazel-nut, black poplar, and aspen-tree,		—— 25th.
Birch, plane-tree, mountain-osier, false acacia, pear, and apple-tree,		November 1st.
Vine, mulberry, fig, sumach, and angelica-tree,		—— 10th.
Elm-tree and willow,		—— 15th.
Apricot and elder-trees,		—— 20th.

It deserves to be remarked, that an evergreen tree grafted upon a deciduous, determines the latter to retain its leaves. This observation is confirmed by repeated experiments, particularly by grafting the laurel, or or cherry-bay, an evergreen, on the common cherry; and the ilex, or evergreen oak, on the oak.

DEFORCEMENT, in *Law*, the casting any one out of his land, or withholding of lands and tenements by force from the right owner.

Deforcement, in *Scots Law*, the opposing or resisting of the officers of the law in the execution of their office. See Law *Index*.

DEFORMITY, the want of that uniformity necessary to constitute the beauty of an object. See Beauty.

Deformity is either natural or moral. These are both referred by Mr Hutcheson to an internal sense; and our perceptions, of them as he supposes, arise from an original arbitrary structure of our own minds, by which certain objects, when observed, are rendered the occasions of certain sensations and affections.

That many objects give no pleasure to our sense is obvious. Many are certainly void of beauty; but then, says this author, there is no form which seems necessarily disagreeable of itself, when we dread no other evil from it, and compare it with nothing better of the kind. Many objects are naturally displeasing and distasteful to our external senses, as well as others pleasing and agreeable; as smells, tastes, and some separate sounds; but with regard to our sense of beauty, no composition of objects which give not unpleasant simple ideas, seems positively unpleasant or painful of itself, had we never observed any thing better of the same kind.

Had there been a species of the form which we now denominate *ugly* or *deformed*, and had we never seen or expected greater beauty, we should have received no disgust from it; though the pleasure would not have been so great in this form as in those we now admire. Our sense of beauty seems designed to give us positive pleasure; but not positive pain or disgust, any farther than what arises from disappointment.

There are indeed many faces which at first view are apt to raise dislike. But this is generally not from any positive deformity; but either from want of expected beauty, or from the carrying some natural indications of morally bad dispositions, which we all acquire a faculty of discerning in countenances, airs, and gestures. That this is not occasioned by any form positively disgusting, appears hence, that if, upon long acquaintance, we are sure of finding sweetness of temper, humanity, and cheerfulness, though the bodily form continues, it shall give us no disgust. There are horrors raised by some objects, which are only the effects of fear for ourselves, or compassion towards others, when either reason, or some foolish association of ideas, makes us apprehend danger; and not the effect of any thing in the form itself. For we find, that most of those objects which excite horror at first, when experience or reason has removed the fear, may become the occasion of pleasure.

The casual conjunction of ideas gives us disgust, when there is nothing disagreeable in the form itself. And this, in effect, is the cause of most of our fantastic aversions to the figures of divers animals, &c. Thus serpents of all kinds, and many insects, really beautiful enough, are beheld with aversion by many people, who have got some accidental ideas of mischief associated to them. A similar reasoning is applied to our perception of moral beauty and deformity. *Inquiry into the Original of our Ideas of Beauty and Virtue*, passim.

But it is more just to distinguish between the sentiments of delight or disgust, excited in us by beautiful or deformed objects, which are effects of some causes, and the natural and real qualities of the perceived objects by which they are produced. There are objects, says an excellent writer, which have a natural aptitude to please or offend, or between which and the contemplating mind there is a necessary congruity or incongruity; and though the actual perception of the understanding, and consequent feeling of the heart, in contemplating the actions and affections of moral agents, may exist in very different degrees, on account of the incidental obstructions arising from bodily indisposition, mental prejudices and biasses, and the association of ideas; yet, in every rational mind properly disposed, morally good actions must for ever be acceptable, and can never of themselves offend; and morally evil actions must for ever be disagreeable, and can never of themselves please. What is right in actions and characters is beautiful and amiable, and gives pleasure; what is wrong is deformed and odious, and excites disgust: right and pleasure, wrong and pain, are as distinct as cause and effect. It is no less absurd to maintain, that the perception of virtue is nothing distinct from the perception of the pleasure resulting from it, than to infer, with some metaphysicians, that solidity, extension, and figure, are only particular modes of sensation, because attended, whenever they are perceived, with some sensations of sight or touch. Thus does the author show, that moral beauty and deformity are real qualities of certain actions; in which consists their aptitude to please or disgust. With respect to natural beauty, he observes, that uniformity amidst variety pleases, because of the natures of variety and uniformity, which are such, that whenever united, they are adapted to please every unbiassed mind that discerns them. He accounts for the pleasure they afford, without referring them to an arbitary internal sense, by the following circumstances that attend them. They are more easily comprehended by the mind: order and symmetry give things their stability and strength, and subserviency to any valuable purpose; regularity and order evidence art and design. Disorder and confusion, whence deformity arises, denote only the negation of regularity and order; or any arrangement and disposition of things, which are not according to a law, rule, or plan, and prove not design. These are not positively displeasing; except where we previously expected order, or where impotence or want of skill appear, and the contriver has either failed of his design or executed it ill.

In a work entitled Fugitive Pieces, is preserved an essay on Bodily Deformity, by William Hay, Esq. who was himself what he describes, and who, while he rallies his own figure with great pleasantry, discusses the general subject in a manner equally instructive and agreeable. He considers, 1. The natural consequences of bodily deformity; 2. How it affects the outward circumstances; and, 3. What turn it gives to the mind.

1. It is certain, that the human frame, being warped and disproportioned, is lessened in strength and activity,

tivity, and rendered less fit for its functions. Scarron had invented an engine to take off his hat; "and I wish (says our author) I could invent one to buckle my shoe, or to take up a thing from the ground, which I can scarce do without kneeling, for I can bend my body no farther than it is bent by nature. For this reason, when ladies drop a fan or glove, I am not the first to take it up; and often restrain my inclination to perform those little services, rather than expose my spiderlike shape. And I hope it will not be construed as pride, if I do not always rise from my seat when I ought: for if it is low, I find some trouble in it; and my centre of gravity is so ill placed, that I am often like to fall back. Things hanging within the reach of others are out of mine; and what they can execute with ease, I want strength to perform. I am in danger of being trampled upon or stifled in a crowd, where my back is a convenient lodgment for the elbow of any tall person that is near. I can see nothing, and my whole employment is to guard my person. I have forborne to attend his majesty in the house of peers since I was like to be squeezed to death there against the wall. I would willingly come thither when his majesty commands, but he is too gracious to expect impossibilities. Besides, when I get in, I can never have the pleasure of seeing on the throne one of the best princes who ever sat on it. These, and many others, are the inconveniences continually attending a figure like mine. They may appear grievous to persons not used to them, but they grow easier by habit; and though they may a little disturb, they are not sufficient to destroy the happiness of life; of which, at an average, I have enjoyed as great a share as most men. And perhaps one proof of it may be my writing this essay; not intended as a complaint against Providence for my lot, but as an innocent amusement to myself and others.

As to what effect deformity may have on the health, it appears natural to imagine, that as the inward parts of the body must in some measure comply with the outward mould, so the form of the latter being iregular, the first cannot be so well placed and disposed to perform their functions; and that generally deformed persons would not be healthy or long lived. But this is a question best determined by facts; and in this case the instances are too few or unobserved, to draw a general conclusion from them: and health is more than is commonly thought in a man's own power, and the reward of temperance more than the effect of constitution; which makes it more difficult to pass a judgment. Æsop could not be young when he died; and might have lived longer if he had not been murdered at Delphi. The prince of Orange scarce passed the meridian of life, and the duke of Luxemburg died about the age of 67. The lord treasurer Burleigh lived to 78; but his son the earl of Salisbury, who died about 15 years after him, could not reach near that age. It is said that Mr Pope's father was deformed, and he lived to 75: whereas the son died in middle age, if he may be said to die whose works are immortal. "My father (adds our author) was not deformed, but active, and my mother a celebrated beauty; and I, that am so unlike them, have lived to a greater age, and daily see my acquaintance of a stronger frame quitting the stage before me."

But whether deformity, abstractedly considered, be really prejudicial to health, in its consequences it appears to be most commonly an advantage. Deformed persons have a less share of strength than others, and therefore should naturally be more careful to preserve it; and as temperance is the great preservative of health, it may incline them to be more temperate. Another great preservative of health is moderate exercise, which few deformed persons can want strength to perform. As a deformed person is not formed for violent exercise, he is less liable to such disorders as are the natural consequences of it. He will also escape many accidents, to which men of athletic make, and who glory in their strength, are always exposing themselves to make trial and proof of it. If he cannot carry an ox, like Milo, he will not like Milo be handcuffed in the oak by attempting to rend it. He will not be the man that shall ride from London to York in a day, or to Windsor in an hour, for a wager; or that shall be perpetually performing surprising long journeys in a surprising short time, for no earthly business but the pleasure of relating them. Conscious of his own weakness, he will be cautious of running into places or occasions of danger. Nature, too, warns deformed persons to be careful not to offer such affronts as may call them forth into the field of false honour, where they cannot acquit themselves well for want of strength and agility; and they are securer from such affronts themselves, since others will consider the little credit they will gain by compelling them to appear on that scene. On the whole, therefore, it may be concluded, that deformity is a protection to a man's health and person; which (strange as it may appear) are better defended by feebleness than strength.

2. The influence of bodily deformity on a man's fortune may next be considered. Among the lower class, he is cut off from many professions and employments. He cannot be a soldier, he is under standard; he cannot be a sailor, he wants activity to climb the rigging; he cannot be a chairman or porter, he wants strength to bear the burden. In higher life, he is ill qualified for a lawyer, he can scarce be seen over the bar: for a divine, he may drop from his hassock out of sight in his pulpit. The improvement of his mind is his proper province, and his business only such as depends on ingenuity. If he cannot be a dancing-master to adjust the heels, he may be a schoolmaster to instruct the head: he cannot be a graceful actor on the stage; but he may produce a good play: he would appear ill as a herald in a procession; but may pass as a merchant on the change: he cannot undergo the fatigue of the campaign; but he may advise the operations of it: he is designed by nature rather to sleep on Parnassus, than to descend on the plains of Eolis: he cannot be crowned at the Olympic games; but may be the Pindar to celebrate them: he can acquire no glory by the sword; but he may by the pen, and may grow famous by only relating those exploits which are beyond his power to imitate.

Lord Bacon (that extensive and penetrating genius who pointed out every part of nature for examination), in his Essay on Deformity, says, "that in their superiors it quencheth jealousy towards them, as persons that they think they may at pleasure despise; and it layeth their competitors and emulators asleep, as never

believing

believing they should be in a possibility of advancement till they see them in possession." But it is much to be doubted whether this is not more than counterbalanced by the contempt of the world, which it requires no mean parts to conquer; for if (as has been said) a good person is a letter of recommendation, deformity must be an obstruction in the way to favour. In this respect, therefore, deformed persons set out in the world to a disadvantage; and they must first surmount the prejudices of mankind before they can be upon a par with others, and must obtain by a course of behaviour that regard which is paid to beauty at first sight. When this point is once gained, the tables are turned, and then the game goes in their favour: for others, sensible of their injustice to them, no sooner find them better than they expected, than they believe them better than they are; whereas in the beautiful person they sometimes find themselves imposed upon, and are angry that they have worshipped only a painted idol. For (again take Lord Bacon's words) "neither is it almost seen, that very beautiful persons are otherwise of great virtue: they prove accomplished, but not of great spirit; and study rather behaviour than virtue. Whereas deformed persons, if they be of spirit, will free themselves from scorn, which must be either by virtue or malice; and therefore let it not be marvelled if they sometimes prove excellent persons, as was Agesilaus, Zanger the son of Solomon, Æsop, Gasca president of Peru; and Socrates may likewise go amongst them, with others." Nay, he says, "in a great wit deformity is an advantage to rising;" and in another part of his works, "that they who by accident have some inevitable and indelible mark on their persons or fortunes, as deformed people, bastards, &c. if they want not virtue, generally prove fortunate."

Osborn, in his Historical Memoirs of Queen Elizabeth, informs us, that "she chose the goodliest persons for her household servants: but in her counsellors did not put by sufficiency, though accompanied with a crooked person; as it chanced in a father and a son of the Cecils, both incomparable for prudence." It is well known the queen would make the father (Burleigh) sit in her presence; telling him that she did not use him for his legs but his head. But the son (afterwards lord treasurer and earl of Salisbury) was not so civilly treated by the populace; and is an instance, not only that envy pursues a great man, but that the highest post cannot redeem a deformed one from contempt: it attends him like his shadow, and like that too is ever reminding him of his ill figure, which is often objected for want of real crimes. For the same writer says of the same great man, "that the misfortunes accompanying him from his birth, did not a little add to that cloud of detraction that fell upon all that he said or did; a mulct in nature, like an optic spectacle, multiplying much in the sight of the people the apparitions of ill." Nor was this contempt buried with him: it trampled on his ashes, and insulted his grave; as appears by an epitaph, which Osborn cites, as void of wit as it is full of scurrility; in one line of which there is an epithet, not so elegant as descriptive of his person, viz. "Little Bossive Robin that was so great."

Such contempt in general, joined with the ridicule of the vulgar, is another certain consequence of bodily deformity; for men naturally despise what appears less beautiful or useful, and their pride is gratified when they see such foils to their own persons. It is this sense of superiority which is testified by laughter in the lower sort; while their betters, who know how little any man whatsoever hath to boast of, are restrained by good sense and good breeding from such an insult. But it is not easy to say why one species of deformity should be more ridiculous than another, or why the mob should be more merry with a crooked man, than with one that is deaf, lame, squinting, or purblind. It is a back in alto relievo that bears all the ridicule; though one would think a prominent belly a more reasonable object of it, since the last is generally the effect of intemperance, and of a man's own creation. Socrates was ugly, but not contemned; and Philopœmen (A) of very mean appearance, and though contemned on that account not ridiculed: for Montaigne says, "Ill features are but a superficial ugliness, and of little certainty in the opinion of men; but a deformity of limbs is more substantial, and strikes deeper in." As it is more uncommon, it is more remarkable; and that perhaps is the true reason why it is more ridiculed by the vulgar.

5. The last consideration on this subject relates to those passions and affectations which most naturally result from deformity. Lord Bacon observes, that "deformed persons are commonly even with nature; for as nature hath done ill by them, so do they by nature, being for the most part (as the scripture saith) *void of natural affection*." But (says Mr Hay) "I can neither find out this passage in scripture, nor the reason of it; nor can I give my assent or negative to a proposition, till I am well acquainted with the terms of it. If by natural affection is here meant universal benevolence, and deformity necessarily implies a want of it, a deformed person must then be a complete monster. But however common the case may be, my own sensations inform me that it is not universally true. If by natural affection is meant a partial regard for individuals, I believe the remark is judicious, and founded in human nature. Deformed persons are despised, ridiculed, and ill-treated by others; are seldom favourites, and commonly most neglected by parents, guardians, and relations; and therefore, as they are not indebted for much fondness, it is no wonder if they repay but little. It is the command of scripture, *Not to set our affections on things below*; and it is the voice of reason not to overvalue what we must soon part with; therefore, to be so fond of others as not to be able to bear their absence, or to survive them, is neither a religious nor moral duty, but a childish and womanish weakness; and I must congratulate deformed persons, who, by example,

---

(A) Coming to an inn, where he was expected, before his attendants, the mistress of the house seeing a plain person of very mean aspect, ordered him to assist in getting things ready for Philopœmen. His attendants finding him so employed, he told them he was then paying the tribute of his ugliness. *Plutarch.*

ample, are early taught another lesson. And I will now lay open my own heart to the reader, that he may judge if Lord Bacon's position is verified in me.

"I hope it proceeds not from a malignity of heart; but I never am much affected with the common accidents of life, whether they befal myself or others. I am little moved when I hear of death, loss, or misfortune; I think the case is common.

> *Tritus, et è medio fortunæ ductus acervo;*
> Juv. Sat. xiii.

And as it is always likely to happen, I am not surprised when it does. If I see a person cry or beat his breast on any such occasion, I cannot bear him company; but am not a Democritus to laugh at his folly. I read of battles and fields covered with slain; of cities destroyed by sword, famine, pestilence, and earthquake; I do not shed a tear: I suppose it is because they are the usual storms, to which the human species are exposed, proceeding from the just judgments of God, or the mistaken and false principles of rulers. I read of persecutions, tortures, murders, massacres; my compassion for the sufferers is great, but my tears are stopped by resentment and indignation against the contrivers and perpetrators of such horrid actions. But there are many things that bring tears into my eyes whether I will or no; and when I reflect, I am often at a loss in searching out the secret source from whence they flow. What makes me weep (for weep I do) when I read of virtue or innocence in distress; of a good man helpless and forsaken, unmoved by the greatest insults and cruelties, or courageously supporting himself against oppression in the article of death? I suppose it is to see vice triumphant, and virtue so ill rewarded in this life. May I judge by myself, I should imagine that few sincere Christians could read the sufferings of their Saviour, or Englishmen those of a Cranmer, Ridley, or Latimer, without tears; the first dying to establish his religion, the last to rescue it from corruption. When I read of Regulus returning to torment, and John of France to imprisonment, against the persuasion of friends, to keep faith with their enemies, I weep to think there is scarce another instance of such exalted virtue. Those who often hear me read, know that my voice changes, and my eyes are full, when I meet with a generous and heroic saying, action, or character, especially of persons whose example or command may influence mankind. I weep when I hear a Titus say, that he had lost the day in which he did no good; when Adrian tells his enemy, that he had escaped by his being emperor; or Louis XII. that he is not to revenge the affront of the duke of Orleans. These are the first instances that happen to occur to me: I might recollect many, too many to insert in this essay; yet all are but few, compared to instances of cruelty and revenge: perhaps I am concerned that they are so rare; perhaps too I inwardly grieve that I am not in a situation to do the like. I am entertained, but not moved, when I read Voltaire's History of Charles XII. but I melt into tears on reading Hanway's character of his antagonist Peter the Great. The first is a story of a madman; the other of a father, friend, and benefactor of his people; whose character (as the author observes in the conclusion of it) will command the admiration of all succeeding generations; and I suppose I lament, that God is pleased to advance to royalty so few such instruments of good to mankind.

Again: "I am uneasy when I see a dog, a horse, or any other animal, ill treated: for I consider them as endued with quick sense, and no contemptible share of reason; and that God gave man dominion over them, not to play the tyrant, but to be a good prince, and promote the happiness of his subjects. But I am much more uneasy at any cruelty to my own species; and heartily wish Procrustes disciplined in his own bed, and Phalaris in his bull. A man bruized all over in a boxing match, or cut to pieces in fighting a prize, is a shocking spectacle; and I think I could with less horror see a thousand fall in battle, than human nature thus depreciated and disgraced. Violence, when exerted in wantonness or passion, is brutality; and can be termed bravery only when it is sanctioned by justice and necessity.

"I have been in a situation to see not a little of the pomp and vanity, as well as of the necessity and misery, of mankind: but the last only affect me; and if, as a magistrate, I am ever guilty of partiality, it is in favour of the poor. When I am at church among my poor but honest neighbours in the country, and see them serious in performing the ceremonies prescribed, tears sometimes steal down my cheek, on reflecting, that they are doing and hearing many things they do not understand, while those who understand them better neglect them; that they, who labour and live hard, are more thankful to heaven than those who fare luxuriously on the fruits of their labour; and are keeping and repeating the fourth commandment at the very instant the others are breaking it.

"These are some of the sensations I feel; which I have freely and fairly disclosed, that the reader may judge how far I am an instance of a deformed person wanting natural affection. And I am a good subject of speculation; because all in me is nature: for to own the truth, I have taken but little pains (though I ought to have taken a great deal) to correct my natural defects.

"Lord Bacon's next position is, 'That deformed persons are extremely bold: first in their own defence, as being exposed to scorn; but in process of time by a general habit.' This probably is so among the inferior sort, who are in the way of continual insults; for a return of abuse is a natural weapon of self-defence, and in some measure justified by the law of retaliation: To upbraid a man with a personal defect, which he cannot help, is also an immoral act; and he who does it, has reason to expect no better quarter than to hear of faults, which it was in his own power not to commit. But I find this observation far from being verified in myself: an unbecoming bashfulness has been the consequence of my ill figure, and of the worse management of me in my childhood. I am always uneasy when any one looks stedfastly on so bad a picture; and cannot look with a proper confidence in the face of another. I have ever reproached myself with this weakness, but am not able to correct it. And it may be a disadvantage to a man in the opinion of those he converses with; for though true modesty is amiable, the false is liable to misconstruction: and when a man is out of countenance for no reason, it may be imagined that he has some bad reason for being so. In point of assurance, I am indeed a perfect riddle to myself; for I, who feel a reluctance in crossing a drawing-room, or in opening my mouth in private company before persons with whom I am not well acquainted, find little in delivering my sentiments in public, and exposing my discourse, often as trifling as my person, to the ears of a thousand. From what cause this proceeds, I know not: it may be partly from hopes of wiping off any ill impression from my person by my discourse, partly from a sense of doing my duty, and partly from a security in public assemblies from any gross personal reflection.

"Lord Bacon compares the case of deformed persons to that of eunuchs; 'in whom kings were wont to put great trust as good spies and whisperers; for they that are envious towards all, are more obsequious and officious towards one.' But, with submission to so good a judge of human nature, I own I can discover no uncommon qualification in them for spies; and very few motives to envy peculiar to themselves. Spies submit to that base and ungenerous office, either for the sake of interest or power: if for interest, it is to gratify their covetousness; if for power, their ambition or revenge; which passions are not confined to the eunuch or deformed, but indiscriminately seize all classes of men. Envy too may prompt a man to mean actions, in order to bring down the person envied to his own level; but if it is on account of superiority of fortune it will operate alike on men of all shapes. Eunuchs have but one peculiar motive to envy: but that (as Lord Bacon expresses it) makes them envious towards all; because it is for a pleasure which all but themselves may enjoy. Deformed persons are deprived only of beauty and strength, and therefore those alone are to be deemed the extraordinary motives to their envy; for they can no more be beautiful or strong than eunuchs be successful lovers. As to myself, whatever sparks of envy might be in my constitution, they are now entirely extinguished; for, by frequent and serious reflections, I have long been convinced of the small value of most things which men value the most.

"There is another passion to which deformed persons seem to be more exposed than to envy; which is jealousy: for being conscious that they are less amiable than others, they may naturally suspect that they are less beloved. I have the happiness to speak this from conjecture, and not from experience; for it was my lot, many years ago, to marry a young lady, very piously educated, and of a very distinguished family, and whose virtues are an honour to her family and her sex: so that I had never any trial of my temper, and can only guess at it by emotions I have felt in my younger days; when ladies have been more liberal of their smiles to those whom I thought, in every respect but person, my inferiors."

The most useful inference from all this to a deformed person is, to be upon his guard against those frailties to which he is more particularly exposed; and to be careful, that the outward frame do not distort the soul. *Orandum est* (says Juvenal), *ut sit mens sana in corpore sano*, "Let us pray for a sound mind in a healthy body:" and every deformed person should add this petition, *ut sit mens recta in corpore curvo*, for "an upright mind in a crooked one." And let him frequently apply to himself this article of self-examination, *Lenior et melior fis, accedente senecta?* "As age approaches, do your temper and morals improve?" It is a duty peculiarly incumbent; for if beauty adds grace to virtue itself, vice must be doubly hideous in deformity.

Ridicule and contempt are a certain consequence of deformity; and therefore what a person cannot avoid, he should learn not to regard. He should bear it like a man; forgive it as a Christian; and consider it as a philosopher. And his triumph will be complete, if he can exceed others in pleasantry on himself. Wit will give over when it sees itself outdone: and so will malice when it finds it has no effect: and if a man's behaviour afford no cause of contempt, it will fall upon those who condemn him without cause.

Instead of repining, therefore, a deformed person ought to be thankful to Providence for giving him such a guard to his virtue and repose. Thousands are daily ruined by a handsome person; for beauty is a flower that every one wants to gather in its bloom, and spares no pains or stratagem to reach it. All the poetical stories concerning it have their moral. A Helen occasions war and confusion; the Hyacinths and Ganymedes are seized on for catamites; the Endymions and Adonises for gallants; Narcissus can admire nobody but himself, and grows old before he is cured of that passion. Who is a stranger to the story of Lucretia killing herself for her violated chastity? or of Virginia killed by her father to preserve it? In those circumstances says Juvenal, she might wish to change persons with Rutila, the only lady we know among the ancients celebrated for a hump-back. The handsomest men are chosen for eunuchs and gallants; and when they are catched in exercising the last function, both (B) Horace and Juvenal inform you of the penalties and indignities they undergo. Silius (C) was converted by the insatiable Messalina into a husband; and Sporus, by the monster Nero, into a wife. The last-mentioned poet shows that praying for beauty is praying for a curse; and (D) Persius refuses to join in such a prayer: and has not the deformed person reason to thank his stars, which have placed him more

---

(B) Hic se præcipitem tecto dedit: ille flagellis
Ad mortem cæsus: fugiens hic decidit acrem
Prædonum in turbam: dedit hic pro corpore nummos:
Hunc perminxerunt calones: quin etiam illud
Accidit, ut cuidam testes caudamque salacem
Demeteret ferrum.———— *Hor.* Sat. ii. lib. i.
——Quosdam mœchos et mugilis intrat. *Juv.* ib.

(C) ——Optimus hic et formosissimus idem
Gentis Patriciæ rapitur miser extinguendus
Messalinæ oculis.———— *Juv.* Sat. x.

(D) Hunc optent generum Rex et Regina: puellæ
Hunc rapiant: quicquid calcaverit hic, rosa fiat:
Ast ego nutrici non mando vota; negato.
Jupiter hæc illi———— *Pers.* Sat. ii.

more out of danger than even virtue could? for that could not guard a Joseph, an (E) Hippolytus, a Bellerophon, and others, against the revenge of slighted love.

Another great advantage of deformity is, that it tends to the improvement of the mind. A man that cannot shine in his person, will have recourse to his understanding; and attempt to adorn that part of him, which alone is capable of ornament. When his ambition prompts him to begin, with Cowley, to ask himself this question,

> What shall I do to be for ever known,
> And make the age to come my own?—

on looking about him, he will find many avenues to the temple of fame barred against him; but some are still open through that of virtue; and those, if he has a right ambition, he will most probably attempt to pass. The more a man is inactive in his person, the more his mind will be at work; and the time which others spend in action, he will pass in study and contemplation: by these he may acquire wisdom; and by wisdom, fame. The name of Socrates is as much sounded as those of Alexander and Cæsar; and is recorded in much fairer characters. He gained renown by wisdom and goodness; they by tyranny and oppression; he by instructing, they by destroying, mankind: and happy it is, that their evil deeds were confined to their lives; while he continues to instruct us to this day. A deformed person will naturally consider where his strength and his foible lie: and as he is well acquainted with the last, he will easily find out the first; and must know, that (if it is anywhere) it is not like Samson's, in the hair; but must be in the lining of the head. He will say to himself, "I am weak in person; unable to serve my country in the field, I can acquire no military glory; but I may, like Socrates, acquire reputation by wisdom and probity: let me therefore be wise and honest. My figure is very bad; and I should appear but ill as an orator either in the pulpit or at the bar: let me therefore pass my time in my study, either in reading what may improve myself, or in writing what may entertain or instruct others. I have not the strength of Hercules, nor can I rid the world of so many monsters: but perhaps I may get rid of some that infest myself. If I cannot draw out Cacus from his den, I may pluck the villain from my own breast. I cannot cleanse the stable of Augeas: but I may cleanse my own heart from filth and impurity: I may demolish the hydra of vices within me; and should be careful too, that while I lop off one, I do not suffer more to grow up in its stead. Let me be serviceable in any way that I can: and if I am so, it may, in some measure, be owing to my deformity; which at least should be a restraint on my conduct, lest my conduct make me more deformed."

Few persons have a house entirely to their mind; or the apartments in it disposed as they could wish. And there is no deformed person, who does not wish that his soul had a better habitation; which is sometimes not lodged according to its quality. Lord Clarendon says of Sir Charles Cavendish (brother to the marquis of Newcastle), that he was a man of the noblest and largest mind, though of the least and most inconvenient body that lived. And every body knows, that the late prince of Orange had many amiable qualities. Therefore, in justice to such persons, we must suppose that they did not repine that their tenements were not in a more regular style of architecture. And let every deformed person comfort himself with reflecting, that though his soul hath not the most convenient and beautiful apartment, yet that it is habitable; that the accommodation will serve as an inn upon the road; that he is but tenant for life, or (more properly) at will; and that, while he remains in it, he is in a state to be envied by the deaf, the dumb, the lame, and the blind.

DEFOSSION (*Defossio*), the punishment of burying alive, inflicted among the Romans on vestal virgins guilty of incontinency. It is also a custom among the Hungarians to inflict this punishment on women convicted of adultery. Heretics were also punished in this manner. See *Burying-Alive*.

DEGENERATION, or Degenerating, in general, denotes the growing worse, or losing some valuable qualities whereof a thing was formerly possessed. Some naturalists have been of opinion, that things are capable of degenerating into quite a distinct species; but this is a mere chimera. All that happens in the degeneration of a plant, for instance, is the losing its usual beauty, colour, smell, &c. a circumstance entirely owing to its being planted in an improper soil, climate, &c.

DEGLUTITION, the action of swallowing. See Anatomy *Index*.

DEGRADATION, in our law-books called *disgradation* and *deposition*, the act of depriving or stripping a person for ever of a dignity or degree of honour, and taking away the title, badge, and privileges thereof.

The degradation of a peer, a priest, a knight, a gentleman, an officer, &c. are performed with divers ceremonies. That which anciently obtained in degrading a person from his nobility is very curious. It was practised in the time of Francis I. upon Captain Fangel, who had in a cowardly manner given up Fontarabia, whereof he was governor. On this occasion, 20 or 30 cavaliers, without blemish or reproach, were assembled; before whom the gentleman was accused of treason and breach of faith by a king-at-arms. Two scaffolds were erected; the one for the judges, heralds, and pursuivants; and the other for the guilty cavalier, who was armed at all points, and his shield placed on a stake before him, reversed with the point upwards. On one side assisted 12 priests in surplices, who sung the vigils of the dead. At the close of each psalm they made a pause, during which the officers of arms

---

(E) ———— Quid profuit olim
Hippolyto grave propositum? Quid Bellerophonti
Erubuit nempe hæc, seu fastidia repulsa:
Nec Sthenobœa minus quam Cressa excanduit, et se
Concussere ambæ.———— *Juv.* Sat. x.

arms stripped the condemned of some piece of his armour, beginning with the helmet, and proceeding thus till he was quite disarmed; which done, they broke his shield in three pieces with a hammer. Then the king-at-arms emptied a bason of hot water on the criminal's head; and the judges, putting on mourning habits, went to the church. This done, the degraded was drawn from off the scaffold with a rope tied under his arm-pits, laid on a bier, and covered with mortuary clothes; the priest singing some of the prayers for the dead; and then he was delivered to the civil judge and the executioner of justice.

For a more domestic instance: Sir Andrew Harcla, earl of Carlisle, being attainted and convicted of treason, 18 Edw. II. *coram rege;* after judgment was pronounced on him, his sword was broken over his head, and his spurs hewn off his heels; Sir Anthony Lucy the judge, saying to him, "Andrew, now thou art no knight but a knave." By stat. 13 Car. II. William Lord Monson, Sir Henry Mildmay, and others, were degraded from all titles of honour, dignities, and preeminences, and prohibited to bear or use the title of lord, knight, esquire, or gentleman, or any coat of arms, for ever afterwards. It has been maintained that the king may degrade a peer; but it appears from late authorities, that he cannot be degraded but by act of parliament.

As to ecclesiastics, we have an instance of degradation before condemnation to death, in the eighth century, at Constantinople. It is in the person of the patriarch Constantine, whom Constantine Copronymus caused to be executed. He was made to ascend the ambo; and the patriarch Nicetas sent some of his bishops to strip him of the pallium, and anathematized him: then they made him go out of the church backwards.

But we have a much later instance in our own history: When Cranmer, archbishop of Canterbury, was degraded by order of Queen Mary, they dressed him in episcopal robes, made only of canvas, put the mitre on his head, and the pastoral staff in his hand; and in this attire showed him to the people. Which done, they stripped him again piece by piece. At present they do not stand so much on the ceremony of degradation in order to the putting a priest to death; by reason of the delays and difficulties that it would occasion. Pope Boniface pronounced that six bishops were required to degrade a priest; but the difficulty of assembling so many bishops rendered the punishment frequently impracticable. In England, a priest, after having been delivered to his ordinary, if he cannot purge himself of the crime with which he is charged, his gown and other robes are stripped over his ears by the common hangman; by which he is declared divested of his orders.

It is decided, however, that degradation does not efface the priestly character. Degradation only seems to differ from deposition in a few ignominious ceremonies which custom has added thereto. Accordingly, in the business of Arnoul archbishop of Rheims, sentenced in the council of Orleans in 991, it was deliberated what form they should follow in the deposition; whether that of the canons, that is, simple deposition; or that of custom, viz. degradation. And it was declared, that he should surrender the ring, pastoral staff, and pallium, but that his robes should not be torn off. In effect, the canons prescribe no more than a mere reading of the sentence. It is the rest, therefore, added thereto by custom, viz. the stripping off the ornaments, and the tearing the pontifical vestments, that properly constitute degradation.

Degradation, in *Painting*, expresses the lessening the appearance of distant objects in a landscape, in the same manner as they would appear to an eye placed at that distance from them.

DEGREE, in *Geometry*, a division of a circle, including a three hundred and sixtieth part of its circumference.

Degree of Latitude. See Latitude.

Degree of Longitude. See Longitude.

A degree of the meridian on the surface of the globe is variously determined by various observers. Mr Picart measured a degree in the latitude of 49° 21′, and found it equal to 57,060 French toises. But the French mathematicians, who have lately examined Mr Picart's operations, assure us, that the degree in that latitude is 57,183 toises. Our countryman, Mr Norwood, measured the distance between London and York, and found it 905,751 English feet; and finding the difference of latitudes 2° 28′, determined the quantity of one degree to be 367,196 English feet, or 69 English miles and 288 yards. Mr Maupertuis measured a degree in Lapland, in the latitude of 66° 20′, and found it 57,438 toises. A degree was likewise measured at the equator by other French mathematicians, and found to contain 56,767.8 toises. Whence it appears, that the earth is not a sphere, but an oblate spheroid.

Degree, in the civil and canon law, denotes an interval in kinship, by which proximity and remoteness of blood are computed. See Consanguinity and Descent.

Degrees, in *Music*, are the little intervals whereof the concords or harmonical intervals are composed.

Degree, in universities, denotes a quality conferred on the students or members thereof, as a testimony of their proficiency in the arts or sciences, and entitling them to certain privileges.

DEJANIRA, in fabulous history, daughter of Oeneus king of Ætolia, and wife to Hercules. The centaur Nessus endeavouring to ravish her, was slain by Hercules with a poisoned arrow. Nessus, when dying, gave his bloody shirt to Dejanira; assuring her, that it was a sovereign remedy to cure her husband if ever he proved unfaithful. Some time after Dejanira thinking she had reason to suspect his fidelity, sent him the shirt; which he had no sooner put on, than he was seized with the most excruciating torments. Being unable to support his pains, he retired to Mount Oeta, and erecting a pile of wood, set fire to it, and threw himself into he flames; upon which Dejanira killed herself in despair.

DEJECTION, in *Medicine*, the act of voiding the excrements by the anus. See Anatomy, N° 93.

Dejection, in *Astrology*, is applied to the planets when in their detriment, as astrologers speak, i. e. when they have lost their force or influence, as is pretended, by reason of their being in opposition to some others which check and counteract them. Or it is used when a planet is in a sign opposite to that in which it has its greatest effect or influence which is called

its

its *exaltation.* Thus, the sign Aries being the exaltation of the sun, the opposite sign Libra is its dejection.

DEIFICATION, in antiquity. See APOTHEOSIS.

DEIPHON, in fabulous history, a brother of Triptolemus, son of Celeus and Metanira. When Ceres travelled over the world, she stopped at his father's court, and undertook to nurse him and bring him up. To reward the hospitality of Celeus, the goddess began to make his son immortal, and every evening she placed him on burning coals to purify him from whatever mortal particles he still possessed. The uncommon growth of Deiphon astonished Metanira, who wished to see what Ceres did to make him so vigorous. She was frightened to see her son on burning coals; and the shrieks that she uttered disturbed the mysterious operations of the goddess, and Deiphon perished in the flames.

DEISCAL, in the ancient British customs, the name of a ceremony originally used in the druidical worship, and retained in many places down to a very late period, as a civil ceremony towards persons of particular distinction. The temples of the ancient Britons were all circular; and the druids, in performing the public offices of their religion, never neglected to make three turns round the altar, accompanied by all the worshippers. This practice was so habitual to the ancient Britons, that it continued in some places many ages after the druids and their religion were both destroyed. In the Scottish isles, the vulgar never come to the ancient sacrificing and fire-hallowing cairns, but they walk three times round them, from east to west, according to the course of the sun. This sanctified tour, or round by the south, is called *deiscal*, from *deas* or *dess*, "the right hand," and *soil* or *sul*, "the sun;" the right hand being ever next the heap or cairn. In the same isles it is the custom and fashion of the people to testify their respect for their chieftains, the proprietors of their several isles, and other persons of distinction, by performing the deiscal round them in the same manner. A gentleman giving an account of his reception in one of the Western islands, of which he was proprietor, describes the ceremony of the deiscal in this manner: "One of the natives would needs express his high esteem for my person, by making a turn round about me, sun-ways, and at the same time blessing me, and wishing me all happiness. But I bid him let alone that piece of homage, telling him I was sensible of his good meaning towards me. But this poor man was very much disappointed, as were also his neighbours; for they doubted not but this ancient ceremony would have been very acceptable to me; and one of them told me, that this was a thing due to my character from them, as to their chief and patron; and that they could not, and would not, fail to perform it."

DEISM, the doctrine or belief of the deists. Deism, from Θεος *God*, may properly be used to denote natural religion, as comprehending those truths which have a real foundation in reason and nature; and in this sense it is so far from being opposite to Christianity, that it is one great design of the gospel to illustrate and enforce it. Thus some of the deistical writers have affected to use it. But deism more precisely signifies that system of religion, relating both to doctrine and practice, which every man is to discover for himself by the mere force of natural reason, independent of all revelation, and exclusive of it; and this religion Dr Tindal and others pretend is so perfect, as to be incapable of receiving any addition or improvement even from divine revelation.

DEISTS, a class of people known also under the denomination of *Free-thinkers*, whose distinguishing character it is, not to profess any particular form or system of religion; but only to acknowledge the existence of a god, and to follow the light and law of nature, rejecting revelation, and opposing Christianity.

This name seems to have been first assumed as the denomination of a party about the middle of the 16th century, by some gentlemen in France and Italy, who were desirous of thus disguising their opposition to Christianity by a more honourable appellation than that of atheists. Virot, an eminent reformer, mentions certain persons, in his epistle dedicatory prefixed to the second tome of his *Instruction Chretienne*, published in 1563, who called themselves by a new name, that of *Deists.* These, he tells us, professed to believe in God, but showed no regard to Jesus Christ, and considered the doctrine of the apostles and evangelists as fables and dreams. He adds, that they laughed at all religion, though they outwardly conformed to the religion of those with whom they lived, or whom they wished to please, or feared to offend. Some, he observes, professed to believe the immortality of the soul; others denied both this doctrine and that of providence. Many of them were considered as persons of acute and subtile genius, and took pains in disseminating their notions.

The deists hold, that, considering the multiplicity of religions, the numerous pretences to revelation, and the precarious arguments generally advanced in proof thereof, the best and surest way is to return to the simplicity of nature and the belief of one God; which is the only truth agreed to by all nations. They complain, that the freedom of thinking and reasoning is oppressed under the yoke of religion; and that the minds of men are ridden and tyrannized by the necessity imposed on them of believing inconceivable mysteries; and contend that nothing should be required to be assented to or believed but what their reason clearly conceives.

The distinguishing character of modern deists is, that they reject all revealed religion, and discard all pretences to it as the effects of imposture or enthusiasm. They profess a regard for natural religion, though they are far from being agreed in their notions concerning it. They are classed by some of their own writers into mortal and immortal deists: the latter acknowledging a future state; and the former denying it, or representing it as very uncertain.

Dr Clarke distinguishes four sorts of deists. 1. Those who pretend to believe the existence of an eternal, infinite, independent, intelligible Being, who made the world, without concerning himself in the government of it. 2. Those who believe the being and natural providence of God, but deny the difference of actions, as morally good or evil, resolving it into the arbitrary constitution of human laws; and therefore they suppose that God takes no notice of them. With respect to both these classes, he observes that their opinions can consistently terminate in nothing but downright atheism.

atheism. 3. Those who have right apprehensions concerning the nature, attributes, and all-governing providence of God, seem also to have some notion of his moral perfections; though they consider them as transcendent, and such in nature and degree, that we can form no true judgment, nor argue with any certainty concerning them: but they deny the immortality of human souls; alleging that men perish at death, and that the present life is the whole of human existence. 4. Those who believe the existence, perfections, and providence of God, the obligation of natural religion, and a state of future retribution, on the evidence of the light of nature, without a divine revelation: such as these, he says, are the only true deists; but their principles, he apprehends, should lead them to embrace Christianity; and therefore he concludes that there is now no consistent scheme of deism in the world.

The first deistical writer of any note that appeared in this country was Herbert, baron of Cherbury. He lived and wrote in the 17th century. His book *De Veritate* was first published at Paris in 1624. This, together with his book *De Causis Errorum*, and his treatise *De Religione Laici*, were afterwards published in London. His celebrated work *De Religione Gentilium* was published at Amsterdam in 1663 in 4to, and in 1700 in 8vo, and an English translation of it was published at London in 1705. As he was one of the first that formed deism into a system, and asserted the sufficiency, universality, and absolute perfection of natural religion, with a view to discard all extraordinary revelation as useless and needless, we shall subjoin the five fundamental articles of this universal religion.—They are these: 1. That there is one supreme God. 2. That he is chiefly to be worshipped. 3. That piety and virtue are the principal part of his worship. 4. That we must repent of our sins; and if we do so, God will pardon them. 5. That there are rewards for good men, and punishments for bad men, both here and hereafter. Our own age has produced a number of advocates in the same cause; and however they may have differed among themselves, they have been agreed in their attempts of invalidating the evidence and authority of divine revelation. We might mention Hobbes, Blount, Toland, Collins, Woolston, Tindal, Morgan, Chubb, Lord Bolingbroke, Hume, &c. Some have also added Lord Shaftesbury to the number.

But the friends of Christianity have no reason to regret the free and unreserved discussion which their religion has undergone. Objections have been stated and urged in their full force, and as fully answered; argument and raillery have been repelled; and the controversy between Christians and deists has called forth a great number of excellent writers, who have illustrated both the doctrines and evidence of Christianity in a manner that will ever reflect honour on their names, and be of lasting service to the cause of genuine religion and the best interests of mankind.

DEITY, *Godhead;* a common appellation given to God; and also by the poets to the heathen gods and goddesses.

DELAWARE, a state of North America, situated on a river of the same name.

The Dutch, under the pretended purchase made by Henry Hudson, took possession of the lands on both sides the river Delaware; and as early as the year 1623 built a fort at the place, which has since been called *Gloucester.* In 1627, by the influence of William Useling, a respectable merchant in Sweden, a colony of Swedes and Finns came over, furnished with all the necessaries for beginning a new settlement, and landed at Cape Henlopen; at which time the Dutch had wholly quitted the country. The Dutch, however, returned in 1630, and built a fort at Lewistown, by them named *Hoarkill.* The following year the Swedes built a fort near Wilmington, which they called *Christein* or *Christiana.* Here also they laid out a small town, which was afterwards demolished by the Dutch. The same year they erected a fort higher up the river, upon Tenecum island, which they called *New Gottenburgh:* they also about the same time built forts at Chester, Elsinburgh, and other places. John Prinz then governed the Swedes, who, in 1654, deputed his son-in-law, John Papgoia, and returned to Sweden. Papgoia soon followed his father-in-law to his native country, and John Rysing succeeded to the government. In 1655, the Dutch, under the command of Peter Stuyvesant, arrived in Delaware river, from New Amsterdam (New York), in seven vessels, with 6 or 700 men. They dispossessed the Swedes of their forts on the river, and carried the officers and principal inhabitants prisoners to New Amsterdam, and from thence to Holland. The common people submitted to the conquerors, and remained in the country. On the first of October 1664, Sir Robert Carr obtained the submission of the Swedes on Delaware river. Four years after, Col. Nicolls, governor of New York, with his council, on the 21st of April, appointed a scout and five other persons to assist Capt. Carr in the government of the country. In 1672, the town of Newcastle was incorporated by the government of New York, to be governed by a bailiff and six assistants; after the first year, the four oldest were to leave their office, and four others to be chosen. The bailiff was president, with a double vote; the constable was chosen by the bench. They had power to try causes not exceeding 10l. without appeal. The office of scout was converted into that of sheriff, who had jurisdiction in the corporation and along the river, and was annually chosen. They were to have a free trade, without being obliged to make entry at New York, as had formerly been the practice. Wampum was at this time the principal currency of the country. Governor Lovelace of New York, by proclamation, ordered that four white grains and three black ones should pass for the value of a stiver or penny. This proclamation was published at Albany, Esopus, Delaware, Long-island, and the parts adjacent. In 1674 Charles II. by a second patent, dated June 29th, granted to his brother duke of York all that country called by the Dutch *New Netherlands,* of which the three counties of Newcastle, Kent, and Sussex, were a part. In 1683, the duke of York, by deed dated Aug. 24th, sold to William Penn the town of Newcastle, with the district of 12 miles round the same; and by another deed of the same date, granted to him the remainder of the territory, which till the revolution was called the *Three Lower Counties.* These three counties were considered as a part of Pennsylvania in matters of government.

vernment. The same governor presided over both: but the assembly and courts of judicature were different; different as to their constituent members, but in form nearly the same. At the late revolution they became a distinct territory, called

The *Delaware State.* This state is bounded on the north by Pennsylvania; on the east by Delaware river and bay; on the south, by a due east and west line, from Cape Henlopen, in lat. 38. 30. to the middle of the peninsula; and on the west by Maryland. It is the smallest state in the Union except Rhode, its area being only 2200 square miles. The land is generally low and flat, which occasions the waters to stagnate, and subjects the inhabitants to intermittent fevers.

The Delaware state is divided into three counties, viz. Newcastle, Kent, Sussex: the chief towns of which are, Wilmington and Newcastle, Dover, Milford, and Lewiston. The population of the whole state in 1810 was 72,674, including 4177 slaves. The number of free blacks was 13,136.

Three rivers, the Choptank, Nanticok, and Pokomoke, having their sources in this state, and are navigable for vessels of 50 or 60 tons, 20 or 30 miles into the country. They all run a westerly course into Chesapeak bay. The fourth part of the state is a low flat country, and a considerable portion of it lies in forest. What is under cultivation is chiefly barren, except in Indian corn, of which it produces fine crops. In some places rye and flax may be raised, but wheat is a foreigner in these parts. Where nature is deficient in one resource, she is generally bountiful in another. This is verified in the tall thick forests of pines which are manufactured into boards, and exported in large quantities into every sea-port in the three adjoining states. As you proceed north, the soil is more fertile, and produces wheat in large quantities, which is the staple commodity of the state. They raise all the other kinds of grain common to Pennsylvania. The state has no mountain in it, except Thunder Hill, in the western part of Newcastle county, and is generally level, except some small parts, which are stony and uneven. The trade of this state is carried on almost entirely in the chief town, Wilmington, which had 9591 tons of shipping in 1815, and contained about 5000 inhabitants. The articles exported are principally wheat, corn, and lumber.

No preference is given by law to any mode of worship. In 1814 the Presbyterians had 24 churches; the Episcopalians 14; the Quakers 8; the Baptists 7; the Methodists several. A considerable fund is appropriated by the state for the support of schools. The expence of instruction varies from 10 to 32 dollars per annum.

The value of lands and houses in this state in 1799, was 6,233,413 dollars, and in 1814 it was 13,449,370 dollars. The value of manufactures in this state in 1810 was 970,701 dollars; and the exports in 1817 amounted to 44,854 dollars. The state taxes in 1811 were stated to be 72,163 dollars.

Under the present constitution, the legislature is divided into two distinct branches, which together are styled *The General Assembly of Delaware.* One branch, called the *House of Assembly*, consists of seven representatives from each of the three counties, chosen annually by the freeholders. The other branch, called the *Council*, consists of nine members, three for a county, who must be more than 25 years of age, chosen likewise by the freeholders. A rotation of members is established by displacing one member for a county at the end of every year. All money bills must originate in the house of assembly, but they may be altered, amended, or rejected by the legislative council. A president or chief magistrate is chosen by the joint ballot of both houses, and continues in office three years; at the expiration of which period, he is ineligible the three succeeding years. If this office becomes vacant during the recess of the legislature, or he is unable to attend to business, the speaker of the legislative council is vice-president for the time; and in his absence the powers of the president devolve upon the speaker of the assembly. A privy council, consisting of four members, two from each house, chosen by ballot, is constituted to assist the chief magistrate in the administration of the government. The three justices of the supreme court, a judge of admiralty, and four justices of the common pleas and orphans courts, are appointed by the joint ballot of the president and general assembly, and commissioned by the president to hold their offices during good behaviour. The president and privy council appoint the secretary, the attorney-general, registers for the produce of wills, registers in chancery, clerks of the common pleas and orphans courts, and the clerks of the peace, who hold their offices during five years, unless sooner removed for mal-conduct. The house of assembly name 24 persons in each county for justices of peace, from which number the president, with the advice of his council, appoints and commissions twelve, who serve for seven years, unless sooner dismissed for mal-administration. The members of the legislative and privy councils are justices of the peace for the whole state.—The courts of common pleas and orphans courts have power to hold chancery courts in certain cases. The clerk of the supreme court is appointed by the chief justice, and the recorders of deeds by the justices of the common pleas, for five years, unless sooner dismissed. All the military and marine officers are appointed by the general assembly. The court of appeals consists of seven persons: the president, who is a member, and presides by virtue of his office, and six others, three to be chosen by the legislative council, and three by the house of assembly. To this court appeals lie from the supreme court, in all matters of law and equity. The judges hold their office during good behaviour.

The justices of the several courts, the members of the privy council, secretary, trustees of the loan office, clerks of the common pleas, and all persons concerned in army or navy contracts, are ineligible to either house of assembly. Every member, before taking his seat, must take the oath of allegiance, and subscribe a religious test, declaring his belief in God the Father, in Jesus Christ, and the Holy Ghost; and in the inspiration of the Scriptures.

The house of assembly have the privilege of impeaching delinquent officers of government; and impeachments are to be prosecuted by the attorney-general, or other persons appointed by the assembly, and tried before the legislative council. The punishment may extend to temporal or perpetual disability to hold

hold offices under government, or to such other penalties as the laws shall direct.

Though slavery exists in this state, the number of slaves was found to have diminished greatly between 1800 and 1810. The habits and character of the people greatly resemble those of the Pennsylvanians.

DELEGATE, in a general sense, a deputy or commissioner.

DELEGATES, commissioners appointed by the king under the great seal, to hear and determine appeals from the ecclesiastical court.

Court of **DELEGATES**, the great court of appeal in all ecclesiastical causes. These delegates are appointed by the king's commission under his great seal, and issuing out of chancery, to represent his royal person, and hear all appeals to him made by virtue of the statute 25 Henry VIII. c. 19. This commission is usually filled with lords spiritual and temporal, judges of the courts at Westminster, and doctors of the civil law. Appeals to Rome were always looked upon by the English nation, even in the times of Popery, with an evil eye, as being contrary to the liberty of the subject, the hononr of the crown, and the independence of the whole realm; and were first introduced, in very turbulent times, in the 16th year of King Stephen (A. D. 1151,) at the same period (Sir Henry Spelman observes) that the civil and canon laws were first imported into England. But in a few years after, to obviate this growing practice, the constitutions made at Clarendon, 11 Hen. II. on account of the disturbances raised by Archbishop Becket and other zealots of the holy see, expressly declare, that appeals in causes ecclesiastical ought to lie from the archdeacon to the diocesan; from the diocesan to the archbishop of the province; and from the archbishop to the king; and are not to proceed any farther without special license from the crown. But the unhappy advantage that was given in the reign of King John, and his son Hen. III. to the encroaching power of the Pope, who was ever vigilant to improve all opportunities of extending his jurisdiction to Britain, at length rivetted the custom of appealing to Rome in causes ecclesiastical so strongly, that it never could be thoroughly broken off till the grand rupture happened in the reign of Hen. VIII. when all the jurisdiction usurped by the pope in matters ecclesiastical was restored to the crown, to which it originally belonged; so that the statute 25 Hen. VIII. was but declaratory of the ancient law of the realm. But in case the king himself be party in any of these suits, the appeal does not then lie to him in chancery, which would be absurd; but, by the 24 Henry VIII. c. 12. to all the bishops of the realm, assembled in the upper house of convocation.

DELEGATION, a commission extraordinary given by a judge to take cognisance of, and determine, some cause which ordinarily does not come before him.

DELEGATION, in *Scots Law*. See LAW *Index*.

DELEN, DIRK VAN, an eminent painter of architecture and perspective, was born at Heusden, but in what year is not known. He was a disciple of Francis Hals, in whose school he practised to paint those particular subjects which were most esteemed by that master, such as portraits and conversations; and by that means he acquired the skill to design figures with a great deal of spirit and correctness. But his predominant inclination directed him to paint architecture and perspective; and these he studied with so much care, as to make his works admired and coveted through the Low Countries. His subjects were the insides of churches, filled with figures; grand temples; magnificent saloons and galleries, with people assembled at concerts of music, feasting, or dancing. Those subjects he finished highly; his architecture was in a noble taste; and the figures were well designed, as well as grouped with a great deal of judgment. Several authors mention the performances of this master with large commendation, for the goodness of his invention, and neatness of his handling.

DELETERIOUS, an appellation given to things of a destructive or poisonous nature. See POISON.

DELFT, a town of the United Provinces, and capital of Delftland in Holland. It is a pretty large place, very clean and well built, with canals in the streets, planted on each side with trees. The public buildings, especially the town-house, are very magnificent. Here are two churches; in one is the tomb of the prince of Orange, who was assassinated; and in the other, that of Admiral Tromp. It has a fine arsenal, well furnished; is about two miles in circumference, and is defended against inundations by three dams or dikes. Here is made a prodigious quantity of fine earthen-ware called *delft-ware;* but the trade is on the decline since extensive potteries were established in England and Germany. It is pleasantly situated among the meadows on the river Shie, in E. Long. 4. 13. N. Lat. 52. 6.

DELFT-Ware, a kind of pottery of baked earth, covered with an enamel or white glazing, which gives it the appearance and neatness of porcelain. Some kinds of this enamelled pottery differ much from others, either in their sustaining sudden heat without breaking, or in the beauty and regularity of their forms, of their enamel, and of the painting with which they are ornamented. In general, the fine and beautiful enamelled potteries, which approach the nearest to porcelain in external appearance, are, at the same time, those which least resist a brisk fire. Again, those which sustain a sudden heat, are coarse, and resemble common pottery.

The basis of this pottery is clay, which is to be mixed, when too fat, with such a quantity of sand, that the earth shall preserve enough of its ductility to be worked, moulded, and turned easily; and yet that its fatness shall be sufficiently taken from it, that it may not crack or shrink too much in drying or in baking. Vessels formed of this earth must be dried very gently to avoid cracking. They are then to be placed in a furnace to receive a slight baking, which is only meant to give them a certain consistence or hardness. And, lastly, they are to be covered with an enamel or glazing, which is done, by putting upon the vessels thus prepared the enamel, which has been ground very fine, and diluted with water.

As vessels on which the enamel is applied are but slightly baked, they readily imbibe the water in which the enamel is suspended, and a layer of the enamel adheres to their surface; these vessels may then be painted with colours composed of metallic calces, mixed and ground with a fusible glass. When they are become perfectly dry, they are to be placed in the furnace, included in cases of baked earth called *seggars*, and exposed

posed to a heat capable of fusing uniformly the enamel which covers them. This heat given to fuse the enamel being much stronger than that which was applied at first to give some consistence to the ware, is also the heat necessary to complete the baking of it. The furnace and colours used for painting this ware, are the same as those employed for porcelain. The glazing, which is nothing but white enamel, ought to be so opaque as not to show the ware under it. There are many receipts for making these enamels; but all of them are composed of sand or flints, vitrifying salts, calx of lead, and calx of tin; and the sand must be perfectly vitrified, so as to form a glass considerably fusible. Somewhat less than an equal part of alkaline salt, or twice its weight of calx of lead, is requisite to effect such vitrifications of sand. The calx of tin is not intended to be vitrified, but to give a white opaque colour to the mass; and one part of it is to be added to three or four parts of all the other ingredients taken together. From these general principles various enamels may be made to suit the different kinds of earths. To make the enamel, lead and tin are calcined together with a strong fire; and the sand is also to be made into a fritt with the salt or ashes. The whole is then to be well mixed and ground together. The matter is then to be placed under the furnace, where it is melted and vitrified during the baking of the ware. It is next to be ground in a mill, and applied as above directed.

Chem. Dict.

The preparation of the white enamel is a very essential article in making delft-ware, and one in which many artists fail. M. Bosc. d'Antic, in a memoir concerning this kind of ware, published in the *Mem. des Sçavans Etran.* tom. vi. recommends the following proportions. A hundred pounds of calx of lead are to be mixed with about a seventh part of that quantity of calx of tin for common delft-ware, or a fourth part of calx of tin for the finest kind; a hundred, or a hundred and ten pounds of fine sand; and about twenty or thirty pounds of sea-salt. Concerning the earth of which the ware is made, he observes, that pure clay is not a proper material when used alone. Different kinds of earth mixed together are found to succeed better. Pieces of ware made of clay alone are found to require too much time to dry; and they crack, and lose their form, unless they are made exceedingly thick. An addition of marle diminishes the contraction of the clay; renders its less compact; and allows the water to escape, without altering the form of the ware in drying. It affords also a better ground for the enamel; which appears more glossy and white than when laid on clay alone. The kinds of clay which are chiefly used in the composition of delft-ware, are the blue and green. A mixture of blue clay and marle would not be sufficiently solid, and would be apt to scale, unless it were exposed to a fire more intense than what is commonly used for the burning of delft-ware. To give a greater solidity, some red clay is added; which, on account of its ferruginous matter, possesses the requisite binding quality. The proportions of these ingredients vary in different works, according to the different qualities of the earths employed. Three parts of blue clay, two parts of red clay, and five parts of marle, form the composition used in several manufactories. M. d'Antic thinks that the best delft-ware might be made of equal parts of pure clay and pure calcareous earth; but this composition would require that the fire should be continued twice as long as it generally is.

DELIA, in antiquity, a festival celebrated every fifth year in the island of Delos, in honour of Apollo. It was first instituted by Theseus, who at his return from Crete placed a statue there, which he had received from Ariadne. At the celebration they crowned the statue of the gods with garlands, appointed a choir of music, and exhibited horse-races. They afterwards led a dance, in which they imitated by their motions the various windings of the Cretan labyrinth, from which Theseus had extricated himself by Ariadne's assistance.—There was another festival of the same name yearly celebrated by the Athenians in Delos. It also was instituted by Theseus, who, when he was going to Crete, made a vow, that if he returned victorious, he would yearly visit in a solemn manner the temple of Delos. The persons employed in this annual procession were called *Deliastæ* and *Theori.* The ship, the same which carried Theseus, and had been carefully preserved by the Athenians, was called *Theoria* and *Delias.* When the ship was ready for the voyage, the priest of Apollo solemnly adorned the stern with garlands, and an universal lustration was made all over the city. The Theori were crowned with laurels, and before them proceeded men armed with axes, in commemoration of Theseus, who had cleared the way from Trœzen to Athens, and delivered the country from robbers. When the ship arrived at Delos, they offered solemn sacrifices to the god of the island, and celebrated a festival to his honour. After this they retired to their ship, and sailed back to Athens, where all the people of the city ran in crowds to meet them. Every appearance of festivity prevailed at their approach, and the citizens opened their doors, and prostrated themselves before the Deliastæ as they walked in procession. During this festival it was unlawful to put to death any malefactor, and on that account the life of Socrates was prolonged for 30 days.

Delia, a surname of Diana, because she was born in Delos.

DELIAC, (*Deliacus*), among the ancients, denoted a poulterer, or a person who sold fowls, fatted capons, &c. The traders in this way were called *Deliaci*; the people of the isle of Delos first practised this occupation. They also sold eggs, as appears from Cicero, in his Academic Questions, lib. iv. Pliny, lib. x. cap. 30. and Columella, lib. viii. cap. 8. likewise mention the *Deliaci.*

DELIACAL PROBLEM, a celebrated problem among the ancients, concerning the duplication of the cube.

DELIBAMENTA, in antiquity, a libation to the infernal gods, always offered by pouring downwards. See LIBATION.

Jus **DELIBERANDI**. See LAW *Index*.

DELIBERATIVE, an appellation given to a kind or branch of rhetoric, employed in proving a thing, or convincing an assembly thereof, in order to persuade them to put it in execution.

To have a DELIBERATIVE voice in the assembly, is when a person has a right to give his advice and his vote therein. In councils, the bishops have deliberative voices; those beneath them have only consultative voices.

DELICT, in *Scots Law*, signifies such small offences or breaches of the peace as are punishable only by fine or short imprisonment.

DELILLE, Jacques, an eminent French poet. See Supplement.

DELINQUENT, a guilty person, or one who has committed some fault or offence for which he is punishable. See Britain, N° 97.

DELIQUESCENCE, in *Chemistry*, signifies the property which certain bodies have of attracting moisture from the air, and becoming liquid thereby. This property is never found but in saline substances, or matters containing them. It is caused by the great affinity which these substances have for water. The more simple they are, according to Mr Macquer, the more they incline to deliquescence. Hence acids, and certain alkalies, which are the most simple, are also the most deliquescent salts. Mineral acids are so deliquescent, that they strongly imbibe moisture from the air, even though they are already mixed with a sufficient quantity of water to be fluid. For this purpose, it is sufficient that they be concentrated only to a certain degree.—Many neutral salts are deliquescent, chiefly those whose bases are not saline substances. Salts formed by the vitriolic acid, with fixed or volatile alkalies, earths, or most metallic substances, are not deliquescent; although this acid is the strongest of all, and, when disengaged, attracts the moisture of the air most powerfully.

Though the immediate cause of deliquescence is the attraction of the moisture of the air, as we have already observed; yet it remains to be shown why some salts attract this moisture powerfully, and others, though seemingly equally simple, do not attract it at all. The vegetable alkali, for instance, attracts moisture powerfully; the mineral alkali, though to appearance equally simple, does not attract it at all. The acid of tartar by itself does not attract the moisture of the air; but if mixed with borax, which has a little attraction for moisture, the mixture is exceedingly deliquescent.—Some theories have been suggested, in order to account for these and other similar facts; but we are as yet too little acquainted with the nature of the atmosphere to form certain conclusions on the subject.

DELIQUIUM, or Deliquium *Animi* (from *delinquo*, "I swoon"), a swooning or fainting away: called also *syncope*, *lipothymia*, *lipopsychia*, *eclysis*, and *asphyxia*.

Deliquium (from *deliquesco*, "to be dissolved"), in *Chemistry*, is the dissolution or melting of a salt by suspending it in a moist cellar.

Salt of tartar, or any fixed alkali, set in a cellar or other cool moist place, and in an open vessel, resolves or runs into a kind of liquor called by the older chemists oil of tartar *per deliquium*.

DELIRIUM (from *deliro*, "to rave or talk idly"). When the ideas excited in the mind do not correspond to the external objects, but are produced by the change induced on the common sensory, the patient is said to be delirious. See Medicine *Index*.

DELIVERY, or Child-Birth. See Midwifery.

DELLI, or Delhi, a city and province in Hindostan. The city was once the capital of the empire. The road between it and *Agra*, the other capital, is that famous alley or walk planted with trees by Jehin Ghir, and 150 leagues in length. Each half league is marked with a kind of turret; and at every stage there are little sarays or caravanseras for the benefit of travellers. The road, though pretty good, has many inconveniences. It is not only frequented by wild beasts, but by robbers. The latter are so dexterous at casting a noose about a man's neck, that they never fail, if within reach, to seize and strangle him. They gain their point likewise by means of handsome women; who, feigning great distress, and being taken up behind the unwary traveller, choke him with the same snare.—The capital consists of three cities, built near one another. The first, now quite destroyed, is said to have had 52 gates; and to have been the residence of King Porus, conquered by Alexander the Great. The second, which is also in ruins, was demolished by Shah Jehan, to build *Jehan-abad* with the materials. This makes the third city, and joins the ruins of the second. This city stands in an open plain country, on the river *Jumna*, which rises in this province. It is encompassed with walls, except towards the river. These are of brick, flanked with round towers; but without a ditch, and terraced behind, four or five feet thick. The circumference of the walls may be about nine miles. The fortress, which is a mile and a half in circuit, has good walls and round towers, and ditches full of water, faced with stone. It is surrounded with fine gardens, and in it is the Mogul's palace. See Indostan. E. Long. 77. 25. N. Lat. 28. 20.

DELMENHORST, a strong town of Germany, in Westphalia, and now united to the grand duchy of Osnaburg, seated on the river Delm, near the Weser. E. Long. 8. 37. N. Lat. 53. 10.

DELOS, an island of the Archipelago, very famous in ancient history. Originally it is said to have been a floating island, but afterwards it became fixed and immoveable. It was held sacred on account of its being the birth-place of Apollo and Diana.—Anciently this island was governed by its own kings. Virgil mentions one Anius reigning here in the time of the Trojan war. He was, according to that poet, both king and high-priest of Apollo, and entertained Æneas with great kindness. The Persians allowed the Delians to enjoy their ancient liberties, after they had reduced the rest of the Grecian islands. In after ages, the Athenians made themselves masters of it; and held it till they were driven out by Mithridates the Great, who plundered the rich temple of Apollo, and obliged the Delians to side with him. Mithridates was in his turn driven out by the Romans, who granted the inhabitants many privileges, and exempted them from all sorts of taxes. At present it is quite abandoned; the lands being covered with ruins and rubbish in such a manner as to be quite incapable of cultivation. The inhabitants of Mycone hold it now, and pay but ten crowns land tax to the Grand Signior for an island which was once one of the richest in the world.—Strabo and Callimachus tells us that the island of Delos was watered by the river Inapus: but Pliny calls it only a spring: and adds, that its waters swelled and abated at the same time with those of the Nile. At present there is no river in the island, but one of the noblest

Delos.

Delos, Delphi.

springs in the world; being twelve paces in diameter, and inclosed partly by rocks, and partly by a wall. Mount Cynthus, whence Apollo had the surname of *Cynthius*, is by Strabo placed near the city, and said to be so high, that the whole island was covered by its shadow; but our modern travellers speak of it as a hill of a very moderate height. It is but one block of granite of the ordinary sort, cut on that side which faced the city into regular steps, and inclosed on both sides by a wall. On the top of the mountain are still to be seen the remains of a stately building, with a mosaic pavement, many broken pillars, and other valuable monuments of antiquity. From an inscription discovered there some time ago, and which mention a vow made to Serapis, Isis, and Anubis, some have conjectured, that on this hill stood a temple dedicated to these Egyptian deities, though nowhere mentioned in history.—The city of Delos, as is manifest from the magnificent ruins still extant, took up that spacious plain reaching from one coast to the other. It was well peopled, and the richest city in the Archipelago, especially after the destruction of Corinth; merchants flocking thither from all parts, both in regard of the immunity they enjoyed there, and of the convenient situation of the place between Europe and Asia. Strabo calls it one of the most frequented empories in the world; and Pliny tells us, that all the commodities of Europe and Asia were sold, purchased, or exchanged, there. It contained many noble and stately buildings; as the temples of Apollo, Diana, and Latona; the porticoes of Philip of Macedon, and Dionysius Eutyches; a gymnasium; an oval bason made at an immense expence, for the representation of sea-fights; and a most magnificent theatre. The temple of Apollo was, according to Plutarch, begun by *Erysichthon* the son of Cecrops; but afterwards enlarged and embellished at the common charge of all the states of Greece. Plutarch tells us, that it was one of the most stately buildings in the universe; and speaks of an altar in it, which, in his opinion, deserved a place among the wonders of the world. It was built with the horns of various animals, so artificially adapted to one another that they hanged together without any cement. This altar is said to have been a perfect cube; and the doubling it was a famous mathematical problem among the ancients. This went under the name of *Problema Deliacum;* and is said to have been proposed by the oracle, for the purpose of freeing the country from a plague. The distemper was to cease when the problem was solved.—The trunk of the famous statue of Apollo, mentioned by Strabo and Pliny, is still an object of great admiration to travellers. It is without head, feet, arms, or legs; but from the parts that are yet remaining, it plainly appears, that the ancients did not exaggerate when they commended it as a wonder of art. It was of gigantic size, though cut out of a single block of marble; the shoulders being six feet broad, and the thighs nine feet round. At a small distance from this statue lies, amongst confused heaps of broken columns, architraves, bases, chapiters, &c. a square piece of marble 15½ feet long, ten feet nine inches broad, and two feet three inches thick: which undoubtedly served as a pedestal for this colossus. It bears in very fair characters this inscription in Greek, "The Naxians to Apollo." Plutarch tells us, in the life of Nicias, that he caused to be set up, near the temple of Delos, an huge palm-tree of brass, which he consecrated to Apollo; and adds, that a violent storm of wind threw down this tree on a colossal statue raised by the inhabitants of Naxos. Round the temple were magnificent porticoes built at the charge of various princes, as appears from inscriptions which are still very plain. The names of Philip king of Macedon, Dionysius Eutyches, Mithridates Euergetes, Mithridates Eupator, kings of Pontus, and Nicomedes king of Bithynia, are found on several pedestals.—To this temple the inhabitants of the neighbouring islands sent yearly a company of virgins to celebrate, with dancing, the festival of Apollo and his sister Diana, and to make offerings in the name of their respective cities.

So very sacred was the island of Delos held by the ancients, that no hostilities were practised here, even by the nations that were at war with one another, when they happened to meet in this place. Of this Livy gives an instance. He tells us, that some Roman deputies being obliged to put in at Delos, in their voyage to Syria and Egypt, found the galleys of Perseus king of Macedon, and those of Eumenes king of Pergamus, anchored in the same harbour, though these two princes were then making war upon one another. —Hence this island was a general asylum, and the protection extended to all kinds of living creatures; for this reason it abounded with hares, no dogs being suffered to enter it. No dead body was suffered to be buried in it, nor was any woman suffered to lie in there; all dying persons, and women ready to be delivered, were carried over to the neighbouring island of Rhenæa.

DELPHI, in *Ancient Geography*, a town of Phocis, situated on the south-west extremity of Mount Parnassus. It was famous for a temple and oracle of that god, of which the following was said to be the origin: A number of goats that were feeding on Mount Parnassus, came near a place which had a deep and long perforation. The steam which issued from the hole seemed to inspire the goats, and they played and frisked about in such an uncommon manner, that the goat-herd was tempted to lean on the hole, and see what mysteries the place contained. He was immediately seized with a fit of enthusiasm, his expressions were wild and extravagant, and passed for prophecies. This circumstance was soon known about the country, and many experienced the same enthusiastic inspiration. The place was revered; a temple was soon after erected in honour of Apollo; and a city built, which became the chief and most illustrious in Phocis. The influence of its god has controuled the councils of states, directed the course of armies, and decided the fate of kingdoms. The ancient history of Greece is full of his energy, and an early register of his authority. The circumjacent cities were the stewards and guardians of the god. Their deputies composed the famous Amphictyonic assembly, which once guided Greece.

The temple of Apollo, it is related, was at first a kind of cottage covered with boughs of laurel; but he was early provided with a better habitation. An edifice of stone was erected by Trophonius and Agamedes, which subsisted about 700 years, and was burned in the year 636 after the taking of Troy, and 548 before Christ. It is mentioned in the hymn to Apollo ascribed to Homer. An opulent and illustrious family, called *Alcmæonidæ*, which fled from Athens and the tyrant Hippias, contracted with the deputies for the building of a new temple, and exceeded their agreement. The front was raised with Parian marble, instead of the stone called *Porus;* which resembled it in whiteness, but was not so heavy. A Corinthian was the architect. The pediments were adorned with Diana, and Latona, and Apollo, and the Muses; the setting of Phœbus or the sun; with Bacchus, and the women called *Thyades.* The architraves were decorated with golden armour; bucklers suspended by the Athenians after the battle of Marathon, and shields taken from the Gauls under Brennius. In the portico were inscribed the celebrated maxims of the seven sages of Greece. There was an image of Homer, and in the cell was an altar of Neptune, with statues of the Fates, and of Jupiter and Apollo, who were surnamed *Leaders of the Fates.* Near the hearth, before the altar at which Neoptolemus the son of Achilles was slain by a priest, stood the iron chair of Pindar. In the sanctuary was an image of Apollo gilded. The inclosure was of great extent, and filled with treasures, in which many cities had consecrated tenths of spoil taken in war, and with the public donations of renowned states in various ages. It was the grand repository of ancient Greece, in which the labours of the sculptor and statuary, gods, heroes, and illustrious persons, were seen collected and arranged; the inequalities of the area of acclivity contributing to a full display of the noble assemblage.

The oracles were delivered by a priestess called Pythia, who received the prophetic influence in the following manner. A lofty tripod, decked with laurel, was placed over the aperture, whence the sacred vapour issued. The priestess, after washing her body and especially her hair, in the cold water of Castalia, mounted on it, to receive the divine effluvia. She wore a crown of laurel, and shook a sacred tree, which grew by. Sometimes she chewed the leaves; and the frenzy which followed may with probability be attributed to this usage, and the gentler or more violent symptoms to the quantity taken. In one instance the paroxysm was so terrible, that the priests and suppliants ran away, and left her alone to expire, it was believed, of the god. Her part was unpleasant; but, if she declined acting, they dragged her by force to the tripod. The habit of her order was that of virgins. The rules enjoined temperance and chastity, and prohibited luxury in apparel. The season of inquiry was in the spring, during the month called Bulsius; after which Apollo was supposed to visit the altars of the Hyperboreans.

The city of Delphi arose in the form of a theatre, upon the winding declivity of Parnassus, whose fantastic tops overshadowed it, like a canopy, on the north, while two immense rocks rendered it inaccessible on the east and west, and the rugged and shapeless Mount Cirphis defended it on the south. The foot of the last named mountain was washed by the rapid Plistus, which discharged itself into the sea at the distance of only a few leagues from the sacred city. This inaccessible and romantic situation, from which the place derived the name of Delphi (signifying, as explained in the glossaries, *solitary, alone*), was rendered still more striking, by the innumerable echoes which multiplied every sound, and increased the ignorant veneration of visitants for the god of the oracle. The artful ministers of Apollo gradually collected such objects in the groves and temple as were fitted to astonish the senses of the admiring multitude. The splendour of marble, the magic of painting, the invaluable statues of gold and silver, represented (to use the language of antiquity) not the resemblance of an earthly habitation, but rather expressed the image of Olympus, adorned and enlightened by the actual presence of the gods.

The protection and superintendence of this precious depository of riches and superstition belonged to the Amphictyons, as already noticed. But the inhabitants of Delphi, who, if we may use the expression, were the original proprietors of the oracles, always continued to direct the religious ceremonies, and to conduct the important business of prophecy. It was their province alone to determine at what time, and on what occasion, the Pythia should mount the sacred tripod, to receive the prophetic steams by which she communicated with Apollo. When overflowing with the heavenly inspiration, she uttered the confused words, or rather frantic sounds, irregularly suggested by the impulse of the god; the Delphians collected these sounds, reduced them into order, animated them with sense, and adorned them with harmony. The Pythia, appointed and dismissed at pleasure, was a mere instrument in the hands of those artful ministers, whose character became so venerable and sacred, that they were finally regarded, not merely as attendants and worshippers, but as the peculiar family of the god. Their number was considerable, and never exactly ascertained, since all the principal inhabitants of Delphi, claiming an immediate relation to Apollo, were entitled to officiate in the rites of his sanctuary; and even the inferior ranks belonging to that sacred city were continually employed in dances, festivals, processions, and in displaying all the gay pageantry of an airy and elegant superstition.

Delphi was conveniently situated for the conflux of votaries, lying in the centre of Greece, and, as was then imagined, of the universe. It was customary for those who consulted the oracle to make rich presents to the god: his servants and priests feasted on the numerous victims which were sacrificed to him; and the rich magnificence of his temple had become proverbial even in the age of Homer. In after times, Crœsus, the wealthiest of monarchs, was particularly munificent in his donations. This sacred repository of opulence was therefore often the object of plunder. Neoptolemus was slain, while sacrificing, on suspicion of a design of that kind. Xerxes divided his army at Panopeus and proceeded with the main body through Bœotia into Attica, while a party keeping Parnassus on the right, advanced along Schiste to Delphi; but was taken with a panic when near Ilium, and fled. This monarch, it is related, was as well apprised of the contents of the temple, and the sumptuous offerings of Halyattes and Crœsus, as of the effects which he had left behind in his own palace. The divine hoard was seized by the Phocensians under Philomelus, and dissipated in a long war with the Amphictyons. The Gauls experienced a reception like that of the Persians, and manifested similar dismay and superstition. Sylla, wanting money to pay his army, sent to borrow from the holy treasury, and when his messenger would have frightened him, by reporting a prodigy, that the sound of a harp had been heard from within the sanctuary, replied, it was a sign that the god was happy to oblige him.

The trade of Apollo, after it had flourished for a long period, was affected by the mal-practices of some concerned in the partnership, who were convicted of bribery and corruption, and ruined the character of their principal. The temple in the time of Strabo was reduced to extreme poverty; but the offerings which remained were very numerous. Apollo was silent, except some efforts at intervals to regain his lost credit. Nero attempted to drive him, as it were, by violence, from the cavern; killing men at the mouth, and polluting it with blood; but he lingered on, and would not entirely forsake it. Answers were reported as given by him afterwards, but not without suspicion of forgery. An oracle of Apollo at another place informed the consultors, that he should no more recover utterance at Delphi, but enjoined the continuance of the accustomed offerings.

The city of Delphi was free under the Romans. In the time of Pausanias, who has particularly described it, there still remained an invaluable treasure of the offerings within the court of the temple. The number, variety, and beauty of these were prodigious. The store appeared inexhaustible; and the robbery of Nero, who removed five hundred brazen images, was rather regretted than perceived. The holy treasuries, though empty, served as memorials of the piety and glory of the cities which erected them. The Athenian portico preserved the beaks of ships and the brazen shields; trophies won in the Peloponnesian war. And a multitude of curiosities remained untouched.

Constantine the Great, however, proved a more fatal enemy to Apollo and Delphi than either Sylla or Nero. He removed the sacred tripods to adorn the hippodrome of his new city; where these, with the Apollo, the statues of the Heliconian muses, and the celebrated Pan, dedicated by the Greek cities, after the war with the Medes, were extant when Sozomen wrote his history. Afterwards Julian sent Oribasius to restore the temple: but he was admonished by an oracle to represent to the emperor the deplorable condition of the place. 'Tell him the well-built court is fallen to the ground. Phœbus has not a cottage, nor the prophetic laurel, nor the speaking fountain Cassotis; and even the beautiful water is extinct.' See DELPHOS.

DELPHINIA, in *Antiquity*, feasts which the inhabitants of Egina celebrated in honour of Apollo, surnamed *Delphinius*, so called, as it is pretended, because he assumed the form of a dolphin to conduct Castilius and his colony from the isle of Crete to the *Sinus Crissæus Delphinium*, one of the courts of judicature of the Athenians; so called from the proximity of the place, where they held their assemblies, to the temple of Apollo Delphinius.

DELPHINIUM, DOLPHIN-FLOWER, or LARKSPUR; a genus of plants belonging to the polyandria class; and in the natural method ranking under the 26th order, *Multisiliquæ*. See BOTANY *Index*.

DELPHINUS, or DOLPHIN, a genus of fishes belonging to the order of *Cete*. See CETOLOGY *Index*.

DELPHINUS, in *Astronomy*, a constellation of the northern hemisphere; whose stars in Ptolemy's catalogue are 10; in Tycho's the same number; in Hevelius's 14; and in Flamstead's 18.

DELPHOS, a town, or rather village, of Turkey in Asia, in the province of Libadia; occupying part of the site of the ancient Delphi. See DELPHI.

A late traveller * informs us, that some vestiges of temples are visible; and above them in the mountain side, are sepulchres, niches, and horizontal cavities for the body, some covered with slabs. Farther on is a niche cut in the rock with a seat, intended, it seems, for the accommodation of travellers wearied with the rugged track and the long ascent. The monastery is on the site of the gymnasium. Strong terrace walls and other traces of a large edifice remain. The village is at a distance. Castalia is on the right hand as you ascend to it, the water coming from on high and crossing the road; a steep precipice, above which the mountain still rises immensely, continuing on in that direction. The village consists of a few poor cottages of Albanians covering the site of the temple and oracle. Beneath it to the south is a church of St Elias, with areas, terrace-walls, arches, and vestiges of the buildings once within the court. The concavity of the rock in this part gave to the site the resemblance of a theatre. Turning to the left hand, as it were toward the extremity of one of the wings, you come again to sepulchres hewn in the rock, and to a semicircular recess or niche with a seat as on the other side. Higher up than the village, is the hollow of the stadium, in which were some seats and scattered fragments.

Higher up, within the village, is a piece of ancient wall, concealed from view by a shed, which it supports. The stone is brown, rough, and ordinary, probably that of Parnassus. On the south side are many inscriptions, with wide gaps between the letters, which are negligently and faintly cut; all nearly of the same tenor, and very difficult to copy. They register the purchase of slaves who had entrusted the price of their freedom to the god; containing the contract between Apollo and their owners, witnessed by his priests and by some of the archons. This remnant seems to be part of the wall before Cassotis; as above it is still a fountain, which supplies the village with excellent water.

The water of Castalia in the neighbourhood, from which the Pythia, and the poets who versified her answers, were believed to deprive a large share of their inspiration, descends through a cleft of Parnassus; the rock on each side high and steep, ending in two summits; of which one was called *Hyampeia*, and had beneath it the sacred portion of Autonous, a local hero as distinguished as Phylacus. From this precipice the Delphians threw down the famous Æsop. By the stream within the cleft, are seen small broken stairs leading to a cavity in which is water, and once perhaps up to the top. Grooves have been cut, and the marks of tools are visible on the rock; but the current, instead of supplying a fountain, now passes over its native bed, and hastens down a course deep-worn to join the Plistus. Close by, at the foot of the eastern precipice,

---

* *Chandler's Travels in Greece.*

precipice, is a bason with steps on the margin, once, it is likely, the bath used by the Pythia. Above, in the side of the mountain, is a pretty church dedicated to St John, within which are excavations resembling niches, partly concealed from view by a tree.

DELTA, is a part of Lower Egypt, which takes up a considerable space of ground between the branches of the Nile and the Mediterranean sea: the ancients called it the *isle of Delta*, because it is in the shape of a triangle, like the Greek letter of that name. It is about 130 miles along the coast from Damietta to Alexandria, and 70 on the sides from the place where the Nile begins to divide itself. It is the most plentiful country in all Egypt, and it rains more there than in other parts, but the fertility is chiefly owing to the inundation of the river Nile. The principal towns on the coast are Damietta, Rosetta, and Alexandria; but, within land, Menousia, and Maala or Elmala.

DELTOIDES, in *Anatomy*. See ANATOMY, *Table of the Muscles*.

DELUGE, an inundation or overflowing of the earth, either wholly or in part, by water.

We have several deluges recorded in history; as that of Ogyges, which overflowed almost all Attica; and that of Deucalion, which drowned all Thessaly in Greece; but the most memorable was that called the *Universal Deluge*, or *Noah's Flood*, which overflowed and destroyed the whole earth; and from which only Noah, and those with him in the ark, escaped.

1
a of the
luge.

This flood makes one of the most considerable epochas in chronology. Its history is given by Moses, Gen. ch. vi. and vii. Its time is fixed, by the best chronologers, to the year from the creation 1656, answering to the year before Christ 2293. From this flood, the state of the world is divided into *diluvian* and *antediluvian*. See ANTEDILUVIANS.

2
jections
the fact.

Among the many testimonies of the truth of this part of the Mosaic history, we may account the general voice of mankind at all times, and in all parts of the world. The objections of the free-thinkers have indeed principally turned upon three points, viz. 1. The want of any direct history of that event by the profane writers of antiquity; 2. The apparent impossibility of accounting for the quantity of water necessary to overflow the whole earth to such a depth as it is said to have been: and, 3. There appearing no necessity for an universal deluge, as the same might have been accomplished by a partial one.

I. The former of these objections has given rise to several very elaborate treatises, though all that has yet been done in this way has scarcely been able to silence the objectors. Mr Bryant, in his system of Mythology, has with great learning and considerable success endeavoured to show, that the deluge was one of the principal, if not the only foundation of the Gentile worship; that the first of their deities was Noah; that all nations of the world look up to him as their founder; and that he, his sons, and the first patriarchs, are alluded to in most if not all of the religious ceremonies, not only of the ancient but of the modern heathens. In short, according to this author, the deluge, so far from being forgot, or obscurely mentioned by the heathen world, is in reality conspicuous throughout every one of their acts of religious worship.

3
Bryant's account of the ancient heroes.

The Egyptian Osiris, according to him, was the same with Ham the son of Noah, though the name was sometimes bestowed on Noah himself. That this is the case, is evident, he thinks, from its being said that he was exposed in the ark, and afterwards restored to day: that he planted the vine, taught mankind agriculture, and inculcated upon them the maxims of religion and justice. Something of the same kind is related of Perseus. He is represented by some ancient historians as a great astronomer, and well versed in other sciences. After being conceived in a shower of gold, he was exposed in an ark upon the waters, and is said to have had a renewal of life.—The history of Myrina the Amazon affords a kind of abridgement and mixture of the histories of Osiris and Perseus. Similar to these is the history of Hercules himself. But our author observes, that under the titles of *Osiris*, *Perseus*, *Myrina*, &c. the ancients spoke of the exploits of a whole nation, who were no other than the Cuthites or Cushites, the descendants of Cush the son of Ham and father of Nimrod. These people spread themselves into the most remote corners of the globe; and hence the heroes whom they represented are always set forth as conquering the whole world.—According to Diodorus Siculus, the Egyptian Osiris was the same with the Dionusus of the Greeks. He is said to have been twice born, and to have had two fathers and two mothers; to have been wonderfully preserved in an ark; to have travelled all over the earth; taught the use of the vine, to build, plant, &c. The Indians claim him as a native of their country, though some allow that he came from the west. Of Cronus and Astarte, it is said that they went over the whole earth, disposing of the countries as they pleased, and doing good wherever they came. The same is related of Ouranus, Themis, Apollo, &c. though all their exploits are said to have been the effects of conquest, and their benevolence enforced by the sword. In a similar manner he explains the histories of other heroes of antiquity; and having thus, in the characters and history of the most celebrated personages, found traces of the history of Noah and his family, our author proceeds to inquire into the memorials of the deluge itself, to be met with in the history or religious rites of the different nations of antiquity.

4
Testimonies of the deluge to be met with in heathen authors.

“We may reasonably suppose (says he), that the particulars of this extraordinary event would be gratefully commemorated by the patriarch himself, and transmitted to every branch of his family; that they were made the subject of domestic converse, where the history was often renewed, and ever attended with a reverential awe and horror, especially in those who had been witnesses to the calamity, and had experienced the hand of Providence in their favour. In process of time, when there was a falling off from the truth, we might farther expect, that a person of so high a character as Noah, so particularly distinguished by the Deity, could not fail of being reverenced by his posterity; and when idolatry prevailed, that he would be one of the first among the sons of men to whom divine honours would be paid. Lastly, we might conclude, that these memorials would be interwoven in the mythology of the Gentile world; and that there would be continual allusions to these ancient occurrences in the rites and mysteries as they were practised by the nations of the earth. In conformity to these

these suppositions, I shall endeavour to shew that these things did happen; that the history of the deluge was religiously preserved in the first ages; that every circumstance of it is to be met with among the historians and mythologists of different countries: and traces of it are to be found, particularly in the sacred rites of Egypt and of Greece.

5 Various titles by which Noah was distinguished.

"It will appear from many circumstances in the more ancient writers, that the great patriarch was highly reverenced by his posterity. They looked up to him as a person highly favoured by heaven; and honoured him with many titles, each of which had a reference to some particular part of his history. They styled him *Prometheus*, *Deucalion*, *Atlas*, *Theuth*, *Zuth*, *Xuthus*, *Inachus*, *Osiris*. When there began to be a tendency towards idolatry, and the adoration of the sun was introduced by the posterity of Ham, the title of *Helius*, among others, was conferred upon him. They called him also Μην and Μαν, which is the moon. When colonies went abroad, many took to themselves the title of *Minyadæ* and *Minyæ* from him; just as others were denominated *Achæmenidæ*, *Auritæ*, *Heliadæ*, from the sun. People of the former name are to be found in Arabia and in other parts of the world. The natives at Orchomenos were styled *Minyæ*, as were some of the inhabitants of Thessaly. Noah was the original Zeus and Dios. He was the planter of the vine, and inventor of fermented liquors: whence he was denominated *Zeuth*, which signifies ferment, rendered *Zeus* by the Greeks. He was also called *Dionusos*, interpreted by the Latins *Bacchus*, but very improperly. Bacchus was Chus, the grandson of Noah; as Ammon may in general be esteemed Ham, so much reverenced by the Egyptians.

"Among the people of the east, the true name of the patriarch was preserved; they called him *Noas*, *Naus*, and sometimes contracted *Nous*; and many places of sanctity, as well as rivers, were denominated from him. Anaxagoras of Clazomene had obtained some knowledge of him in Egypt. By him the patriarch was denominated *Noas* or *Nous*; and both he and his disciples were sensible that this was a foreign appellation; notwithstanding which, he has acted as if it had been a term of the Greek language. Eusebius informs us, that the disciples of Anaxagoras say, 'that Nous is, by interpretation, the deity Dis or Dios; and they likewise esteem Nous the same as Prometheus, because he was the renewer of mankind, and was said to have fashioned them again,' after they had been in a manner extinct. After this, however, he gives a solution of the story, upon the supposition that Nous is the same with the Greek word νους, the mind: that 'the mind was *Prometheia*; and Prometheus was said to renew mankind, from new forming their minds, and leading them, by cultivation, from ignorance.'

"Suidas has preserved, from some ancient author, a curious memorial of this wonderful personage, whom he affects to distinguish from Deucalion, and styles *Nannacus*. According to him, this Nannacus was a person of great antiquity, and prior to the time of Deucalion. He is said to have been a king, who foreseeing the approaching deluge, collected every body together, and led them to a temple, where he offered up his prayers for them, accompanied with many tears. There is likewise a proverbial expression about Nannacus applied to people of great antiquity.

"Stephanus gives great light to this history, and supplies many deficiencies. 'The tradition is (says he), that there was one formerly named *Annacus*, the extent of whose life was above 300 years. The people who were of his neighbourhood and acquaintance had inquired of an oracle how long he was to live; and there was an answer given, that when Annacus died, all mankind would be destroyed. The Phrygians, upon this account, made great lamentations, from whence arose the proverb το επι Αννακου κλαυσειν, *the lamentation of Annacus*, made use of for people in circumstances highly calamitous. When the flood of Deucalion came, all mankind were destroyed, according as the oracle had foretold. Afterwards, when the surface of the earth began to be again dry, Zeus ordered Prometheus and Minerva to make images of clay in the form of men; and, when they were finished, he called the winds, and made them breathe into each, and render them vital."

From these histories Mr Bryant concludes as follows: "However the story may have been varied, the principal outlines plainly point out the person who is alluded to in these histories. It is, I think, manifest, that Annacus, and Nannacus, and even Inachus, relate to Noachus or Noah. And not only these, but the histories of Deucalion and Prometheus have a like reference to the patriarch; in the 600th year, and not the 300th, of whose life the waters prevailed upon the earth. He was the father of mankind, who were renewed in him. Hence he is represented by another author, under the character of Prometheus, as a great artist, by whom men were formed anew, and were instructed in all that was good.

6 Inachus, Deucali and Pro theus, t same wi Noah.

"Noah was the original Cronus and Zeus; though the latter is a title conferred sometimes upon his son Ham. There is a very particular expression recorded by Clemens of Alexandria, and attributed to Pythagoras, who is said to have called the sea the *tear of Cronus*; and there was a farther tradition concerning this person, that he drank, or swallowed up all his children. The tears of Isis are represented as very mysterious. They are said to have flowed whenever the Nile began to rise, and to flood the country.—The overflowing of that river was the great source of affluence to the people, and they looked upon it as their chief blessing; yet it was ever attended with mystical tears and lamentations. This was particularly observed at Coptos, where the principal deity was Isis. An ancient writer imagines that the tears and lamentations of the people were to implore an inundation; and the tears of Isis were supposed to make the river swell. But all this was certainly said and done in memorial of a former flood, of which they made the overflowing of the Nile a type.

"As the patriarch was by some represented as a king called *Naachus* or *Nauchus*; so by others he was styled *Inachus*, and supposed to have reigned at Argos. Hence Inachus was made a king of Greece; and Phoroneus and Apis brought in succession after him. But Inachus was not a name of Grecian original; it is mentioned by Eusebius, in his account of the first ages, Deluge.

ages, that there reigned in Egypt Telegonus a prince of foreign extraction, who was the son of Ones the shepherd, and the seventh in descent from Inachus. And in the same author we read, that a colony went forth from that country into Syria, where they founded the ancient city of Antioch; and that they were conducted by Casus and Belus, who were sons of Inachus. By Inachus is certainly meant Noah; and the history relates to some of the more early descendants of the patriarch. His name has been rendered very unlike itself, by having been lengthened with terminations, and likewise fashioned according to the idiom of different languages. But the circumstances of the history are so precise and particular, that we cannot miss of the truth.

"He seems in the east to have been called *Noas*, *Noasis*, *Nusus*, and *Nus*; and by the Greeks his name was compounded *Dionusus*. The Ammonians, wherever they came, founded cities to his honour; hence places called *Nusa*, will often occur; and indeed a great many of them are mentioned by ancient authors. These, though widely distant, being situated in countries far removed, yet retained the same original histories; and were generally famous for the plantation of the vine. Misled by this similarity of traditions, people in after times imagined that Dionusus must necessarily have been where his history occurred; and as it was the turn of the Greeks to place every thing to the account of conquest, they made him a great conqueror, who went over the face of the whole earth, and taught mankind the plantation of the vine. We are informed, that Dionusus went with an army over the face of the whole earth, and taught mankind, as he passed along, the method of planting the vine, and how to press out the juice, and receive it in proper vessels. Though the patriarch is represented under various titles, and even these not always uniformly appropriated; yet there will continually occur such peculiar circumstances of his history as will plainly point out the person referred to. The person preserved is always mentioned as preserved in an ark. He is described as being in a state of darkness, which is represented allegorically as a state of death. He then obtained a new life, which is called a second birth; and is said to have his youth renewed. He is, on this account, looked upon as the first-born of mankind; and both his antediluvian and postdiluvian states are commemorated, and sometimes the intermediate state is also spoken of. Diodorus calls him *Deucalion;* but describes the deluge as in a manner universal. 'In the deluge which happened in the time of Deucalion, almost all flesh died.' Apollodorus having mentioned Deucalion εν λαρνακι, *consigned to the ark*, takes notice upon his quitting it, of his offering up an immediate sacrifice to the God who delivered him. As he was the father of all mankind, the ancients have made him a person of very extensive rule; and supposed him to have been a king. Sometimes he is described as a monarch of the whole earth; at other times he is reduced to a petty king of Thessaly. He is mentioned by Helladias in this latter capacity; who speaks of the deluge in his time, and of his building altars to the gods. Apollonius Rhodius supposes him to have been a native of Greece, according to the common notions; but notwithstanding his prejudices he gives so particular a character of him, that the true history cannot be mistaken. He makes him indeed the son of Prometheus, the son of Japetus; but in these ancient mythological accounts all genealogy must be entirely disregarded. Though this character be not precisely true, yet we may learn that the person represented was the first of men, through whom religious rites were renewed, cities built, and civil polity established in the world; none of which circumstances are applicable to any king of Greece. We are assured by Philo, that Deucalion was Noah; and the Chaldeans likewise mentioned him by the name of Xisuthrus, as we are informed by Cedrenus.

7
Deucalion proved not to have belonged to Thessaly.

"That Deucalion was unduly adjudged by the people of Thessaly to their country solely, may be proved from his name occurring in different parts of the world, and always accompanied with some history of the deluge. The natives of Syria laid the same claim to him. He was supposed to have founded the temple at Hierapolis, where was a chasm through which the waters after the deluge were said to have retreated. He was likewise reported to have built the temple of Jupiter at Athens; where there was a cavity of the same nature, and a like tradition, that the waters of the flood passed off through this aperture. However groundless the notions may be of the waters having retreated through these passages, yet they show what impressions of this event were retained by the Ammonians, who introduced some history of it wherever they came. As different nations succeeded one another in these parts, and time produced a mixture of generations, they varied the history, and modelled it according to their notions and traditions; yet the ground-work was always true, and the event for a long time universally commemorated. Josephus, who seems to have been a person of extensive knowledge, and versed in the histories of nations, says, that this great occurrence was to be met with in the writings of all persons who treated of the first ages. He mentions Berosus of Chaldea, Hieronymus of Egypt, who wrote concerning the antiquities of Phœnicia; also Alnaseas, Abydenus, Melon, and Nicholaus Damascenus, as writers, by whom it was recorded, and adds, that it was taken notice of by many others.

8
Accounts of the flood among the eastern nations.

"Among the eastern nations, the traces of this event are more vivid and determinate than those of Greece, and more conformable to the accounts of Moses. Eusebius has preserved a most valuable extract to this purpose from Abydenus; which was taken from the archives of the Medes and Babylonians. This writer speaks of Noah, whom he names Seisithrus, as a king; and says, that the flood began upon the 15th day of the month Desius; that during the prevalence of the waters, Seisithrus sent out birds, that he might judge if the flood had remained; but that the birds, not finding any resting place, returned to him again. This was repeated three times; when the birds were found to return with their feet stained with soil; by which he knew the flood was abated. Upon this he quitted the ark, and was never more seen of men, being taken away by the gods from the earth. Abydenus concludes with a particular, in which the eastern writers are unanimous; that the place of descent from the ark was in Armenia, and speaks of its remains being preserved for a long time. Plutarch mentions the

Noachic dove, and its being sent out of the ark. But the most particular history of the deluge, and the nearest of any to the account given by Moses, is to be found in Lucian. He was a native of Samosata, a city of Comagene, upon the Euphrates, a part of the world where memorials of the deluge were particularly preserved, and where a reference to that history was continually kept up in the rites and worship of the country. His knowledge, therefore, was obtained from the Asiatic nations among whom he was born, and not from his kinsmen the Helladians, who were far inferior in the knowledge of ancient times. He describes Noah under the name of *Deucalion;* and says, 'that the present race of mankind are different from those who first existed; for those of the antediluvian world were all destroyed. The present world is peopled from the sons of Deucalion; having increased to so great a number from one person. In respect to the former brood, they were men of violence, and lawless in their dealings. They regarded not oaths, nor observed the rights of hospitality, nor showed mercy to those who sued for it. On this account they were doomed to destruction; and for this purpose there was a mighty eruption of waters from the earth, attended with heavy showers from above; so that the rivers swelled, and the sea overflowed, till the whole earth was covered with a flood, and all flesh drowned. Deucalion alone was preserved to repeople the world. This mercy was shown to him on account of his piety and justice. His preservation was effected in this manner: He put all his family, both his sons and their wives, into a vast ark which he had provided, and he went into it himself. At the same time animals of every species, boars, horses, lions, serpents, whatever lived upon the face of the earth, followed him by pairs; all which he received into the ark, and experienced no evil from them; for there prevailed a wonderful harmony throughout, by the immediate influence of the Deity. Thus were they wafted with him as long as the flood endured.' After this he proceeds to mention, that upon the disappearing of the waters, Deucalion went forth from the ark, and raised an altar to God; but he transposes the scene to Hierapolis in Syria, where the natives pretended, as has been already mentioned, to have very particular memorials of the deluge.

9
Remains of the ark said to have been long visible.

"Most of the authors who have transmitted to us these accounts, at the same time informs us, that the remains of the ark were to be seen in their days on one of the mountains of Armenia. Abydenus particularly says, in confirmation of this opinion, that the people of the country used to get small pieces of the wood, which they carried about by way of amulet. And Berosus mentions, that they scraped off the asphaltus with which it was covered, and used it as a charm. Some of the fathers seem to insist on the certainty of the ark being still remaining in their time. Theophilus says expressly, that the remains were to be seen upon the mountains of Aram, or Armenia. And Chrysostom appeals to it as to a thing well known. 'Do not (says he) those mountains of Armenia bear witness to the truth? those mountains where the ark first rested? And are not the remains of it preserved there even unto this day.'

"There was a custom among the priests of Ammon, of carrying a boat in procession at particular seasons, in which was an oracular shrine held in great veneration. They were said to have been 80 in number, and to have carried the sacred vessel about just as they were directed by the impulse of the Deity. This custom was likewise in use among the Egyptians; and Bishop Pocock has preserved three specimens of ancient sculpture, wherein this ceremony is displayed. They are of wonderful antiquity, and were found by him in Upper Egypt.

10
Boats or ships carried in pro cession by the Amm nians and Egyptian

"Part of the ceremony in most of the ancient mysteries consisted in carrying about a ship or boat; which custom, upon due examination, will be found to relate to nothing else but Noah and the deluge. The ship of Isis is well known, and the festivity among the Ægyptians whenever it was carried in public. The name of this, and of all the navicular shrines, was Baris; which is remarkable, for it was the very name of the mountain, according to Nicolaus Damascenus, on which the ark of Noah rested, the same as Ararat in Armenia. He mentions, that there is a large mountain in Armenia, which stands above the country of the Minyæ, called *Baris;* to this it was said that many people betook themselves in the time of the deluge, and were saved; and there is a tradition of one person in particular floating in an ark, and arriving at the summit of the mountain. We may be assured then, that the ship of Isis was a sacred emblem; in honour of which there was among the Egyptians an annual festival. It was in after times admitted among the Romans, and set down in their kalendar for the month of March. The former, in their description of the primary deities, have continually some reference to a ship or float. Hence we frequently read of Θεοι ναυτιλλοντες (sailing gods). They oftentimes, says Porphyry, describe the sun in the character of a man sailing upon a float. And Plutarch observes to the same purpose, that they did not represent the sun and moon in chariots, *but wafted about upon floating machines.* In doing which they did not refer to the luminaries, but to a person represented under those titles. The sun, or Orus, is likewise described by Jamblichus as sitting upon the lotus, and sailing in a vessel.

11
Wonder ship of S sostris ex plained.

"It is said of Sesostris, that he constructed a ship which was 280 cubits in length. It was of cedar, plated without with gold, and inlaid with silver; and it was, when finished, dedicated to Osiris at Thebes. It is not credible that there should have been a ship of this size, especially in an inland district, the most remote of any in Egypt. It was certainly a temple and a shrine. The former was framed upon this large scale; and it was the latter on which the gold and silver were so lavishly expended. There is a remarkable circumstance relating to the Argonautic expedition; that the dragon slain by Jason was of the size of a trireme; by which must be meant, that it was of the shape of a ship in general, for there were no triremes at the time alluded to. And I have moreover shown, that all these dragons, as they have been represented by the poets, were in reality temples, *Dracontia;* where, among other rites, the worship of the serpent was instituted. There is another reason to think, that this temple, as well as that of Sesostris, was fashioned, in respect to its superficial contents, after the model of a ship; and as to the latter, it was probably intended in its outlines, to be the exact representation of the ark, in commemoration of which it was certainly built. It was a temple sacred to Osiris at Theba: or, to say the truth, it was itself called *Theba;* and both the city, said to be one of the most ancient in Egypt, as well as the province, were undoubtedly denominated from it. Now *Theba* was the name of the ark. It is the very word made use of by the sacred writer; so that we may, I think, be assured of the prototype after which this temple was fashioned. It is said indeed to have been only 280 cubits in length; whereas the ark of Noah was 300. But this is a variation of only one-fifteenth in the whole: and as the ancient cubit was not in all countries the same, we may suppose that this disparity arose rather from the manner of measuring, than from any real difference in the extent of the building. It was an idolatrous temple, said to have been built by Sesostris in honour of Osiris. I have been repeatedly obliged to take notice of the ignorance of the Greeks in respect to ancient titles, and have shown their misapplication of terms in many instances; especially in their supposing temples to have been erected by persons to whom they were in reality sacred. Sesostris was Osiris; the same as Dionusus, Menes, and Noah. He is called *Seisithrus* by Abydenus; *Xixouthros* by Berosus and Apollodorus; and is represented by them as a prince in whose time the deluge happened. He was called *Zuth*, *Xuth*, and *Zeus;* and had certainly divine honours paid to him.

12
Other emblematical representations explained.

"Pausanias gives a remarkable account of a temple of Hercules at Eruthra in Ionia; which he mentions as of the highest antiquity, and very like those of Egypt. The deity was represented upon a float, and was supposed to have come thither in this manner from Phœnicia. Aristides mentions, that at Smyrna, upon the feast called *Dionysia*, a ship used to be carried in procession. The same custom prevailed among the Athenians at the Panathenæa; when what was termed the sacred ship was borne with great reverence through the city to the temple of Dameter at Eleusis. At Phalerus, near Athens, there were honours paid to an unknown hero, who was represented in the stern of a ship. At Olympia, the most sacred place in Greece, was a representation of the like nature. It was a building like the fore-part of a ship, which stood facing the end of the hippodromus; and towards the middle of it was an altar, upon which, at the renewal of each olympiad, certain rites were performed.

"I think it is pretty plain that all these emblematical representations, of which I have given so many instances, related to the history of the deluge, and the conservation of one family in the ark. This history was pretty recent when these works were executed in Egypt, and when the rites were first established: and there is reason to think, that in early times most shrines of the Mizraim were formed under the resemblance of a ship, in memory of this great event. Nay, farther, both ships and temples received their names from thence, being styled by the Greeks, who borrowed largely from Egypt, Ναυς, and Ναος, and mariners Ναυται, *Nautæ*, in reference to the patriarch, who was variously styled *Noas*, *Nous*, and *Noah*.

"However the Greeks may in their mysteries have sometimes introduced a ship as a symbol, yet in their reference to the deluge itself, and to the persons preserved, they always speak of an ark. And though they were apt to mention the same person under various titles, and by these means different people seem to be made principals in the same history; yet they were so far uniform in their account of this particular event, that they made each of them to be exposed in an ark. Thus it is said of Deucalion, Perseus, and Dionusus, that they were exposed upon the waters in a machine of this fabric. Adonis was hid in an ark by Venus, and was supposed to have been in a state of death for a year. Theocritus introduces a pastoral personage named *Comates*, who was exposed in an ark for the same term, and wonderfully preserved. Of Osiris being exposed in an ark we have a very remarkable account in Plutarch; who mentions, that it was on account of *Typhon*, and that it happened on the 17th of the month Athyr, when the sun was in Scorpio. This, in my judgment, was the precise time when Noah entered the ark, and when the flood came, which, in the Egyptian mythology, was called *Typhon.*

13
Explanation of the word *Typhon.*

"Typhon is one of those whose character has been greatly confounded. This has arisen from two different personages being included under one name, who undoubtedly were distinguished in the language of Egypt. Typhon was a compound of *Tuph* or *Tupha-On;* and signified a high altar of the Deity. There were several such in Egypt, upon which they offered human sacrifices; and the cities which had these altars were styled *Typhonian.* But there was another Typhon, who was very different from the former, however by mistake blended with that character. By this was signified a mighty whirlwind and inundation; and it oftentimes denoted the ocean; and particularly the ocean in a ferment. For, as Plutarch observes, by Typhon was understood any thing violent and unruly. It was a derivative from *Tuph*, like the former name; which Tuph seems here to have been the same as the Suph of the Hebrews. By this they denoted a whirlwind; but among the Egyptians it was taken in a greater latitude, and signified any thing boisterous, particularly the sea. Plutarch speaks of it as denoting the sea; and says likewise, that the salt of the sea was called the foam of Typhon. It signified also a whirlwind, as we learn from Euripides, who expresses it Tuphos; and the like is to be found in Hesychius, who calls it a violent wind.

"The history of Typhon was taken from hieroglyphical descriptions. In these the dove, *oinas*, was represented as hovering over the *mundane* egg, which was exposed to the fury of Typhon: For an egg, containing in it the elements of life, was thought no improper emblem of the ark, in which were preserved the rudiments of the future world. Hence, in the Dionusiaca, and in other mysteries, one part of the nocturnal ceremony consisted in the consecration of an egg. By this, we are informed by Porphyry, was signified the world. This world was Noah and his family; even all mankind, inclosed and preserved in the ark.

"In respect to Typhon, it must be confessed that the history given of him is attended with some obscurity. The Grecians have comprehended several characters under one term, which the Egyptians undoubtedly distinguished. The term was used for a title as well as a name; and several of those personages which had a relation to the deluge were styled Typhonian or Diluvian. All these the Grecians have included under one and the same name, Typhon. The real deity by whom the deluge was brought upon the earth had the appellation of Typhonian, by which was meant *Diluvii Deus* (A). It is well known that the ark was constructed by a divine commission: in which, when it was completed, God inclosed the patriarch and his family. Hence it is said, that Typhon made an ark of curious workmanship, that he might dispose of the body of Osiris. Into this Osiris entered, and was shut up by Typhon. All this relates to the Typhonian deity who inclosed Noah, together with his family, within the limits of an ark. The patriarch also, who was thus interested in the event, had the title of Typhonian. I have shown that the ark by the mythologists was spoken of as the mother of mankind. The stay in the ark was looked upon as a state of death and of regeneration. The passage to life was through the door of the ark, which was formed in its side. Through this the patriarch made his descent; and at this point was the commencement of time. This history is obscurely alluded to in the account of Typhon; of whom it is said, that without any regard to time or place, he forced a passage and burst into light obliquely through the side of his mother. This return to light was described as a revival from the grave; and Plutarch accordingly mentions the return of Osiris from *Hades*, after he had been for a long season inclosed in an ark and in a state of death. This renewal of life was by the Egyptians esteemed a second state of childhood. They accordingly, in their hieroglyphics, described him as a boy, whom they placed upon the lotus or water-lily, and called him Orus. He was the supposed son of Isis; but it has been shown that Isis, Rhea, Atargatis, were all emblems of the ark, that *receptacle* which was styled the mother of mankind. Orus is represented as undergoing from the Titans all that Osiris suffered from Typhon; and the history at bottom is the same. Hence it is said of Isis, that she had the power of making people immortal; and that when she found her son Orus, in the midst of the waters, dead through the malice of the Titans, she not only gave him a renewal of life, but also conferred upon him immortality."

In this manner does our author decipher almost all the ancient fables, of which no satisfactory solution was ever given before. He shows that the primitive gods of Egypt, who were in number eight, were no other than the eight persons saved in the ark; that almost all the heathen deities had one way or other a reference to Noah. He shows that he was characterised under the titles of Janus, Nereus, Proteus, Oannes, Dagon, &c. &c. and in short, that the deluge, so far from being unknown to the heathens, or forgot by them, was in a manner the basis of the whole of their worship. He traces the history of the raven and dove sent forth by Noah in the customs of various nations, not only in the east but the west also. Of the numberless testimonies of the truth of this part of sacred history to be met with among the western nations, however, we shall select one more, which is an ancient coin usually known by the name of the *Apamean medal*. "The learned Falconerius (says Mr Bryant) has a curious dissertation upon a coin of Philip the Elder, which was struck at Apamea (B), and contained on its reverse an epitome of this history. The reverse of most Asiatic coins relates to the religion and mythology of the places where they were struck. On the reverse of this coin is delineated a kind of square machine floating upon the water. Through an opening in it are seen two persons, a man and a woman, as low as the breast; and upon the head of the woman is a veil. Over this ark is a triangular kind of pediment, on which there sits a dove; and below it another, which seems to flutter its wings, and hold in its mouth a small branch of a tree. Before the machine is a man following a woman, who by their attitude seem to have just quitted it, and to have got upon dry land. Upon the ark itself, underneath the persons there inclosed, is to be read in distinct characters, ΝΩΕ. The learned editor of this account says, that it had fallen to his lot to meet with three of these coins. They were of brass, and of the medallion size. One of them he mentions to have seen in the collection of the duke of Tuscany; the second in that of the cardinal Ottoboni; and the third was the property of Augustino Chigi, nephew to Pope Alexander VII."

14
Account of the Apamean medal.

15
Accounts of the flood to be met with in China and Japan.

Not content with these testimonies, however, which are to be met with in the western regions, or at least in those not very far to the eastward, our author shows that "the same mythology (of the Egyptians), and the same hieroglyphics, were carried as far as China and Japan; where they are to be found at this day." The Indians have a person whom they call Buto or Budo. This is the same as Boutus of Egypt, Battus of Cyrene, and Bœotus of Greece: the account given of him is similar to that of Typhon; for it is said that he did not come to life in the usual way, but made himself a passage through the side of his mother; which mother is represented as a virgin. This history, though now current among the Indians, is of great antiquity, as we may learn from the account given of this personage by Clemens Alexandrinus. "There is a cast of Indians (says he) who are disciples of Boutas. This person, on account of his extraordinary sanctity, they look up to as a god." The name of Boutas, Battus, and Bœotus, though apparently conferred upon the patriarch, yet originally related to the machine in which he was preserved. Of this some traces may be found among the Greeks. One of the Ammonian names for the ark was Aren or Arene; and Bœotus is said by Diodorus Siculus to have been the son of Neptune and Arne, which is a contraction of *arene* the ark. The chief city, Boutus in Egypt, where

---

(A) "Plutarch owns that the Egyptians in some instances esteemed Typhon to be no other than Helius the chief deity; and they were in the right, though he will not allow it."

(B) Our author had before shown that the ancient name of Apamea was *Cibotus*, one of the names of the ark.

where was the floating temple, signified properly the city of the float or ark. The Bœotians, who in the Dionusiaca so particularly commemorated the ark, were supposed to be descended from an imaginary personage *Bœotus*; and from him likewise their country was thought to have received its name. But Bœotus was merely a variation from Boutus, and Butus, the ark; which in ancient times was indifferently styled Theba, Argus, Aren, Butus, and Bœotus. The term Cibotus is a compound of the same purport, and signifies both the temple of the ark and also a place for shipping.

16 Explana-
ion of the
ord *Chaos.*

"All the mysteries of the Gentile world seem to have been memorials of the deluge, and of the event which immediately succeeded. They consisted for the most part of a melancholy process; and were celebrated by night, in commemoration of the state of darkness in which the patriarch and his family had been involved. The first thing at those awful meetings was to offer an oath of secrecy to all who were to be initiated: after which they proceeded to the ceremonies: these began with a description of chaos; by which was signified some memorial of the deluge. Chaos was certainly the same as βυθος, the great abyss. Who, says Epiphanius, is so ignorant as not to know, that Chaos and Buthos, the abyss, are of the same purport?

"The names of the deities in Japan and China, and the form of them, as well as the mythology with which they are attended, point out the country from whence they originally came. In China the deity upon the lotus in the midst of waters, has been long a favourite emblem, and was imported from the west: the insigne of the dragon was from the same quarter. The Cuthites worshipped Cham, the sun; whose name they variously compounded. In China, most things which have any reference to splendour and magnificence, seem to be denominated from the same object. Cham is said, in the language of that country, to signify any thing *supreme*. Cum is a fine building or palace, similar to Coma of the Ammonians. Cum is a lord or master; Cham a sceptre. Lastly, by Cham is signified a priest, analogous to the Chamanim and Chamenim of Cutha and Babylonia. The country itself is by the Tartars called *Ham*. The cities Cham-ju, Campion, Compition, Cumdan, Chamul, and many others of the same form, are manifestly compounded of the sacred term Cham. Cambalu, the name of the ancient metropolis, is the city of Cham-bal; and Milton styles it very properly *Cambalu, seat of Cathaian Chan*. By this is meant the chief city of the Cuthean monarch; for Chan is a derivative of Cahen, a prince. It seems sometimes in China and Japan to have been expressed Quan and Quano.

"Two temples are taken notice of by Hamilton, near Syrian in Pegu, which he represents as so like in structure, that they seemed to be built on the same model. One of these was called *Kiakiack*, or the *God of Gods temple*. The other is called *the temple of Dagun*; and the doors and windows of it are perpetually shut, so that none can enter but the priests. They will not tell of what shape the idol is, but only say that it is not of human form. The former deity, Kiakiack, is represented as asleep, of a human shape, and 60 feet long; and when he awakes, the world is to be destroyed. As soon as Kiakiack has dissolved the frame and being of this world, Dagun will gather up the fragments, and make a new one. I make no doubt but the true name of the temple was *Iach Iach*, and dedicated to the same god as the Jachusi in Japan. Mr Wise takes notice of the Grecian exclamation to Dionusus, when the terms *Iacche, O Iacche*, were repeated: and he supposes, with great probability, that the Pegnan name had a reference to the same deity. It is certain, that the worship of Dionusus prevailed very early among the nations in the east. The Indians used to maintain, that his rites first began among them. Professor Bayer has shown, that traces of his worship are still to be observed among the Tamuli of Tranquebar. "They have a tradition (says he), that there was once a gigantic person named *Maidashuren*, who was born of Nisadabura near the mountain Meru. He had the horns of a bull, and drank wine, and made war upon the gods. He was attended by eight *Pudam*, who were gigantic and mischievous dæmons, of the family of those Indian shepherds called *Kobaler*." In this account we have a manifest reference to the history of Dionusus, as well as that of the Dionusians, by whom his rites were introduced. And we may perceive that it bears a great resemblance to the acconnts transmitted by the Grecians. What are these Kobaler, who were descended from the shepherds, but the same as the Cobali of Greece, the uniform attendants upon Dionusus? a set of priests whose cruelty and chicanery rendered them infamous. 'The Cobali (says an ancient author) were a set of cruel dæmons, who followed in the retinue of Dionusus. It is a term made use of for knaves and cheats.'

"As the deity, in the second temple of Syrian, to which strangers were not admitted, was not of a human form, and was called *Dagun*, we may easily conceive the hidden character under which he was described. We may conclude, that it was no other than that mixed figure of a man and a fish, under which he was of old worshipped both in Palestine and Syria. He is expressed under this symbolical representation in many parts of India; and by the Bramins is called *Wistnou* or *Vishnou*. Dagon and Vishnou have a like reference. They equally represent the man of the sea, called by Berosus *Oannes*; whose history has been reversed by the Indians. They suppose that he will restore the world, when it shall be destroyed by the chief God. But by Dagon is signified the very person through whom the earth has been already restored when it was in a state of ruin, and by whom mankind was renewed. Dagon and Noah, I have shown to be the same. Vishnou, is represented, like Dagon, under the mixed figure of a man and a fish, or rather of a man, a princely figure, proceeding from a fish. The name of this district, near which the temples above stand, we find to be called *Syrian*; just as was named the region where stood the temples of Atargatis and Dagon. Syrus, Syria, and Syrian, are all of the same purport, and signify Cœlestis and Solaris from *Sehor*, the sun."

Our author next proceeds to describe some of the Indian temples or pagodas; particularly those of Salsette, Elephanta, and another called *Elora*, near Aurunghabad in the province of Balagate, which was visited by Thevenot. The traveller relates, that "upon making diligent inquiry among the natives about

about the origin of these wonderful buildings, the constant tradition was, that all these pagodas, great and small, with all their works and ornaments, were made by giants; but in what age they could not tell."

"Many of these ancient structures (continues Mr Bryant) have been attributed to *Ramscander*, or Alexander the Great; but there is nothing among these stately edifices that in the least savours of Grecian workmanship; nor had that monarch, nor any of the princes after him, opportunity to perform works of this nature. We have not the least reason to think that they ever possessed the country; for they were called off from their attention this way by feuds and engagements nearer home. There is no tradition of this country having been ever conquered except by the fabulous armies of Hercules and Dionusus. What has led people to think that those works were the operation of Alexander, is the similitude of the name *Ramtxander*. To this person they have sometimes been attributed; but Ramtxander was a deity, the supposed son of Bal; and he is introduced among the personages who were concerned in the incarnations of Vishnou.

"The temple of Elora, and all the pagodas of which I have made mention, must be of great antiquity, as the natives cannot reach their era. They were undoubtedly the work of the Indo-Cuthites, who came so early into these parts. And that these structures were formed by them, will appear from many circumstances; but especially from works of the same magnificence which were performed by them in other places. For scarce any people could have effected such great works, but a branch of that family which erected the tower in Babylonia, the walls of Baalbec, and the pyramids of Egypt."

Having then described a number of East Indian idols of surprising magnitude, "the Babylonians and Egyptians (says he), and all of the same great family, used to take a pleasure in forming gigantic figures, and exhibiting other representations equally stupendous. Such were the colossal statues at Thebes, and the sphinx in the plains of Coume. The statue erected by Nebuchadnezzar in the plains of Dura, was in height threescore Babylonish cubits. It was probably raised in honour of *Cham*, the sun; and perhaps it was also dedicated to the head of the Chaldaic family, who was deified, and reverenced under that title. Marcellinus takes notice of a statue of Apollo named *Comeus*; which, in the time of the emperor Verus, was brought from Seleucia to Rome. This related to the same deity as the preceding. We may also infer, that the temple at Kamju was erected to Cham the sun, whom the people worshipped under the name of *Samonifu*."

It is remarkable, that in Japan the priests and nobility have the title of Cami. The emperor Quebacondono, in a letter to the Portuguese viceroy, 1585, tells him that Japan is the kingdom of Chamis; whom, says he, we hold to be the same as *Scin*, the origin of all things. By Scin is probably meant *San*, the sun, who was the same as Cham, rendered here *Chamis*. The laws of the country are spoken of as the laws of Chamis; and we are told by Kæmpfer, that all the gods were styled either *Sin* or *Cami*. The founder of the empire is said to have been *Tensio Dai Sin*, or "Tensio the god of light." Near his temple was a cavern religiously visited, upon account of his having been once hid, when no sun nor stars appeared. He was esteemed the fountain of day, and his temple was called *the temple of Naiku*. Near this cavern was another temple, in which the canusi or priests showed an image of the deity sitting upon a cow. It was called *Daimits No Ray*, "the great representation of the sun." One of their principal gods is *Jakusi*, similar to the Iacchus of the west. Kæmpfer says, that he is the Apollo of the Japanese, and they describe him as the Egyptians did Orus. His temple stands in a town called *Minnoki*: and Jakusi is here represented upon a gilt tarate flower; which is said to be the *nymphæa palustris maxima*, or *faba Egyptiaca* of Prosper Alpinus. One half of a large scallop shell is like a canopy placed over him; and his head is surrounded with a crown of rays. They have also an idol named *Menippe*, much reverenced in different parts. Both these, continues our author, relate to the same person, viz. Noah. Kæmpfer, an author of great credit, saw the temple of Dabys, which he truly renders *Daibod*, at Jedo in Japan. By *Daibod* was meant the god Budha, whose religion was styled the *Budso*, and which prevailed greatly upon the Indus and Ganges. Kæmpfer, from whom Mr Bryant takes this account, says, that the people of Siam represent him under the form of a Moor, in a sitting posture, and of a prodigious size. His skin is black, and his hair curled (probably), and the images about him are of the same complexion. "This god was supposed (says Mr Bryant) to have neither father nor mother. By *Budha* we are certainly to understand the idolatrous symbol called by some nations *Buddo*; the same as *Argus* and *Theba* (names for the ark). In the mythology concerning it, we may see a reference both to the machine itself and to the persons preserved in it. In consequence of which we find this person also styled *Bod*, *Budha*, and *Buddo*; and in the west *Butus*, *Battus*, and *Bœotus*. He was said by the Indians not to have been born in the ordinary way, but to have come to light indirectly through the side of his mother. By Clemens of Alexandria he is called *Bouta*: and in the history of this person, however varied, we may perceive a relation to the arkite deity of the sea, called *Poseidon* or Neptune; also to Arculus and Dionusus, styled *Bœotus* and *Thebanus*. Kæmpfer has a curious history of a deity of this sort called *Abutto*; whose temple stood in the province of Bungo, upon the sea-shore, near the village of Toma. About a quarter of a German mile before you come to this village, stands a famous temple of the god Abutto; which is said to be very eminent for miraculously curing many inveterate distempers, as also for procuring a wind and good passage. For this reason, sailors and passengers always tie some farthings to a piece of wood, and throw it into the sea, as an offering to this Abutto, to obtain a favourable wind. The same deity, but under a different name, was worshipped in China. The Apis, Mneuis, and Anubis of Egypt, have often been mentioned and explained, as well as the Minotaur of Crete. The same hieroglyphics occur in Japan; and we are informed by Marco Polo, that the inhabitants worship idols of different shapes. Some have the head of an ox, some of a swine, and others the head of a dog. The

The most common representation in this country is that of *Godso Ten Oo*, or ‘ the ox-headed prince of heaven.’

“ It has already been noticed, that the ark was represented under the symbol of an egg, called the *mundane egg ;* which was exposed to the rage of Typhon. It was also described under the figure of a lunette, and called *Selene*, the moon. The person by whom it was framed, and who through its means was providentially preserved, occurs under the character of a steer, and the machine itself under the semblance of a cow or heifer. We have moreover been told that it was called *Cibotus*, which Clemens of Alexandria calls *Thebotha.* Epiphanius mentions it by the name *Idaal Baoth ;* and says that, according to an eastern tradition, a person named *Nun* was preserved in it. The horse of Neptune was another emblem, as was also the hippopotamus or river-horse. The people of Elis made use of the tortoise for the same purpose, and represented Venus as resting upon its back. Some traces of these hieroglyphics are to be found in Japan, which were certainly carried thither by the Indic Ethiopians.

“ From an account of a temple of *Daiboth* (probably the same with Daibod) at Meaco in Japan, we may perceive that the people there speak of the renewal of the world at the deluge as the real creation, which I have shown to be a common mistake in the histories of the event. And though the story is told with some variation, yet in all the circumstances of consequence it accords very happily with the mythology of Egypt, Syria, and Greece. It matters not how the emblems have by length of time been misinterpreted. We have the mundane egg upon the waters, and the concomitant symbol of the moon ; and the egg at last opened by the assistance of the sacred steer, upon which the world issues forth to this day.” The author proceeds afterwards to mention the great veneration paid in these parts to the ox and cow ; and says, that nobody dares injure them. One deity of the Japanese was Canon, the reputed lord of the ocean. He was represented in an erect posture, crowned with a flower, and coming out of the mouth of a fish. He is represented in the same manner by the natives of India, and named *Vishnou* and *Macauter ;* and he is to be found in other parts of the east. Father Boushet mentions a tradition among the Indians concerning a flood in the days of Vishnou which covered the whole earth. It is moreover reported of him, that seeing the prevalence of the waters, he made a float ; and being turned into a fish, he steered it with his tail. This person, in the account of the Banians by Lord, is called *Menow ;* which certainly should be expressed *Men-Now.* It is said, that in the Shaster of this people, a like history is given of the earth being overwhelmed by a deluge, in which mankind perished ; but the world was afterwards renewed in two persons called *Menou* and *Ceteroupa.* Vishnou is described under many characters, which he is said at times to have assumed. One of these, according to the bramins of Tanjour, was that of Rama Sami. This undoubtedly is the same as Sama Rama of Babylonia, only reversed : and it relates to that great phenomenon the Iris ; which was generally accompanied with the dove, and held in veneration by the Semarim.

“ As the history of China is supposed to extend upwards to an amazing height, it may be worth while to consider the first eras in the Chinese annals, as they are represented in the writings of Japan (for the Japanese have preserved histories of China) ; and by such a collation, I believe no small light may be obtained towards the discovery of some important truths. Hitherto it has not been observed that such a collation could be made.

17
Japanese history of China.

“ In the histories of this country, the first monarch of China is named *Foki ;* the same whom the Chinese call *Fohi*, and place at the head of their list. This prince had, according to some, the body, according to others the head, of a serpent. If we may believe the Japanese historians, he began his reign above 21,000 years before Christ. The second Chinese emperor was Sin-Noo, by the people of China called *Sin-Num ;* and many begin the chronology of the country with him. He is supposed to have lived about 3000 years before Christ ; consequently there is an interval of near 18,000 years between the first emperor and the second ; a circumstance not to be credited. The third, who immediately succeeded Sin-Noo, was Hoam-Ti. In this account we may, I think, perceive, that the Chinese have acted like the people of Greece and other regions. The histories which were imported they have prefixed to the annals of the nation ; and adopted the first personages of antiquity, and made them monarchs in their own country. Whom can we suppose Fohi, with the head of a serpent, to have been, but the great founder of all kingdoms, the father of mankind ? They have placed him at an immense distance, not knowing his true era. And I think we may be assured, that under the character of Sin-Num and Sin-Noo we have the history of Noah ; and Hoam-Ti was no other than Ham. According to Kæmpfer, Sin-Noo was exactly the same character as Serapis of Egypt. ‘ He was a husbandman, and taught mankind agriculture, and those arts which relate to the immediate support of life. He also discovered the virtues of many plants ; and he was represented with the head of an ox, and sometimes only with two horns. His picture is held in high estimation by the Chinese.’ Well indeed might Kæmpfer think, that in Sin-Noo he saw the character of Serapis ; for this personage was no other than Sar-Apis, the great father of mankind, the same as Men-Neuas of Egypt, the same also as Dionusus and Osiris. By Du Halde he is called *Chin-Nong*, and made the next monarch after Fohi. The Chinese accounts afford the same history as has been given above.

“ As the family of Noah consisted of eight persons inclusive, there have been writers who have placed some of them in succession, and supposed that there were three or four persons who reigned between Sin-Noo and Hoam. But Du Halde says, that in the true histories of the country, the three first monarchs were Fohi, Chin-Nong, and Hoam, whom he styles *Hoang-Ti.* To these, he says, the arts and sciences owe their invention and progress. Thus we find, that those who were heads of families have been raised to be princes ; and their names have been prefixed to the list of kings ; and their history superadded to the annals of the country. It is further observable, in the accounts given of those supposed kings, that their term of life, for the first five or six generations, corresponds with that of the patriarchs after the flood, and decreases much in the same proportion.

18 History of Japan.

"The history of Japan is divided into three æras; which consist of gods, demigods, and mortals. The person whom the natives look upon to be the real founder of their monarchy is named *Synmu;* in whose reign the Sintoo religion, the most ancient of the country, was introduced. It was called *Sin-sju* and *Chami-mitsa;* from Sin and Chami, the deities which were the objects of worship. At this time it is said that 600 foreign idols were brought into Japan. To the Sintoo religion was afterwards added the Budso, together with the worship of Amida. This deity they commonly represented with the head of a dog, and esteemed him the guardian of mankind. This religion was more complicated than the former, and abounded with hieroglyphical representations and mysterious rites. It is the same which I have termed the *Arkite Idolatry*, wherein the sacred steer and cow were venerated. The deity was represented upon the lotus and upon a tortoise, and oftentimes as proceeding from a fish. In this also, under the character of Budha, we may trace innumerable memorials of the ark, and of the person preserved in it. The author above, having mentioned the eleventh emperor inclusive from Syn-Mu, tells us, that in his time these rites began. 'In his reign Budo, otherwise called *Kobotus*, came over from the Indies to Japan; and brought with him, upon a white horse, his religion and doctrines.' We find here, that the object of worship is made the person who introduced it (a mistake almost universally prevalent); otherwise in this short account what a curious history is unfolded!

"The only people to whom we can have recourse for any written memorials concerning these things are the inhabitants of India Proper. They were, we find, the persons who introduced these hieroglyphics both in China and Japan. It will therefore be worth while to consider what they have transmitted concerning their religious opinions; as we may from hence obtain still greater light towards explaining this symbolical worship. Every manifestation of God's goodness to the world was in the first ages expressed by an hieroglyphic; and the Deity was accordingly described under various forms, and in different attitudes. These at length were mistaken for real transfigurations; and Vishnou was supposed to have appeared in different shapes, which were styled *incarnations*. In one of these he is represented under the figure before mentioned, of a princely person coming out of a fish. In another he appears with the head of a boar, treading upon an evil dæmon, which seems to be the same as the Typhon of the Egyptians. On his head he supports a lunette, in which are seen cities, towers, in short, all that the world contains. In Baldæus we have a delineation and history of this incarnation. Kircher varies a little in his representation, yet gives him a similar figure of the Deity, and styles him *Vishnou Barachater*. By this I should think was signified Vishnou, "the offspring of the fish." The bramins say, that there was a time when the serpent with a thousand heads withdrew itself, and would not support the world, it was so overburdened with sin. Upon this the earth sunk in the great abyss of waters, and mankind and all that breathed perished. But Vishnou took upon himself the form above described, and diving to the bottom of the sea, lifted up the earth out of the waters, and placed it, together with the serpent of a thousand heads, upon the back of a tortoise.

19 Account the cosm gony and deluge given by t Persees.

"In the third volume of M. Perron's Zendavesta there is an account given of the cosmogony of the Persees; also of the subsequent great events that ensued. The supreme Deity, called by him *Ormisda*, is said to have accomplished the creation at six different intervals. He first formed the heavens; at the second the waters; at the third the earth. Next in order were produced the trees and vegetables; in the fifth place were formed birds and fishes, and the wild inhabitants of the woods; and in the sixth and last place, he created man. The man thus produced is said to have been an *ox-like* person, and is described as consisting of a purely divine and a mortal part. For some time after his creation he lived in great happiness; but at last the world was corrupted by a dæmon named *Ahriman*. This dæmon had the boldness to visit heaven: whence he came down to the earth in the form of a serpent, and introduced a set of wicked beings, called *karsesters*. By him the first ox-like personage, called *Aboudad*, was so infected that he died; after which Kaimorts, probably the divine part, of which the ox was the representative, died also. Out of the left arm of the deceased proceeded a being called *Goschoraun*, who is said to have raised a cry louder than the shout of 1000 men. After some conversation between the supreme Deity and Goschorann, it was determined to put Ahriman to flight, and to destroy all those wicked persons he had introduced; for there now seemed to be an universal opposition to the supreme Deity Ormisda. At this season a second ox-like personage is introduced by the name of *Taschter*. He is spoken of both as a star and a sun. At the same time he is mentioned as a person upon earth under three forms. By Taschter is certainly signified *De Ashter;* the same person whom the Greeks and Syrians represented as a female, and called *Astarte*. She was described horned, and sometimes with the head of a bull; supposed to proceed from an egg; and they esteemed her the same as Juno and the moon. At last it was thought proper to bring an universal inundation over the face of the earth; that all impurity might be washed away; which being accomplished by Taschter, every living creature perished, and the earth was for some time entirely covered. At last, the waters retreating within their proper bounds, the mountain of Albordi in Ferakh-kand first appeared; which the author compares to a tree, and supposes that all other mountains proceeded from it. After this there was a renewal of the world; and the earth was restored to its pristine state. The particular place where Ormisda planted the germina from whence all things were to spring, was Ferakh-kand, which seems to be the land of Arach; the country upon the Araxes in Armenia."

Thus we have given an ample specimen of this very ingenious author's method of reasoning, and discovering traces of the sacred history even in things which have been thought least to relate to it. That the Greeks and western nations had some knowledge of the flood, the flood, has never been denied; and from what has been already related, it appears that the same has pervaded the remotest regions of the east. The knowledge which these people have of the fall of man, and the evil consequences which ensued, cannot, according to our author, be the consequences of their intercourse with Christians: for their traditions afford neither any traces of Christianity, nor its founder. Whatever truths may be found in their writings, therefore, must be derived from a more ancient source. "There are (says he) in every climate some shattered fragments of original history; some traces of a primitive and universal language: and these may be observed in the names of deities, terms of worship, and titles of honour, which prevail among nations widely separated, who for ages had no connexion. The like may be found in the names of pagodas and temples; and of sundry other objects which will present themselves to the traveller. Even America would contribute to this purpose. The more rude the monuments, the more ancient they may possibly prove, and afford a greater light upon inquiry."

20
merican
ccounts of
e deluge.

The accounts hitherto met with in this continent, indeed, are far from being equally authentic and satisfactory with those hitherto treated of. In Acosta's history of the Indies, however, we are informed, that the Mexicans make particular mention of a deluge in their country, by which *all men* were drowned. According to them, one *Viracocha* came out of the great lake Titicaca in their country. This person staid in Tiaguanaco, where at this day are to be seen the ruins of some ancient and very strange buildings. From thence he came to Cusco, where mankind began to multiply. They show also a small lake, where they say the sun hid himself: for which reason they sacrifice largely to him, both men and other animals.—Hennepin informs us, that some of the savages are of opinion, that a certain spirit, called *Otkon* by the Iroquois, and *Atahauta* by those at the mouth of the river St Lawrence, is the creator of the world; that *Messou* repaired it after the deluge. They say, that this Messou or Otkon, being a-hunting one day, his dogs lost themselves in a great lake, which thereupon overflowing, covered the whole earth in a short time, and swallowed up the world. According to Herrera, the people of Cuba knew that the heavens and the earth had been created; and said they had much information concerning the flood; and that the world had been destroyed by water, by three persons, who came three several ways. Gabriel de Cabrera was told by a man of more than 70 years of age, that an old man, knowing the deluge was to come, built a great ship, and went into it with his family and abundance of animals; that he sent out a crow, which did not at first return, staying to feed on the carcases of dead animals, but afterwards came back with a green branch. He is said to have added other particulars nearly consonant to the Mosaic account, as far as Noah's sons covering him when drunk, and the other scoffing at it. The Indians, he said, descended from the latter, and therefore had no clothes: but the Spaniards descending from the former, had both clothes and horses.—The same author likewise informs us, that it was reported by the inhabitants of Castilla del Oro in Terra Firma, that when the universal deluge happened, one man with his wife and children escaped in a canoe, and that from them the world was peopled. The Peruvians, according to our author, likewise affirmed, that they had received by tradition from their ancestors, that, many years before there were any incas or kings, when the country was very populous, there happened a great flood; the sea breaking out beyond its bounds, so that the land was covered with water, and all the people perished. To this it is added by the Guancas, inhabiting the vale of Xausea, and the natives of Chiquito in the province of Callao, that some persons remained in the hollows and caves of the highest mountains, who again peopled the land. Others affirm, that all perished in a deluge, only six persons being saved in a float, from whom descended all the inhabitants of that country. In Nieuhoff's voyages to Brazil, we are informed, that the most barbarous of the Brasilians, inhabiting the inland countries, scarce knew any thing of religion or an Almighty Being: they have some knowledge remaining of a general deluge; it being their opinion that the whole race of mankind were extirpated by a general deluge, except one man and his sister, who, being with child before, they by degrees repeopled the world. M. Thevet gives us the creed of the Brasilians in this matter more particularly. In the opinion of these savages the deluge was universal. They say, that *Summay*, a Caribbee of great dignity, had two children named *Tamendonare* and *Ariconte*. Being of contrary dispositions, one delighting in peace and the other in war and rapine, they mortally hated each other. One day Ariconte, the warrior, brought an arm of an enemy he had encountered to his brother, reproaching him at the same time with cowardice. The other retorted by telling, that if he had been possessed of the valour he boasted, he would have brought his enemy entire. Ariconte on this threw the arm against the door of his brother's house. At that instant the whole village was carried up into the sky, and Tamendonare striking the ground with violence, a vast stream of water issued out from it, and continued to flow in such quantity, that in a short time it seemed to rise above the clouds, and the earth was entirely covered. The two brothers, seeing this, ascended the highest mountains of the country, and with their wives got upon the trees that grew upon them. By this deluge all mankind, as well as all other animals, were drowned, except the two brothers above mentioned and their wives, who having descended when the flood abated, became heads of two different nations," &c.

21
Testimonies from Otaheite and the East Indies.

To these American testimonies we may add another from the remote and uncivilized island of Otaheite. Dr Watson *, in his discourse to the clergy, informs us, that one of the navigators to the southern hemisphere have asked some of the inhabitants of that island concerning their origin, was answered, that their supreme God, a long time ago, being angry, dragged the earth through the sea, and their island being broken off, was preserved. In the East Indies, we are informed by Dr Watson †, that Sir William Jones, by whom a society for the advancement of Asiatic literature was instituted at Calcutta, discovered in the oldest mythological books of that country, such an account of the deluge as corresponds sufficiently with that of Moses.

---

* *Sermons and Tracts*, p. 203.

† *Ibid.* p. 221.

22
Hypotheses concerning the means by which the deluge took place.

II. The fact being thus established by the universal consent of mankind, that there was a general deluge which overflowed the whole world; it remains next to inquire, by what means it may reasonably be supposed to have been accomplished. The hypotheses on this subject have been principally the following.

23.
Supposed creation; and annihilation of water.

1. It has been asserted, that a quantity of water was created on purpose, and at a proper time annihilated, by divine power. This, however, besides its being absolutely without evidence, is directly contrary to the words of the sacred writer whom the assertors of this hypothesis mean to defend. He expressly derives the waters of the flood from two sources; first, the fountains of the great deep, which he tells us were all broken up; and secondly, the windows of heaven, which he says were opened: and speaking of the decrease of the waters, he says, the fountains of the deep and the windows of heaven were stopped, and the waters returned continually from off the earth. Here it is obvious, that Moses was so far from having any difficulty about the quantity of water, that he thought the sources from whence it came were not exhausted; since both of them required to be stopped by the same almighty hand who opened them, lest the flood should increase more than it actually did.

24
Theory of Dr Burnet.

2. Dr Burnet, in his *Telluris Theoria Sacra*, endeavours to show, that all the waters in the ocean were not sufficient to cover the earth to the depth assigned by Moses. Supposing the sea drained quite dry, and all the clouds of the atmosphere dissolved into rain, we should still, according to him, want much the greatest part of the water of a deluge. To get clear of this difficulty, Dr Burnet and others have adopted Descartes's theory. That philosopher supposes the antediluvian world to have been perfectly round and equal, without mountains or valleys. He accounts for its formation on mechanical principles, by supposing it at first in the condition of a thick turbid fluid replete with divers heterogeneous matters; which, subsiding by slow degrees, formed themselves into different concentric strata, or beds, by the laws of gravity. Dr Burnet improves on this theory, by supposing the primitive earth to have been no more than a shell or crust investing the surface of the water contained in the ocean, and in the central abyss which he and others suppose to exist in the bowels of the earth *. At the time of the flood, this outward crust, according to him, broke in a thousand pieces; and consequently sunk down among the water, which thus spouted up in vast cataracts, and overflowed the whole surface. He supposes also, that before the flood there was a perfect coincidence of the equator with the ecliptic, and consequently that the antediluvian world enjoyed a perpetual spring; but that the violence of the shock by which the outer crust was broken, shifted also the position of the earth, and produced the present obliquity of the ecliptic. The theory, it will be observed, is equally arbitrary with the former. But it is, besides, directly contrary to the words of Moses, who assures us, that all the high hills were covered; while Dr Burnet affirms that there were then no hills in being.

*See *Abyss*.

25
Centre of gravity of the earth supposed to be shifted.

3. Other authors, supposing a sufficient fund of water in the abyss or sea, are only concerned for an expedient to bring it forth: accordingly some have recourse to a shifting of the earth's centre of gravity, which, drawing after it the water out of its channel, overwhelmed the several parts of the earth successively.

26
Mr Whiston's theor

4. The inquisitive Mr Whiston, in his *New Theory of the Earth*, shows, from several remarkable coincidences, that a comet descending in the plane of the ecliptic, towards its perihelion, passed just before the earth on the first day of the deluge; the consequences whereof would be, first, that this comet, when it came below the moon, would raise a vast and strong tide, both in the small seas, which according to his hypothesis were in the antediluvian earth (for he allows no great ocean there as in ours), and also in the abyss which was under the upper crust of the earth. And this tide would rise and increase all the time of the approach of the comet towards the earth; and would be at its greatest height when the comet was at its least distance from it. By the force of which tide, as also by the attraction of the comet, he judges, that the abyss must put on an elliptical figure, whose surface being considerably larger than the former spherical one, the outward crust of the earth, incumbent on the abyss, must accommodate itself to that figure, which it could not do while it held solid, and conjoined together. He concludes, therefore, that it must of necessity be extended, and at last broken by the violence of the said tides and attraction; out of which the included water issuing, was a great means of the deluge; this answering to what Moses speaks of the "fountains of the great deep being broken open."—Again, the same comet, he shows, in its descent towards the sun, passed so close by the body of the earth, as to involve it in its atmosphere and tail for a considerable time; and of consequence left a vast quantity of its vapours, both expanded and condensed on its surface; a great part of which being rarefied by the solar heat, would be drawn up into the atmosphere, and afterwards return in violent rains: and this he takes to be what Moses intimates by "the windows of heaven being opened," and particularly by the "forty days rain." For as to the following rain, which with this made the whole time of raining 150 days, Mr Whiston attributes it to the earth coming a second time within the atmosphere of the comet, as the comet was on its return from the sun. Lastly, to remove this vast orb of waters again, he supposes a mighty wind to have arisen, which dried up some, and forced the rest into the abyss through the clefts by which it came up: only a good quantity remained in the alveus of the great ocean, now first made, and in lesser seas, lakes, &c. This theory was at first only proposed as an hypothesis; but, on further consideration, Mr Whiston thought he could actually prove that a comet did at that time pass very near the earth, and that it was the same which afterwards appeared in 1688. After this he looked upon his theory no longer as an hypothesis, but published it in a particular tract, entitled *The Cause of the Deluge demonstrated.* But the uncertainty of the comet's return in 1758, and the absolute failure of that which ought to have appeared in 1788 or 1789, must certainly render Mr Whiston's calculations for such a length of time extremely dubious: and the great similarity between the tails of comets, and streams of electric matter, renders his sup-

position of their being aqueous vapours exceedingly improbable.

27 eory of de la yme.

5. According to Mr de la Pryme, the antediluvian world had an external sea as well as land, with mountains, rivers, &c. and the deluge was effected by breaking the subterraneous caverns and pillars thereof, with dreadful earthquakes, and causing the same to be for the most part, if not wholly, absorbed and swallowed up, and covered by the seas that we now have. Lastly, this earth of ours arose out of the bottom of the antediluvian sea: and in its room, just as many islands are swallowed down, and others thrust up in their stead. On this, as on all the other hypotheses, it may be remarked, that it is quite arbitrary, and without the least foundation from the words of Moses. The sacred historian speaks not one word of earthquakes, nay, from the nature of the thing, we know it is impossible that the flood could have been occasioned by an earthquake, and the ark preserved, without a miracle. It is certain, that if a ship sinks at sea, the commotion excited in the water by the descent of such a large body, will swallow up a small boat that happens to come too near. If the pillars of the earth itself then were broken, what must the commotion have been, when the continents of Europe, Asia, and Africa, descended into the abyss at once; not to mention America, which lying at so great a distance from Noah, he might be supposed out of danger from that quarter. By what miracle was the little ark preserved amidst the tumult of those impetuous waves which must have rushed in from all quarters? Besides, as the ark was built not at sea, but on dry ground, when the earth on which it rested sunk down, the ark must have sunk along with it; and the waters falling in as it were overhead, must have dashed in pieces the strongest vessel that can be imagined. Earthquakes, also, operate suddenly and violently; whereas, according to the Mosaic account, the flood came on gradually, and did not arrive at its height till six weeks, or perhaps five months, after it began.

28 tchinso- an theo-

6. Mr Hutchinson and his followers present us with a theory of the deluge, which they pretend to derive from the word of God itself. This theory hath been particularly enlarged upon and illustrated by Mr Catcot, who in 1768 published a volume on the subject. This gentleman asserts, that when the world was first created, at the time when it is said to have been "without form and void," the terrestrial matter was then entirely dissolved in the aqueous; so that the whole formed, as it were, a thick muddy water. The figure of this mass was spherical; and on the outside of this sphere lay the gross dark air. Within the sphere of earth and water was an immense cavity, called by Moses the *deep*; and this internal cavity was filled with air of a kind similar to that on the outside. On the creation of light, the internal air received elasticity sufficient to burst out through the external covering of earth and water. Upon this the water descended, filled up the void, and left the earth in a form similar to what it hath at present. Thus, according to him, the antediluvian world, as well as the present, consisted of a vast collection or nucleus of water, called the *great deep*, or the *abyss*; and over this the shell of earth perforated in many places; by which means the waters of the ocean communicated with the abyss. The breaking up of these fountains was occasioned by a miraculous pressure of the atmosphere, from the immediate action of the Deity himself. So violent was this pressure, that the air descended to where it had been originally; occupied the space of the abyss; and drove out the waters over the whole face of the dry land. But this account, so far for being infallibly certain, seems inconsistent with the most common observation. No pressure, however violent, will cause water rise above its level, unless the pressure is unequal. If, therefore, the atmosphere entered into the supposed abyss, by a vehement pressure on the surface of the ocean, that pressure must only have been on one place, or on a few places; and even though we suppose the atmosphere to have been the agent made use of, it is impossible that it could have remained for any time in the abyss without a continued miracle; as the pressure of the water would immediately have forced it up again through those holes which had afforded it a passage downwards.

The explication given from Hutchinson by Mr Catcot, of the "windows of heaven," is somewhat extraordinary. According to him, these windows are not in heaven, but in the bowels of the earth; and mean no more than the cracks and fissures by which the *airs*, as he calls them, found a passage through the shell or covering of earth, which they utterly dissolved and reduced to its original state of fluidity. It is, however, difficult to conceive how the opening of such windows as these, could cause a violent rain for 40 days and nights.

It is not to be supposed, that we can pretend to ascertain any thing on the subject more than others have done. The following conjectures, however, may be offered on the manner in which the deluge might have happened, without any violence to the established laws of nature.

29 Another theory.

1. If we consider the quantity of water requisite for the purpose of the deluge, it will not appear so very extraordinary as has been commonly represented. The height of the highest hills is thought not to be quite four miles. It will therefore be deemed a sufficient allowance, when we suppose the waters of the deluge to have been four miles deep on the surface of the ground. Now it is certain, that water, or any other matter, when spread out at large upon the ground, seems to occupy an immense space in comparison of what it does when contained in a cubical vessel, or when packed together in a cubical form. Suppose we wanted to overflow a room 16 feet every way, or containing 256 square feet, with water, to the height of one foot, it may be nearly done by a cubical vessel of six feet filled with water. A cube of eight feet will cover it two feet deep, and a cube of ten feet will very nearly cover it four feet deep. It makes not the least difference whether we suppose feet or miles to be covered. A cube of ten miles of water would very nearly overflow 256 square miles of plain ground to the height of four miles. But if we take into our account the vast number of eminences with which the surface of the earth abounds, the above-mentioned quantity of water would do a great deal more. If, therefore, we attempt to calculate the quantity of water sufficient to deluge the earth, we must make a very considerable allowance for the bulk of all the hills on its surface.

To consider this matter, however, in its utmost latitude: The surface of the earth is supposed, by the latest computations, to contain 199,512,595 square miles. To overflow this surface to the height of four miles, is required a parallelopiped of water 16 miles deep, and containing 49,878,148 square miles of surface. Now, considering the immense thickness of the globe of the earth, it can by no means be improbable, that this whole quantity of water may be contained in its bowels, without the necessity of any remarkable abyss or huge collection of water, such as most of our theorists suppose to exist in the centre. It is certain, that as far as the earth has been dug, it hath been found not dry, but moist; nor have we the least reason to imagine, that it is not at least equally moist all the way down to the centre. How moist it really is cannot be known, nor the quantity of water requisite to impart to it the degree of moisture it has; but we are sure it must be immense. The earth is computed to be near 8000 miles in diameter. The ocean is of an unfathomable depth; but there is no reason for supposing it more than a few miles. To make all reasonable allowance, however, we shall suppose the whole solid matter in the globe to be only equal to a cube of 5000 miles; and even on this supposition we shall find, that all the waters of the deluge would not be half sufficient to moisten it. The above-mentioned parallelopiped of water would indeed contain 798,050,368 cubic miles of the fluid; but the cube of earth containing no less than an hundred and twenty-five thousand millions of cubic miles, it is evident that the quantity assigned for the deluge would scarce be known to moisten it. It could have indeed no more effect this way, than a single pound of water could have upon 150 times its bulk of dry earth. We are persuaded, therefore, that any person who will try by experiment how much water a given quantity of earth contains, and from that experiment will make calculations with regard to the whole quantity of water contained in the bowels of the earth, must be abundantly satisfied, that though *all* the water of the deluge had been thence derived, the diminution of the general store would, comparatively speaking, have been next to nothing.

2. It was not from the bowels of the earth only that the waters were discharged, but also from the air; for we are assured by Moses, that it rained 40 days and 40 nights. This source of the diluvian waters hath been considered as of small consequence by almost every one who hath treated on the subject. The general opinion concerning this matter we shall transcribe from the Universal History, vol. i. where it is very fully expressed. "According to the observations made of the quantity of water that falls in rain, the rains could not afford one ocean, nor half an ocean, and would be a very inconsiderable part of what was necessary for a deluge. If it rained 40 days and 40 nights throughout the whole earth at once, it might be sufficient to lay all the lower grounds under water, but it would signify very little as to the overflowing of the mountains; so that it has been said, that if the deluge had been made of rains only, there would have needed not 40 days, but 40 years, to have brought it to pass. And if we suppose the whole atmosphere condensed into water, it would not all have been sufficient for this effect; for it is certain that it could not have risen above 32 feet, the height to which water can be raised by the pressure of the atmosphere; for the weight of the whole air, when condensed into water, can be no more than equal to its weight in its natural state, and must become no less than 800 times denser; for that is the difference between the weight of the heaviest air and that of water."

On this subject we must observe, that there is a very general mistake with regard to the air, similar to the above-mentioned one regarding the earth. Because the earth below our feet appears to our senses firm and compact, therefore the vast quantity of water, contained even in the most solid parts of it, and which will readily appear on proper experiment, is overlooked, and treated as a non-entity. In like manner, because the air does not always deluge with excessive rains, it is also imagined that it contains but very little water. Because the pressure of the air is able to raise only 32 feet of water on the surface of the earth, it is therefore supposed we may know to what depth the atmosphere could deluge the earth if it was to let fall the *whole* water contained in it. But daily observation shows, that the pressure of the atmosphere hath not the least connexion with the quantity of water it contains. Nay, if there is any connexion, the air seems to be lightest when it contains most water. In the course of a long summer's drought, for instance, the mercury in the barometer will stand at 30 inches, or little more. If it does so at the beginning of the drought, it ought to ascend continually during the time the dry weather continues; because the air is all the while absorbing water in great quantity from the surface of the earth and sea. This, however, is known to be contrary to fact. At such times the mercury does not ascend, but remains stationary; and what is still more extraordinary, when the drought is about to have an end, the air, while it yet contains the whole quantity of water it absorbed, and hath not discharged one single drop, becomes suddenly lighter, and the mercury will perhaps sink an inch before any rain falls. The most surprising phenomenon, however, is yet to come. After the atmosphere has been discharging for a number of days successively, a quantity of matter 800 times heavier than itself, instead of being *lightened* by the discharge, it becomes *heavier*, nay, *specifically* heavier, than it was before. It is also certain, that very dry air, provided it is not at the same time very hot, is always heaviest; and the driest air which we are acquainted with, namely Dr Priestley's *dephlogisticated* air (oxygen gas), is considerably heavier than the air we commonly breathe. For these reasons, we think the quantity of water contained in the whole atmosphere ought to be considered as *indefinite*, especially as we know that by whatever agent it is suspended, that agent must counteract the force of gravity, otherwise the water would immediately descend; and while the force of gravity in any substance is counteracted, that substance cannot appear to us to gravitate at all.

3. The above considerations render it *probable* at least that there is in nature a quantity of water sufficient to deluge the world, provided it was applied to the purpose. We must next consider whether there is any natural agent powerful enough to effectuate this purpose. We shall take the phrases used by Moses in their most obvious sense. *The breaking up of the fountains of the deep,*

deep, we may reasonably suppose to have been the opening of all passages, whether small or great, through which the subterraneous waters possibly could discharge themselves on the surface of the earth. The *opening of the windows of heaven* we may also suppose to be the pouring out the water contained in the atmosphere, through those invisible passages by which it enters in such a manner as totally to elude every one of our senses, as when water is absorbed by the air in evaporation. As both these are said to have been opened at the same time, it seems from thence probable, that one natural agent was employed to do both. Now it is certain, that the industry of modern inquiry hath discovered an agent unknown to the former ages, and whose influence is so great, that with regard to this world, it may be said to have a kind of *omnipotence*. The agent we mean is electricity. It is certain, that, by means of it, immense quantities of water can be raised to a great height in the air. This is proved by the phenomena of water-spouts. Mr Forster relates, that he happened to see one break very near him, and observed a flash of lightning proceed from it at the moment of its breaking. The conclusion from this is obvious. When the electric matter was discharged from the water, it could no longer be supported by the atmosphere, but immediately fell down, Though water-spouts do not often appear in this country, yet every one must have made an observation somewhat similar to Mr Forster's. In a violent storm of thunder and rain, after every flash of lightning or discharge of electricity from the clouds, the rain pours down with increased violence: thus showing, that the cloud, having parted with so much of its electricity, cannot longer be supported in the form of vapour, but must descend in rain. It is not indeed yet discovered that electricity is the cause of the suspension of water in the atmosphere; but it is certain that evaporation is promoted by electrifying the fluid to be evaporated *. It may therefore be admitted as a *possibility*, that the electric fluid contained in the air is the agent by which it is enabled to suspend the water which rises in vapour. If therefore the air is deprived of the due proportion of this fluid, it is evident that rain must fall in prodigious quantities.

Again, we are assured from the most undeniable observations that electricity is able to swell up water on the surface of the earth. This we can make it do even in our trifling experiments; and much more must the whole force of the fluid be supposed capable of doing it, if applied to the waters of the ocean, or any others. The agitation of the sea in earthquakes is a sufficient proof of this †. It is certain, that at these times there is a discharge of a vast quantity of electric matter from the earth into the air; and as soon as this happens, all becomes quiet on the surface of the earth.

From a multitude of observations it also appears, that there is at all times a passage of electric matter from the atmosphere into the earth, and, *vice versa*, from the earth into the atmosphere. There is therefore no absurdity in supposing the Deity to have influenced the action of the natural powers in such a manner, that for 40 days and nights the electric matter contained in the atmosphere should descend into the bowels of the earth,—if indeed there is occasion for supposing any such immediate influence at all, since it is not impossible that there might have been, from some natural cause, a descent of this matter from the atmosphere for that time. But by whatever cause the descent was occasioned, the consequence would be, the *breaking up of the fountains of the deep*, and the *opening the windows of heaven*. The water contained in the atmosphere being left without support, would descend in impetuous rains; while the waters of the ocean, those from which fountains originate, and those contained in the solid earth itself, would rise from the very centre, and meet the waters which descended from above. Thus the breaking up of the fountains of the deep, and the opening the windows of heaven, would accompany each other, as Moses tells us they actually did; for, according to him, both happened on the same day.

In this manner the flood would come on quietly and gradually, without that violence to the globe which Burnet, Whiston, and other theorists, are obliged to suppose. The abatement of the waters would ensue on the ascent of the electric fluid to where it was before. The atmosphere would then absorb the water as formerly; that which had ascended through the earth would again subside; and thus every thing would return to its pristine state.

III. Having thus shown in what manner it is possible that an universal deluge might take place by means of the natural agents known to us at present, we shall next consider some more of the evidences that such an event actually did happen, and that the deluge was universal. The proof here is so strong from the traditions prevalent among almost every nation on the face of the earth, and which have been already so amply treated, that no farther objection could be made to the Mosaic account, were it not that the *necessity* of an universal deluge is denied by some, who contend that all the deluges mentioned in history or recorded by tradition were only partial, and may be accounted for from the swelling of rivers or other accidental causes. Many indeed, even of those who profess to believe the Mosaic account, have thought that the deluge was not universal; or, though it might be universal with respect to mankind, that it was not so with regard to the earth itself. The learned Isaac Vossius was of this opinion, though his reasons seem principally to have been that he could not conceive how an universal deluge could happen. "To effect this (says he) many miracles must have concurred; but God works no miracles in vain. What need was there to drown those lands where no men lived, or are yet to be found! 'Tis a foolish thing to think that mankind had multiplied so much before the flood as to have overspread all the earth. How slow and sluggish the first men were in propagating their kind, is evident from hence, that Noah was but the ninth in a lineal descent from Adam. They are quite wide of the truth, therefore, who think mankind to have spread over all the earth in the days of Noah, who perhaps at that time had not extended themselves beyond the borders of Syria and Mesopotamia: but no reason obliges us to extend the inundation of the deluge beyond those bounds which are inhabited; yea, it is altogether absurd to aver, that the effect of a punishment inflicted upon mankind only, should extend to those places where no men lived. Although we should therefore believe that part of the earth only to have been overflowed

30
Vossius's scheme of a partial deluge.

---

* See *Elec-* *city* and *vapora-* *n.*

† e *Earth*.

overflowed by the waters which we have mentioned, and which is not the hundredth part of the terrestrial globe, the deluge will nevertheless be *universal*, *œcumenical*, since the destruction was universal, and overwhelmed the whole habitable world."

31 Coetlogon's scheme.

Another scheme of a partial deluge is published by Mr Coetlogon in his Universal History of Arts and Sciences, under the article ANTEDILUVIANS. This appears to have been formed with a design to accommodate the belief of a deluge to the opinions of the freethinkers, who deny the truth of the Mosaic accounts, as he tells us that they are willing to allow it. According to this author, the first inhabitants of the earth being placed at the confluence of two great rivers, the Euphrates and Tigris, those rivers may have overflowed their banks all of a sudden, and surprised the neighbouring inhabitants not yet accustomed to such sorts of visits, and drowned part of them (and if really designed as a punishment), such as were more guilty. That some of the animals, particularly the more slothful, and consequently not so apprehensive of danger or so ready to take to flight to avoid it, might have been involved in the same calamity, as well as some of the *volatiles*, which being deprived of food by the earth's being covered with water, might have perished; particularly those who, by the too great weakness of their wings to support their bodies, were not proper for a long flight. As for others who had these advantages above the rest, they would no doubt take care of their own preservation, by flying to those parts of the earth which their natural instinct could shew them free from the inundation.

32 Bishop Stillingfleet's scheme.

A third scheme of a partial deluge is given by the learned Bishop Stillingfleet in his *Origines Sacræ*. "I cannot (says he) see any urgent necessity from the Scripture to assert, that the flood did spread itself all over the surface of the earth. That all mankind (those in the ark excepted) were destroyed by it, is most certain, according to the Scripture. When the Lord said, that he would destroy man from the face of the earth, it could not be any particular deluge of so small a country as Palestine, as some have ridiculously imagined; for we find an universal corruption in the earth mentioned as the cause; an universal threatening upon all men for this cause; and afterwards an universal destruction expressed as the effect of this flood. So then it is evident, that the flood was universal with regard to mankind; but from thence follows no necessity at all of asserting the universality of it as to the globe of the earth, unless it be sufficiently proved that the whole earth was peopled before the flood, which I despair of ever seeing proved; and what reason can there be to extend the flood beyond the occasion of it, which was the corruption of mankind?—The only probability then of asserting the universality of the flood, as to the globe of the earth, is from the destruction of all living creatures, together with man. Now though men might not have spread themselves over the whole surface of the earth, yet beasts and creeping things might, which were all destroyed with the flood; for it is said, 'that all flesh died that moved upon the earth, both of fowl and of cattle, and of every creeping thing that creepeth upon the earth, and every man.' To what end should there be not only a note of universality added, but such a particular enumeration of the several kinds of beasts, creeping things and fowls, if they were not all destroyed? To this I answer; I grant that, as far as the flood extended, all these were destroyed: but I see no reason to extend the destruction of those beyond that compass and space of the earth where men inhabited, because the punishment upon the beasts was occasioned by, and could not be concomitant with, the destruction of man; but the occasion of the deluge being the sin of man, who was punished in the beasts that were destroyed for his sake, as well as in himself) where the occasion was not, as where there were animals and no men, there seems no necessity of extending the flood thither.—But to what end, will it therefore be replied, did God command Noah, with so much care, to take all kinds of birds, beasts, and creeping things into the ark with him, if all these living creatures were not destroyed by the flood? I answer, because all those things were destroyed wherever the flood was. Suppose then the whole continent of Asia was peopled before the flood, which is as much as in reason we may suppose; I say, all the living creatures in that continent were destroyed; or if we may suppose it to have extended over our whole continent of the ancient known world, what reason would there be, that in the opposite part of the globe, which we suppose to be unpeopled then, all the living creatures should there be destroyed, because men had sinned in this? and would there not have been on this supposition a sufficient reason to preserve living creatures in the ark for future propagation?" &c.

33 A partial deluge proved to be impossible.

Thus we have the strength of all the arguments that have been offered in support of a partial deluge, and which may all be summed up in the three following articles: 1. The impossibility, in a natural way, of accounting for the quantity of water, necessary to overflow the whole world; 2. The small number of mankind supposed at that time to have existed on the earth; and, 3. The inutility of an universal deluge, when the divine purposes could have been equally well answered by a partial one. But to all this we may make one general answer, that a partial deluge is in the nature of things impossible. We cannot imagine that the waters could accumulate upon any country without going off to the sea, while the latter retained its usual level; neither can we suppose any part of the sea to remain above the level of the rest. On the supposition of Bishop Stillingfleet, therefore, that the deluge extended over the whole continent of Asia, we know that it must have covered the high mountains of Ararat, on which the ark rested; Caucasus, Taurus, &c. The height of Ararat is indetermined, as no traveller of any credit pretends to have ascended to its top; but from the distance at which it is seen, we can scarce look upon it to be inferior to the most celebrated mountains of the old continent *. Sir John Chardin thinks that some part of Caucasus is higher; and supposing each of these to be only a mile and a half in height, the sea all round the globe must have been raised to the same height; and therefore, all that could remain of dry ground as a shelter to animals of any kind, must have been the uninhabitable tops of some high mountains scattered at immense distances from one another. We may therefore with equal reason suppose that these were in like manner

---

* See Ararat.

manner covered, and that no living creature whatever could find shelter even for a moment: and it is certainly more agreeable to the character of the Deity to believe, that he would at once destroy animal life by suffocation in water, rather than allow numbers of them to collect themselves on the tops of mountains to perish with hunger and cold. It is besides very improbable, that any creature, whether bird or beast, could sustain a continued rain of 40 days and 40 nights, even without supposing them to have been absolutely immersed in water.

This consideration alone is sufficient to show, that if there was a deluge at all, it must have been universal with regard to the world as well as the human race; and the possibility of such a deluge by natural means has already been evinced. Under the article ANTEDILUVIANS it is shown, that, according to the most moderate computation, the world must have been vastly more full of people than at present. The least calculation there made indeed seems incredible, since, according to it, the world must have contained upwards of 68,719 times as many inhabitants as are at present to be met with in the empire of China, the most populous country in the world: but China bears a much larger proportion to the habitable part of the world than this. The violences exercised by mankind upon one another have always been the means of thinning their numbers, and preventing the earth from being overstocked with inhabitants; and the strong expression in Scripture, that the "earth was filled with violence," shows that it must have gone to an extraordinary height. But though this violence must have undoubtedly thinned the old world of its inhabitants, it must likewise have dispersed some of them into distant regions. There is therefore no reason for supposing that before the flood the human race were not driven into the remotest regions of the habitable world, or that America was destitute of inhabitants then more than it is at present. At any rate, the schemes of Vossius and Coetlogon, who would confine the whole race of mankind to a small part of Asia, must appear evidently futile and erroneous in the highest degree.

34
bjections
om some
ecies of
imals be-
g peculiar
certain
untries.

Some objections have been made to the doctrine of an universal deluge from the state of the continent of America, and the number of animals peculiar to that and other countries, which could not be supposed to travel to such a distance either to or from the ark of Noah. On this subject Bishop Stillingfleet observes, that the supposition of animals being propagated much farther in the world than mankind before the flood, seems very probable, "because the production of animals is parallel in Genesis with that of fishes, and both of them different from man. For God saith, 'Let the waters bring forth every moving creature that hath life, viz. fish and fowl:' And accordingly it is said, that the waters brought forth abundantly every living creature after their kind, and every fowl after his kind. Accordingly, in the production of beasts, we read, 'Let the earth bring forth the living creature after his kind, cattle, and every creeping thing, and beast of the earth, after his kind: and it was so.' But in the production of man it is said, 'Let us make man in our image, and after our likeness.' From hence I observe this difference between the formation of animals and of man, that in one God gave a prolific power to the earth and waters for the production of the several living creatures which came from them, so that the seminal principles of them were contained in the matter out of which they were produced; which was otherwise in man, who was made by a peculiar hand of the great Creator himself, who thence is said to have formed man out of the dust of the ground.

"If now this supposition be embraced, by it we presently clear ourselves of many difficulties concerning the propagation of animals in the world, and their conservation in the ark; as how the unknown kind of serpent in Brazil, the slow-bellied creature in the Indies, and all those strange species of animals seen in the West Indies, should either come into the ark of Noah, or be conveyed out of it into those countries which are divided by so vast an ocean on one side, and at least so large a tract of land on the other. Besides, some kind of animals cannot live out of the climate where they are; and there are many sorts of animals discovered in America, and the adjoining islands, which have left no remainder of themselves in these parts of the world. And it seems strange, that these should propagate into those parts of the world from the place of the flood, and leave none at all of their number behind them in these parts whence they were propagated."

35
Replies by
Mr Cockburn.

To this Mr Cockburn, in his treatise on the deluge, replies, 1. That as it pleased God to create only one man and one woman at the beginning, and their posterity were sufficient to overspread the earth, it might well be supposed to be furnished with animals from an original pair of each. 2. On the supposition of many pairs of brute animals having been created originally, they must, when the human race were few in number, have multiplied to such a degree as to render the world uninhabitable. In confirmation of this, he informs us from the accounts of the Indian missionaries, that in the kingdom of Champua in the Indies, the river called by the natives *Tinacoreu*, but by the Portuguese *Varella*, goes up 80 leagues into the country to a mountain called *Moncalor*, above which it is much broader, but not so deep by far; there being banks of sand in some places, and lands overflowed with water, where there are an infinite number of fowls that cover all the country; insomuch, that by reason of them the whole kingdom of Chintalcuhos had for 40 years been desolate, though it was eight days journey in length; which, at 30 miles a-day, made it 240 miles long. After passing this country, another was met with more wild, and full of great rocks; where there were a vast number of animals yet worse than the fowls, as elephants, rhinoceroses, lions, bears, buffaloes, and other beasts, in such multitudes, that whatever men cultivated for the support of life was spoiled or destroyed by them, nor was it possible for the inhabitants to prevent it.

36
Countries
rendered
uninhabitable by the
abundance
of brute
creatures.

The isle of France may be said to be the kingdom of rats. They come down from the mountains like an army, creep up the steepest rocks, march into the flat country, assemble in the marshy grounds, and bring desolation everywhere, especially in the night. Men can scarce sleep for them, and are obliged to roll themselves in such things as may best secure them from their bitings. It was the same in the isle of Bourbon, which was as much infested with them at first, till it

became

became more fully peopled. "We have good reason therefore (says Mr Cockburn) to conclude, that there was but one pair of animals created at first, that they might not increase too fast for mankind; and though they would multiply much more, and increase faster than men could do, they had room to spread themselves for a long time without much annoyance to man; and as men increased in number, and extended their habitations, they would be able to drive them further off, or defend themselves from their depredations." The same mode of reasoning is by our author made use of with regard to aquatic animals. The multitude of these indeed, however great, could be no detriment to man, who lived on land; but if we consider how large and numerons a spawn fishes cast at once, and in how short a time they mnltiply to immense numbers, he thinks it reasonable to conclude, that only one pair was created at once; and that the command to the waters to bring forth abundantly both fish and fowl, related only to the variety of species, not to a number of each.

37
Vast increase of the animal creation.

3. Though at the restoration of the world it was to be repeopled by six persons instead of two, and though at the same time animal food was given to man, yet Noah was commanded only to take a single pair of each of the animals, clean beasts, which are but few in number, only excepted. It is further observable, that notwithstanding this scanty supply of animals, they had increased so much by the time of Nimrod, that it then became necessary to hunt and destroy them; Nimrod was celebrated for his courage and skill in that necessary employment. "So nnmerous (adds he) were the animals before the flood, though but two of a kind were created, that Dr Woodward, from the remains of that earth, as well the animal as vegetable productions of it still preserved, concludes, that 'at the time the deluge came, the earth was so loaded with herbage, and so thronged with animals, that such an expedient was even wanting to ease it of the burden, and to make room for a new succession of its productions.'

38
Of the peopling of America, and migration of animals to it.

4. Mr Cockburn is of opinion, that America must have been peopled before the flood, as the old continent could not be supposed able to hold the number of inhabitants.

5. With regard to the main difficulty, viz. how the animals peculiar to different countries could travel to such distances to and from the ark, Mr Cockburn replies, that America, which Bishop Stillingfleet chiefly insists upon, has nothing peculiar to it, but what may equally well be urged both with respect to Asia and Africa; each of them having animals peculiar to themselves. It is also possible, that there might formerly be a more easy communication between the Asiatic and American continents than there is now. See the article AMERICA, N° 101—113.

Our author likewise observes, that though the ark rested on Mount Ararat, yet we are not told where it was built, which might be far enough from the place where it is commonly supposed; so that these animals which are peculiar to America might not have so far to travel to the ark as is commonly imagined. This argument, however, seems to be very inconclusive; for though we should suppose the ark to have been constructed in America itself, the animals of Mesopotamia would have had as far to travel from thence to America, as the American animals from their own country to Mesopotamia, according to the common opinion. But in whatever part of the earth Noah lived and the ark was built, it was at God's command that the several kinds of animals came hither in order to their preservation; and his command could bring them from the farthest parts of the earth during the 120 years that all the world lay under condemnation. Though after all, none of the animals might have very far to travel to the ark; for if only one pair of each kind was created at first, and all of these in or near one place, since they were all brought before Adam, and received names from him, there is no absurdity in supposing that some of every kind might remain in the country where they were first produced, from thence Noah's habitation might not be very distant. Neither can any objection be brought from the extinction of some species of animals in certain countries of the world, since they might have been hunted and destroyed either by the human race or by other creatures. Thus it is said, that there are now few or no deer in Switzerland, though formerly there were a great many when it was full of woods. In Britain also there are no wolves now to be found, though the island was infested with them in former times.

39
Of the subsistence of carnivorous animals in the ark.

In considering the subject of the deluge, among other questions which occur, one is, by what means were ravenous animals, which feed only upon flesh, supported in the ark? For this some authors have supposed, that Noah, besides these animals whom he took into the ark for preservation, took likewise a great number for slaughter. For this purpose Bishop Wilkins has allowed no fewer than 1825 sheep, though he was of opinion that there were no carnivorous animals before the flood; and this latter opinion is adopted by Mr Cockburn. The idea indeed of slaughtering a number of harmless animals to satisfy a few vile rapacious ones, and that too in a place designed for the common asylum of the animal creation, seems inconsistent with that scheme of mercy displayed in the whole transaction. It is by much the more probable supposition then, that though some animals had been accustomed to live on flesh in their natural state, they could nevertheless subsist upon vegetable food. This seems the more probable, as some animals naturally carnivorous, particularly dogs and cats, may be supported in their domestic state by vegetable food alone. If we extend this to the whole canine and feline genera, we shall take in most of the beasts of prey; as lions, tygers, leopards, panthers, wolves, foxes, hyænas, &c. Bears are well known sometimes to feed on berries; snakes will eat bread and milk; and there is no reason to suppose that even the most carnivorous birds could not be kept alive by grain or other vegetable food. By thus excluding such a number of useless animals, a very considerable space will be allowed for the circulation of air in the ark, the want of which seems to be the most inexplicable difficulty, if we may judge from the present constitution of things. It seems indeed to be certain, that no equal number of animals could subsist for a twelvemonth in an equal space so closely shut up as they were. The ark, it is true, contained near two millions of cubic feet; but considering the number of its inhabitants,

habitants, the great space necessary for the food with which they were to be supplied, and the continual pollution of the air by their dung and filth, as well as the effluvia from their bodies, there seems little probability that even such a vast bulk of air could suffice for any length of time. This difficulty will appear the greater, when we consider that any ventilation was impossible, as this could not have been done without opening both the door and window; and the former, we are certain, was not opened until the time that the command was given to come forth out of the ark. Neither is there the smallest probability, that the opening of a single window could renew the air in such a manner as to make it fit for breathing throughout the whole extent of the ark. In this particular, therefore, we must have recourse to the immediate interposition of Divine power, and suppose that the air was miraculously preserved of a sufficient degree of purity, as the garments of the Israelites were preserved from turning old, and their feet from being affected by the journey through the desert in which they wandered so long.—Many other questions concerning the economy of the ark might be proposed; as, how they supplied themselves with water; in what manner they could use fire for the dressing of their victuals, &c. But as every answer to these must be founded wholly upon conjecture, and none can pretend that there was a natural impossibility of effecting any of these things, we forbear to insist farther upon them. The case, however, is very different with respect to the air necessary for sustaining animal life; for here there is a plain impossibility in a natural way; nay, we may even doubt whether the general mass of atmosphere, after being deprived of its electric matter, or otherwise altered in such a manner as to let fall such a quantity of the water it contained, was fit for the support of animal life; so that a miracle would have been necessary at any rate. To this indeed it may be replied, that on such a supposition, men and other animals would have been destroyed, not by the flood, but by the vitiated air they breathed. But, as has been already hinted, it is improbable that any living creature could resist the violent rain which took place, and which would soon drive the birds from their shelter, as the waters beginning to overflow the ground would soon expel the human race from their houses; and it would not be till the end of the 40 days and 40 nights that the air could be at its worst state, long before which time all animal life would be extinct.

41
anges
ich have
en place
i conse-
ence of
deluge.

We shall conclude this article with considering some of the alterations which are supposed to have taken place in the world in consequence of the deluge. One of these is the much greater quantity of water on the present than on the old world. Dr Keill has indeed endeavoured to prove, that the present extent of the surface of the waters is necessary to raise such a quantity of vapours as may supply the surface of the earth with rain and with springs. In answer to this, it is said, that it may be justly questioned whether all springs are derived from the vapours raised by the sun's heat? and, 2. Whether the primitive earth stood in need of such a quantity of rain to render it as fertile as the present? Dr Woodward gives the following reason for supposing the antediluvian seas to have been nearly of the same extent with those at present, viz. that "the spoils of the sea, the shells and other marine bodies, are left in such prodigious numbers, and in heaps upon heaps in the earth, besides those which have long since perished, that they could not have been left in such quantities, had not the seas occupied much the same space as they do now." This argument, however, is thought by Mr Cockburn to be also inconclusive: "For (says he), 1. Animal food, whether fish or flesh, was not used by mankind before the deluge: but, 2. Suppose it had, yet for the first 500 years the number of mankind was but small, and likely at a great distance from the sea; so that the increase of all kinds of fish during so long a time must have been prodigious. We need not be surprised, then, at the immense quantities of the exuviæ of marine animals left on the earth by the deluge. But the reason he brings to prove that the several continents of the world were encompassed with seas as they are now, viz. that as there are different sorts of fishes in the different seas of the world, so the exuviæ of the same kind are generally found upon contiguous lands, does not always hold, since there are some shells found in the continent which are strangers to the parts of the sea conterminous to these continents. That the seas in the present earth are vastly more extended, and consequently the dry land so much less in proportion, may likewise be inferred from the great multitude of islands that lie near the shores of the greater continents, if it be true, what some allege, that they are parts broken off by the deluge from the main land, which before that reached to and beyond them. And though islands are thought to be rarely found in the great ocean, yet there have of late been found in the midst of the Indian ocean vast clusters of islands, &c.

To all this it may be replied, That the Mosaic account says nothing of the extent of the seas either before or after the flood; but simply tells us, that the waters were poured out upon the surface of the earth from the windows of heaven and the fountains of the deep, and that as the flood decreased, the waters *returned* from off the face of the earth. If part of them returned, we have not the least reason to suppose that the whole did not do so likewise. That the fish, as well as land animals, were more numerous in the antediluvian world than now when such quantities are destroyed by mankind, is very probable, as we see they abound to this day in uninhabited places. This may account for the astonishing quantities of their exuviæ to be met with in many different parts of the earth; but from the formation of islands nothing can be concluded concerning the antediluvian world. Late discoveries have shown that many islands have a volcanic origin; others are formed by the growth of coral; some by an accumulation of sea-weeds and other matters floating on the surface of the ocean, and detained upon sand banks or sunk rocks: while not a few of those near the great continents owe their origin to the quantities of mud brought down by the great rivers which empty themselves into the ocean. Authentic history scarcely affords an instance of an island formed by the breaking off a piece from the continent, though it does many of islands being joined to continents by some one or other of the causes just mentioned.

The inferior fertility of the earth after the deluge is much

much insisted upon by the same author, for the following reasons: "1. The grant of animal food to Noah and his posterity; which he thinks is an indication of greater barrenness in the ground than formerly. 2. Our Saviour compares the days of Noah with those of Lot; and as the country about Sodom is said to have been exceedingly fertile like *the garden of the Lord*, he is of opinion that the antediluvian world must have been very fertile also. 3. As (according to Dr Woodward) the first earth brought forth all manner of plants of itself, without any labour or culture of man, and even before there was a man to till the ground, we may reasonably suppose that the exterior stratum or surface of the earth consisted of such terrestrial matter as was fit for these productions; that is, of a rich light mould, affording plentifully matter for vegetation. Now, though God was pleased, upon man's transgression, to withdraw in part his benediction from the earth; yet the earth itself was untouched till the deluge, the same surface of rich mould was still upon it, and brought forth plentifully, especially when man's culture for corn was added. But the inundation of waters at the deluge greatly altered the constitution of the earth itself; it mixed and confounded this upper stratum of vegetative earth with other terrestrial matter not fit for vegetation, with sand, gravel, stones, and all kinds of mineral matter, which must needs render the earth in general much less fertile than before, and which made the plough necessary to dig up the proper vegetative mould, and bring it to the surface, and also manure or compost to increase and enrich it; neither of which before the flood it needed. 4. There is a moral reason why the earth after the flood should be less fertile than before. The luxuriant productions of the first earth, after man's nature became corrupted, and to deviate more and more from righteousness, served only to excite and foment his lusts, and to minister plentiful fuel to his vices and luxury. To cut off, therefore, such occasion of sin and wickedness, God, in great mercy to men, retrenched the earth in its former fertility, thereby obliging them to labour and diligence, and employing most of their time to procure their necessary subsistence, which the earth by diligent culture will still afford, but not that luxuriant abundance it did before the flood. If we take a survey of the different regions and countries of the world, we shall find this to be the truth of the case. Some places, both in Asia and America, are as it were a paradise in respect of the rest, to show us perhaps what was and would have been the state of the earth had not man sinned; but far the greatest part is nothing to be compared to these, and evidently shows that effect which the sins of men had upon the earth itself. In a word, if we take a survey of the whole, it cannot be thought that the first blessing was restored to the earth after the flood, or that it came out of the hands of its Maker, in the state it is at present, since so great a part of it bears still the marks of the curse laid upon it."

Notwithstanding all that is here alleged, the extraordinary fertility of the ancient earth must still appear very problematical, if we consider all circumstances. For,

1. Even at the creation, when the earth was at its utmost perfection, we cannot suppose that every part of it produced spontaneously like the garden of Eden. On the contrary, we are told that this garden was *planted by the Lord God*, and that Adam was put into it to *dress it* and *keep it*. It appears, therefore, that even in the Paradisaical state the earth would not have produced food for man without culture; for as God *planted* the first garden, there can be no doubt that had man continued in his state of innocence and multiplied, he must have *planted* other gardens when it became necessary. After the fall, the fertility of the earth was expressly removed, and that not in a slight degree; but if we can judge from the present state of things, it must have become extremely wild and barren. Thus, when it is said, "Thorns also and thistles shall it bring forth to thee;" we may judge of the state of the soil from that which we see bringing forth thorns and thistles at this day. Every one knows that an abundant crop of these weeds indicates poor ground, which will require a great deal of cultivation to bring it into order. Nay, that we may be sure that the cultivation of the earth was at this time no easy matter, it is likewise said, "In sorrow shalt thou eat of it all the days of thy life." Hence it would appear, that the antediluvian earth, instead of being more fertile, was much more barren than at present. That the labour of cultivating the ground at that time was also so great as to be almost intolerable, is evident from the speech of Lamech on the birth of Noah: "This same (says he) shall comfort us concerning our work and toil of our hands, concerning the ground which the Lord hath cursed."

2. There is a very evident natural reason why the antediluvian world should have been more barren than the present, and why the delnge should have removed that barrenness. Under the article ANTEDILUVIANS, N° 19. it is hinted, that the purity of the air at that time was a principal cause of the longevity of the human race. If this was really the case, which is very probable, we must suppose the atmosphere to have then contained a greater quantity of *pure air* than it does at present; for experiments have put it beyond doubt, that from this the support of animal life is immediately derived. But this kind of air, however favourable to animal life, is found to be very unfavourable to vegetation; and therefore in proportion to its abundance in the antediluvian atmosphere, the animals will be healthy, and the vegetables weak, puny, and sickly. But the deluge, by overflowing the earth for a whole year, destroyed every animal and vegetable, and consequently induced a vast putrefaction all over the globe; the consequence of which was the production of an immense quantity of what is called *phlogisticated air* (*azotic gas*). This, mixing with the pure atmosphere, vitiated it to such a degree as to make it less friendly to animal life, but more so to vegetation. Hence the present world must naturally be more fertile than the former; and not only on this account, but by reason of its being manured by the stagnation of the waters upon its surface for a twelvemonth, and the immense quantity of animal matter left by them, the ground, instead of being lessened in its fertility, as Dr Woodward supposes, must have been restored, as far as we can judge, to the very state it was in at its original formation.

3. That this was really the case appears probable from what

what the Deity said to Noah after offering up his sacrifice. "I will not (says he) curse the ground any more for man's sake." Now this was plainly intimating that the earth was restored to its primitive fertility, and that he would no more take it away; for when he did so to the primitive world, it was in these words, "Cursed is the ground for thy sake." That the curse here alluded to was really the depriving the earth of its fertility, and not the overflowing the earth with water, is evident; because, after declaring that he would no more curse the ground for man's sake, he adds, "Neither will I again smite every living thing as I have done."

4. The moral reasons assigned why the present world should be less fertile than the former, seem to be inconclusive. However barren we may reckon the earth just now, it is certain that it produces, or might produce, much more than would suffice for all its inhabitants. The difficulties which mankind undergo are not at all owing to the barrenness of the earth, but to their own conduct, or their oppression of one another. Neither does it clearly appear that animal food is in any degree cheaper than vegetable, but rather the contrary: so that whatever was the reason of this grant after the flood, we cannot fairly ascribe it to a foresight of the future barrenness of the earth.

Another question which naturally occurs on the subject of the deluge is, Whether there was any rain before it or not? The argument against the existence of rain before the flood, is obviously derived from the rainbow being made a symbol of the divine favour immediately after. It is certain, indeed, unless we suppose the nature of light or of water to have been different before this event from what it was afterwards, there is a natural impossibility of the refraction of the sun's light being prevented from showing the appearance of a rainbow, whenever the sun and clouds were in a certain position with regard to one another. It appears improbable to those who take this side of the question, that the Deity should institute any thing as an emblem of his displeasure being turned away, when the same emblem had been seen perhaps a very short time before the catastrophe happened. On the other hand, it is replied, that there is no absurdity in supposing this to have been the case; for though the rainbow existed before the deluge, yet it never was appointed to be the symbol of this particular event, viz. the reconciliation of the Deity; and the impossibility of vegetables being supplied with a sufficient quantity of moisture without rain, is likewise urged as a decisive argument. Still, however, it appears, that even vegetation may subsist, and that in its utmost perfection, without rain; for we are informed, that by means of a mist the ground was originally watered, and vegetables supplied with moisture, before there was any rain; and if this was the case at one time, it might have been at any other, or at any number of times we can suppose. Indeed, as matters stand at present, this would undoubtedly be a very scanty supply; and perhaps so it was in the antediluvian world; and thus the want of rain might have been one cause of that barrenness in the antediluvian world which we have already mentioned as probable, and which Mr Bryant mentions as the opinion of all the ancient mythologists.

DEMADES, a famous Athenian, who from being a mariner, became a great orator, and appeased Philip by his eloquence, after the famous victory over the Athenians at Cheronea, in the 338th year B. C.

DEMAIN, or DEMESNE, in *Law*, is commonly understood to be the lord's chief manor place, with the lands thereto belonging, which he and his ancestors have, time out of mind, kept in their own manual occupation.

DEMAND, in its popular sense, denotes a calling for or requiring one's due.

DEMAND, in *Law*, has a more special signification, as contradistinguished from *plaint*; for all civil actions are pursued either by demands or plaints; according to which the pursuer is called either *demandant* or *plaintiff*; viz. in real actions, *demandant*; and in personal actions, *plaintiff*. See PLAINTIFF.

DEMERARY, formerly a Dutch settlement in Guiana, now in possession of the English. See DEMARARA, SUPPLEMENT.

DEMESNE. See DEMAIN.

DEMESNE Lands. See REVENUE.

DEMETRIA, a festival in honour of Ceres, called by the Greeks *Demeter*. The votaries of the goddess lashed themselves with whips made with the bark of trees. The Athenians had a solemnity of the same name in honour of Demetrius Poliorcetes.

DEMETRIUS, a son of Antigonus and Stratonice, surnamed *Poliorcetes*, "Destroyer of towns." At the age of 22, he was sent by his father against Ptolemy, who invaded Syria. He was defeated near Gaza; but he soon repaired his loss by a victory over one of the generals of the enemy. He afterwards sailed with a fleet of 250 ships to Athens, and restored the Athenians to liberty, by freeing them from the power of Cassander and Ptolemy, and expelling the garrison which was stationed there under Demetrius Phalereus. After this successful expedition, he besieged and took Munychia, and defeated Cassander at Thermopylæ. His reception at Athens after these victories was attended with the greatest servility, and the Athenians were not ashamed to raise altars to him as a god, and consult his oracles. This uncommon success raised the jealousy of the successors of Alexander; and Seleucus, Cassander, and Lysimachus, united to destroy Antigonus and his son. Their hostile armies met at Ipsus, 299 years before the Augustan age. Antigonus was killed in the battle: and Demetrius, after a severe loss, retired to Ephesus. His ill success raised him many enemies; and the Athenians, who had lately adored him as a god, refused to admit him into their city. He soon after ravaged the territory of Lysimachus, and reconciled himself to Selencus, to whom he gave his daughter Stratonice in marriage. Athens now laboured under tyranny, and Demetrius relieved it and pardoned the inhabitants. The loss of his possessions in Asia recalled him from Greece, and he established himself on the throne of Macedonia by the murder of Alexander the son of Cassander. Here he was continually at war with the neighbouring states, and the superior power of his adversaries obliged him to leave Macedonia, after he had sat on the throne for seven years. He passed into Asia, and attacked some of the provinces of Lysimachus, with various success; but famine

mine and pestilence destroyed the greatest part of his army, and he retired to the court of Seleucus for support and assistance. He met with a kind reception; but hostilities were soon begun; and after he had gained some advantages over his son-in-law, Demetrius was totally forsaken by his troops in the field of battle, and became an easy prey to the enemy. Though he was kept in confinement by his son-in-law, yet he maintained himself like a prince, and passed his time in hunting, and in every laborious exercise. His son Antigonus offered Seleucus all his possessions, and even his person, to procure his father's liberty; but all proved unavailing, and Demetrius died in the 54th year of his age, after a confinement of three years, 286 years before Christ. His remains were given to Antigonus, and honoured with a splendid funeral pomp at Corinth, and hence conveyed to Demetrias. His posterity remained in possessiou of the Macedonian throne till the age of Perseus who was conquered by the Romans. Demetrius has rendered himself famous for his fondness of dissipation when among the dissolute, and for his love of virtue and military glory in the field of battle. He has been commended as a great warrior; and his ingenious inventions, his warlike engines, and stupendous machines in the war with the Rhodians, justify his claims to that character. He has been blamed for his voluptuous indulgences; and his biographer observes that no Grecian prince had more wives and concubines than Poliorcetes. His obedience and reverence to his father has been justly admired; and it has been observed, that Antigonus ordered the ambassadors of a foreign prince particularly to remark the cordiality and friendship which subsisted between him and his son.

Demetrius, surnamed *Donatus*, succeeded his father Antigonus on the throne of Macedonia. He reigned 12 years, and was succeeded by his son Philip.

Demetrius, a son of Philip king of Macedonia, delivered as an hostage to the Romans. His modesty delivered his father from a heavy accusation laid before the Roman senate. When he returned to Macedonia, he was falsely accused by his brother Perseus, who was jealous of his popularity, and his father too credulously consented to his death.

Demerius I. surnamed *Soter* or *Saviour*, was son of Seleucus Philopator, the son of Antiochus the Great, king of Syria. His father gave him as a hostage to the Romans. After the death of Seleucus, Antiochus Epiphanes, the deceased monarch's brother, usurped the kingdom of Syria, and was succeeded by his son Antiochus Eupator. This usurpation displeased Demetrius, who was detained at Rome. He procured his liberty on pretence of going to hunt, and fled to Syria, where the troops received him as their lawful sovereign. He put to death Eupator and Lysias, and established himself on his throne by cruelty and oppression. Alexander Bala, the son of Antiochus Epiphanes, laid claims upon the crown of Syria, and defeated Demetrius in a battle, 250 years before Christ.

Demetrius II. surnamed *Nicator*, or *Conqueror*, was son of Soter, to whom he succeeded by the assistance of Ptolemy Philometor. He married Cleopatra, the daughter of Ptolemy, who was before the wife of the expelled monarch Alexander Bala. Demetrius gave himself up to luxury and voluptuousness, and suffered his kingdom to be governed by his favourites. At that time a pretended son of Bala, called *Diodorus Tryphon*, seized a part of Syria; and Demetrius, to oppose his antagonist, made an alliance with the Jews, and marched into the east, where he was taken by the Parthians. Phraates, king of Parthia, gave him his daughter Rodogyne in marriage; and Cleopatra was so incensed at his new connection, that she gave herself up to Antiochus Sidetes her brother-in-law, and married him. Sidetes was killed in a battle against the Parthians, and Demetrius regained the possession of his kingdom. His pride and oppression rendered him odious; and his subjects asked a king of the house of Seleucus from Ptolemy Physcon king of Egypt; and Demetrius, unable to resist the power of his enemies, fled to Ptolemais, which was then in the hands of his wife Cleopatra. The gates were shut up against his approach by Cleopatra; and he was killed by order of the governor of Tyre, whither he had fled for protection, A. U. C. 627. He was succeeded by Alexander Zebina, whom Ptolemy had raised to the throne.

Demetrius Phalereus, a celebrated orator and Peripatetic philosopher, was the scholar of Theophrastus. He acquired so much authority at Athens, that he governed the city for ten years; and ruled with so much wisdom and virtue, that they set up 36 statues in honour of him. By the slanders of some malicious persons in his absence, he was, however, condemned to die; and his image was pulled down; which, when Demetrius heard, he said, they could not pull down that virtue for which those images were set up. He escaped into Egypt, and was protected by Ptolemy Lagus. This king, it is said, asked his advice concerning the succession of his children to the throne; viz. whether he ought to prefer those he had by Euridice to Ptolemy Philadelphus, whom he had by Berenice? and Demetrins advised him to leave his crown to the former. This displeased Philadelphus so much, that his father being dead, he banished Demetrius; who was afterwards killed by the bite of an asp. Demetrius composed more works in prose and verse than any other Peripatetic of his time; and his writings consisted of poetry, history, politics, rhetoric, harangues, and embassies. None of them are extant except his rhetoric, which is usually printed among the *Rhetores Selecti*.

Demetrius, a Cynic philosopher, disciple of Apollonius Tyanæus, in the age of Caligula. The emperor wished to gain the philosopher to his interest by a large present; but Demetrius refused it with indignation, and said, If Caligula wishes to bribe me, let him send me his crown. Vespasian was displeased with his insolence, and banished him to an island. The Cynic derided the punishment, and bitterly inveighed against the emperor. He died in a great old age; and Seneca observes that "nature had brought him forth to show mankind that an exalted genius can live securely, without being corrupted by the vices of the world."

DEMI (formed from *dimidium*), a word used in composition with other words to signify *half*.

Demi-Attici, boroughs or larger villages of Attica. The Athenian tribes were distinguished into Demi. Homer, in his catalogue, distinguishes the Athenians by the appellation *Demos*. And when Theseus prevailed on them to quit the country and settle at Athens, they still continued to frequent the demi, and to perform their several religious ceremonies there.

Demi-Culverin, a piece of ordnance, usually $4\frac{1}{2}$ inches bore, 2700 pounds weight, 10 feet long, and carrying point blank 175 paces. A demi-culverin of the least size is $4\frac{1}{2}$ inches bore, 10 feet long, and 2000 pounds weight. It carries a ball of 4 inches diameter and of 9 pounds weight, and its level range is 174 paces. A demi-culverin of the largest sort is $4\frac{3}{4}$ inches bore, $13\frac{1}{3}$ feet long, and weighs 3000 pounds weight. It carries a ball $4\frac{1}{2}$ inches diameter, weighing 12 pounds 11 ounces, point blank 178 paces.

Demi-God. See Hero.

Demi-Gorge, in *Fortification*, is that part of the polygon which remains after the flank is raised, and goes from the curtain to the angle of the polygon. It is half of the vacant space or entrance into a bastion.

Demi-Quaver, a note in *Music*, two of which are equal to a quaver.

Demi-Semi-Quaver, in *Music*, the shortest note, two of them being equal to a semiquaver.

DEMISE, in *Law*, is applied to an estate either in fee-simple, fee-tail, or for a term of life or years; and so it is commonly taken in many writs. The king's death is in law termed the demise of the king.

Demise and *Redemise*, denote a conveyance where there are mutual leases made from one to another of the same land, or something out of it.

DEMIURGE (from δημιος, which denotes a "public servant," and εργον "work"), in the mythology of the eastern philosophers, was one of the ÆONS employed by the supreme Deity in the creation of the world. He is represented as claiming dominion over the new world he had formed; and excluding totally the supreme Deity from all concern in it.

DEMOCRACY, from δημος, "people," and κρατειν, "to command" or "govern;" the same with a popular government, wherein the supreme power is lodged in the hands of the people; such were Rome and Athens of old; but the most perfect example of democracy is afforded by the United States of North America at the present day, the government of which, for the security it gives, the good order it preserves, the small burdens it imposes, and the admirable judgment with which its foreign and domestic policy has been conducted, deserves to be considered as one of the best and wisest in the world. See Government, Supplement.

DEMOCRITUS, one of the greatest philosophers of antiquity, was born at Abdera, a town of Thrace, about the 80th Olympiad; that is, about 460 years before Christ. His father, says Valerius Maximus, was able to entertain the army of Xerxes; and Diogenes Laertius adds, upon the testimony of Herodotus, that the king, in requital, presented him with some Magi and Chaldeans. From these Magi and Chaldeans Democritus received the first part of his education; and from them, whilst yet a boy, he learned theology and astronomy. He next applied to Leucippus, and learned from him the system of atoms and a vacuum. His father dying, the three sons, for so many there were, divided the estate. Democritus made choice of that part which consisted in money, as being, though the least share, the most convenient for travelling; and it is said, that his portion amounted to above 100 talents, which is near 20,000l. sterling. His extraordinary inclination for the sciences and for knowledge, induced him to travel into all parts of the world where he hoped to find learned men. He went to visit the priests of Egypt, from whom he learned geometry; he consulted the Chaldeans and the Persian philosophers; and it is said that he penetrated even into India and Ethiopia, to confer with the Gymnosophists. In these travels he wasted his substance; after which, at his return, he was obliged to be maintained by his brother; and if he had not given proofs of the greatest understanding, and thereby procured to himself the highest honours, and the strongest interest of his country, he would have incurred the penalty of that law which denied interment in the family-sepulchre to those who had spent their patrimony. After his return from travelling, he lived at Abdera, and governed there in a most absolute manner, by virtue of his consummate wisdom. The magistrates of that city made him a present of 500 talents, and erected statues to him even in his lifetime: but being naturally more inclined to contemplation than delighted with public honours and employments, he withdrew into solitude and retirement. Democritus incessantly laughed at human life, as a continued farce, which made the inhabitants of Abdera think he was mad; on which they sent Hippocrates to cure him; but that celebrated physician having discoursed with the philosopher, told the Abderians, that he had a great veneration for Democritus; and that in his opinion, those who esteemed themselves the most healthy were the most distempered. Democritus died, according to Diogenes Laertius, in the 361st year before the Christian era, aged 109. It is said that he put out his eyes, in order that he might meditate more profoundly on philosophical subjects; but this has little probability. He was the author of many books, which are lost; and from these Epicurus borrowed his philosophy.

DEMOIVRE, Abraham, an eminent mathematician, was born at Vitri in Champagne, May 1667. The revocation of the edict of Nantz, in 1685, determined him to fly into England, rather than abandon the religion of his fathers. He laid the foundation of his mathematical studies in France, and perfected himself at London; where a mediocrity of fortune obliged him to employ his talents in this way, and to read public lectures for his better support. The *Principia Mathematica* of Newton, which chance is said to have thrown in his way, made him comprehend at once, how little he had advanced in the science he professed. He fell hard to work: he succeeded as he went along; and he soon became connected with, and celebrated among, the first-rate mathematicians. His eminence and abilities soon opened to him an entrance into the Royal Society of London, and afterwards into the Academy of Sciences at Paris. His merit was so known and acknowledged by the former, that they judged him a fit person to decide the famous contest between Newton and Leibnitz. The collection of the academy of Paris contains no memoir of this author, who died at London Nov. 1754, soon after his admission into it; but the Philosophical Transactions of London have several, and all of them interesting. He published also some capital works, such as, *Miscellanea Analytica, de seriebus et quadraturis*, &c. 1730, 4to. But perhaps he has been more generally known by his "Doctrine of Chances; or, Method of calculating the Probabilities of Events at Play." This work was first printed 1618, in 4to, and dedicated to Sir Isaac Newton: it was reprinted 1738, with great alterations and improvements; and a third edition was afterwards published with additions, and "A Treatise on Annuities," dedicated to Lord Carpenter.

DEMONSTRABLE, a term used in the schools to signify that a thing may be clearly proved. Thus, it is demonstrable, that the three angles of a triangle are equal to two right ones.

DEMONSTRATION, in *Logic*, a series of syllogisms, all whose premises are either definitions, self-evident truths, or propositions already established. See Logic.

DEMONSTRATIVE, in *Grammar*, a term given to such pronouns as serve to indicate or point out a thing. Of this number are *hic*, *hæc*, *hoc*, among the Latins; and *this*, *that*, *these*, *those*, in English.

DEMOSTHENES, the famous Athenian orator, was born at Athens 381 B. C. He lost his father at seven years of age; and was placed under the conduct of guardians, who robbed him of his substance, and neglected his education. Demosthenes repaired this loss by his love of eloquence and his extraordinary abilities. He became the disciple of Isæus and Plato, and applied himself to study the orations of Isocrates. At the age of 17 he gave an early proof of his eloquence and abilities against his guardians, from whom he obtained the retribution of the greatest part of his estate. His rising talents were, however, impeded by various natural defects. But these were at last conquered by dint of resolution and unwearied attention. He declaimed by the sea-shore, that he might be used to the noise of a tumultuous assembly; and with pebbles in his mouth, that he might correct a defect in his speech. He practised at home with a naked sword hanging over his shoulder, that he might check an ungraceful motion to which he was subject. He also confined himself in a subterraneous cave, to devote himself more closely to studious pursuits; and to eradicate all curiosity of appearing in public, he shaved one half of his head. In this solitary retirement, by the help of a glimmering lamp, he composed the greatest part of his orations, which have ever been the admiration of every age; though his contemporaries and rivals inveighed against them, and observed that they smelt of oil. His abilities as an orator raised him to consequence at Athens, and he was soon placed at the head of government. In this public capacity he roused his countrymen from their indolence, and animated them against the encroachment of Philip of Macedonia. In the battle of Cheronæa, Demosthenes betrayed his pusillanimity, and saved his life by flight. After the death of Philip, he declared himself warmly against his son and successor Alexander; and when the Macedonians demanded of the Athenians their orators, Demosthenes reminded his countrymen of the fable of the sheep, which delivered their dogs to the wolves. By the prevalence of party, however, he was forced to retire from Athens; and in his banishment, which he passed at Trœzen and Ægina, he lived with more effeminacy than true heroism. When Antipater made war against Greece after the death of Alexander, Demosthenes was publicly recalled from his exile, and a galley was sent to fetch him from Ægina. His return was attended with much splendour, and all the citizens crowded at the Piræus to see him land. His triumph and popularity were short. Antipater and Craterus were near Athens, and demanded all the orators to be delivered up into their hands. Demosthenes fled to the temple of Neptune in Calauria; and when he saw that all hopes of safety were vanished, he took a dose of poison, which he always carried in a quill, and expired on the day that the Thesmophoria were celebrated, 322 years before Christ. The Athenians raised a brazen statue to his honour, with an inscription translated into this distich:

Si tibi par menti robur, Vir magne, fuisset,
Græcia non Macedo succubuisset hero.

Demosthenes has been deservedly called *the prince of orators*. Indeed no orator had ever a finer field than Demosthenes in his Olynthiacs and Philippics, which are his capital orations; and undoubtedly to the greatness of the subject, and to that integrity and public spirit which breathe in them, they owe a large portion of their merit. The subject is, to excite the indignation of his countrymen against Philip of Macedon, the public enemy of the liberties of Greece; and to guard them against the treacherous measures by which that crafty tyrant endeavoured to lull them into a neglect of their danger. To attain this end, we see him use every proper means to animate a people distinguished by justice, humanity and valour, but in many instances become corrupt and degenerate. He boldly accuses them of venality, indolence, and indifference to the public good; while, at the same time, he reminds them of their former glory and of their present resources. His contemporary orators, who were bribed by Philip, and who persuaded the people to peace, he openly reproaches as traitors to their country. He not only prompts to vigorous measures, but teaches how they are to be carried into execution. His orations are strongly animated, and full of the impetuosity and ardour of public spirit. His composition is not distinguished by ornament and splendour. It is an energy of thought, peculiarly his own, which forms his character, and raises him above his species. He seems not to attend to words, but to things. We forget the orator, and think of the subject. He has no parade and ostentation, no studied introductions: but is like a man full of his subject; who after preparing his audience by a sentence or two for the reception of plain truths, enters directly on business.

The style of Demosthenes is strong and concise; though sometimes, it must be confessed, harsh and abrupt. His words are highly expressive, and his arrangement firm and manly. Negligent of lesser graces, he seems to have aimed at that sublime which lies in sentiment. His action and pronunciation are said to have been uncommonly vehement and ardent; which, from the manner of his writings, we should readily believe. His character appears to have been of the austere rather than of a gentle kind. He is always grave, serious, passionate; never degrading himself, nor attempting any thing like pleasantry. If his admirable eloquence be in any respect faulty, it is that he sometimes borders on the hard and dry. He may be thought to want smoothness and grace; which is attributed to his imitating too closely the manner of Thucydides, who was his great model for style, and whose history he is said to have transcribed eight times with his own hand. But these defects are more than atoned for by that masterly force of masculine eloquence, which, as it overpowered all who heard it, cannot in the present day be read without emotion.

Cicero calls him a perfect model, and such as he himself wished to be. These two great princes of eloquence have been often compared together; but the judgment hesitates to which to give the preference. The archbishop of Cambray, however, seems to have stated their merits with great justice and perspicuity in his Reflections on Rhetoric and Poetry. The passage, translated, is as follows: "I do not hesitate to declare that I think Demosthenes superior to Cicero. I am persuaded no one can admire Cicero more than I do. He adorns whatever he attempts. He does honour to language. He disposes of words in a manner peculiar to himself. His style has great variety of character. Whenever he pleases, he is even concise and vehement, for instance, against Catiline, against Verres, against Antony. But ornament is too visible in his writings. His art is wonderful, but it is perceived. When the orator is providing for the safety of the republic, he forgets not himself, nor permits others to forget him. Demosthenes seems to escape from himself, and to see nothing but his country. He seeks not elegance of expression; unsought for, he possesses it. He is superior to admiration. He makes use of language, as a modest man does of dress, only to cover him. He thunders, he lightens. He is a torrent which carries every thing before it. We cannot criticise, because we are not ourselves. His subject enchains our attention, and makes us forget his language. We lose him from our sight: Philip alone occupies our minds. I am delighted with both these orators; but I confess that I am less affected by the infinite art and magnificent eloquence of Cicero, than by the rapid simplicity of Demosthenes."

DEMPSTER, Thomas, a very learned man, but of a singular character. He was born in Scotland, but we do not find in what year. He went over to France for the sake of embracing the Catholic religion, and taught classical learning at Paris about the beginning of the 17th century. Though his business was to teach school, yet he was as ready to draw his sword, and as quarrelsome, as if he had been a duellist by profession; and it is said, that there scarce passed a day but he had something or other of this kind upon his hands. This spirit and turn of temper drew him into many scrapes; and one in particular, which obliged him to quit the country. Grangier, principal of the college of Beauvais at Paris, being obliged to take a journey, appointed Dempster his substitute. Dempster caused whip a scholar, in full school, for challenging one of his fellows to fight a duel. The scholar, to revenge this affront, brought three gentlemen of his relations, who were of the king's life-guards, into the college. Dempster made the whole college take arms; hamstrung the three life-guard-men's horses before the college-gate; and put himself in such a posture of defence, that the three sparks were forced to ask for quarter. He gave them their lives; but imprisoned them, and did not release them for some days. They sought another way to revenge themselves: they caused an information to be made of the life and moral behaviour of Dempster, and got some witnesses to be heard against him. Upon this he went over to England, where he found refuge; but did not make any long stay. He went abroad again, and read lectures upon polite learning in several universities; in that of Nismes particularly, where he disputed for a professor's chair, and obtained it. He went to Bologna, and was professor there for the remainder of his life; and was there also admitted a member of the Academy Della Rotte. He died there in September 1625, leaving behind him several learned works; as Commentaries on *Rosinus de Antiquitatibus Romanorum*, and upon Claudian, &c.; four books of epistles; several dramatic pieces, and other poems; some books of law; an Apparatus to the History of Scotland; a Martyrology of Scotland; and a List of the Scottish Writers.

Dempster of Court, the name formerly given in Scotland to the common executioner or hangman.

DEMSTER, or DEEMSTER. See DEEMSTER.

DEMULCENTS, among physicians, medicines good against acrimonious humours. Such are the roots of marsh-mallows, of white lilies, of liquorice, and of viper-grass, the five emollient herbs, &c.

DEMURRAGE, in *Commerce*, an allowance made to the master of a ship by the merchants, for staying in a port longer than the time first appointed for his departure.

DEMURRER, in *Law*, a stop put to any action upon some point of difficulty which must be determined by the court, before any further proceedings can be had in the suit.

DEN, a syllable which, added to the names of places, shows them to be situated in valleys or near woods; as Tenterden.

DENARIUS, in Roman antiquity, the chief silver coin among the Romans, worth in our money about sevenpence three farthings. As a weight, it was the seventh part of a Roman ounce.

DENARIUS, is also used in our law-books for an English penny.

DENBIGHSHIRE, a county of Wales, bounded on the south by Merioneth and Montgomery shires, on the north by Flintshire and the Irish sea, on the west by Caernarvon. It is about 40 miles long and 23 broad. It contains 410,000 acres, a considerable part of which is rugged and mountainous. It contained 66,400 inhabitants in 1811. The soil in general is barren; but the vale of Clwyd, so called from its being watered by that river, is a very fertile pleasant spot of great extent. The chief commodities are black-cattle, sheep, and goats, rye, called here *amelcorn*, and lead-ore. The county sends two members to parliament, viz. a knight for the shire, and a burgess for Denbigh the capital. See DENBIGHSHIRE, SUPPLEMENT.

DENBIGH, the capital town in Denbighshire in North Wales. It is seated on the side of a rocky hill, on a branch of the river Clwyd, and was formerly a place of great strength, with an impregnable castle, now demolished. It is pretty large, well-built, and inhabited by tanners and glovers, and gives the title of earl to the noble family of Fielding. Population 2714 in 1811. W. Long. 3. 30. N. Lat. 53. 15.

DENDERA, a town of Egypt, on the west side of the Nile. Near it are very magnificent ruins, supposed to be those of an ancient temple of Serapis. It is 48 miles south-south-east of Girge, and 242 south of Cairo. E. Long. 31. 40. N. Lat. 26. 10.

DENDERMOND, a handsome and strong town in the kingdom of the Netherlands, with a strong citadel. It was taken by the allies in 1706, and by the French in 1745. It is surrounded by marshes and fine meadows, which the inhabitants can lay under water when they please. It is seated at the confluence of the Dender and Scheldt. E. Long. 4. 3. N. Lat. 51. 3.

DENDRACHATES, in *Natural History*, the name used by the ancients for an extremely elegant and beautiful species of agate, the ground of which is whitish, variegated with veins of a brighter white. These veins are beautifully disposed in a number of various figures; but generally in many concentric irregular circles, drawn round one or more points. It is common also, in various parts of this stone, to find very beautiful delineations of trees, mosses, sea-plants, and the like, so elegantly expressed, that many have erroneously taken them for real plants included in the substance of the stone: whence the name *dendrachates*.

DENDROMETER, (from δενδρον *a tree*, and μετρεω *I measure*, (an instrument invented by Messrs Duncombe and Whittel, for which they obtained a patent; and so called from its use in measuring trees. This instrument consists of a semicircle A (fig. 1.), divided into two quadrants, and graduated from the middle: upon the diameter B there hangs a plummet L for fixing the instrument in a vertical position: there is also a chord D parallel to the diameter, and a radius E, passing at right angles through the diameter and chord. From a point on the radius hangs an altimeter C, between the chord and diameter, to which is fixed a small semicircle G, and a screw, to confine it in any position. The altimeter, which is contrived to form the same angle with the radius of the instrument as the tree forms with the horizon, is divided from its centre both ways into forty equal parts: and these parts are again subdivided into halves and quarters. Upon the small semicircle G, on which is accounted the quantity of the angle made by the altimeter and radius, are expressed degrees from 60 to 120, being 30 on each quadrant. The radius is numbered with the same scale of divisions as the altimeter. There is also a nonius to the small semicircle, which shows the quantity of an angle to every five minutes. On the back of the instrument the stock M of the sliding piece is confined to the axis N, which moves concentrically parallel to the elevation index F on the opposite side, to which it is fixed. This index is numbered by a scale of equal divisions with the altimeter and radius: at the end of the index is a nonius, by which the angles of elevation above, or of depression below, the horizon, measured upon the semicircle of the instrument, are determined to every five minutes. There is also a groove in the radius, that slides across the axis by means of a screw I, working between the chord and semicircle of the instrument; and this screw is turned by the key O. Upon the stock M (fig. 2.) is a sliding piece P, that always acts at right angles with the altimeter, by means of a groove in the latter. To the shank of the sliding piece is affixed a moveable limb Q, which forms the same angle with the altimeter as the bough forms with the body or trunk of the tree. This limb may be of any convenient length, divided into equal parts of the same scale with all the foregoing divisions. At the extremity of the fixed axis, on a centre, an index R, with telescope sights, works horizontally upon the moveable limb of the sliding piece. Upon this horizontal index R may be fixed a small quadrant T, described with any convenient radius from the centre on which the index moves, and divided into 90 degrees, beginning at a right line drawn from the centre at right angles with the fiducial edge of the said index; and upon the extremity of the axis is a nonius, whereby to determine the quantity of an angle upon the quadrant every five minutes. There are also two small circular arches S S, serving to keep the sights in a parallel position, each containing an equal number of degrees. Upon these arches is measured the angle, subtending a side equal to the difference of the altitudes of the observed objects above the plane of the horizon, and whose base is the nearest distance between the perpendiculars in which these objects are situated. The dendrometer is fitted to a theodolite, and may be used either with or without it as occasion requires.

Plate CLXVIII. fig. 1.

Dendrometer. Fig. 2.

The principal use of this instrument is for measuring the length and diameter of any tree, perpendicular or oblique to a horizontal plane, or in any situation of the plane on which it rests, or of any figure, whether regular or irregular, and also the length and diameter of the boughs, by mere inspection; and the inventors of it have calculated tables, annexed to their account of the instrument itself, by the help of which the quantity of timber in a tree is obtained without calculation, or the use of the sliding rule. The instrument is rectified by setting it in a perpendicular position, by means of the plummet, and screwing it to the staff; then the altimeter is placed in the exact position of the tree, whether perpendicular, reclining, or inclining, and screwed fast. If the tree stands on level ground, the horizontal distance from the tree to the axis of the instrument is measured with a tape-line, and the radius is moved with the key till that distance be cut upon it by the inside of the diameter; but if the ground be slanting, the distance from the tree to the instrument is measured, and the elevation index is moved till the point of the tree from which the distance was measured is seen through the sights, and there screwed fast; and the radius is moved backwards or forwards with the key, till this distance is cut upon the elevation index by the perpendicular line of the altimeter; and the horizontal line will be marked upon the radius by the inside of the diameter. In order to obtain the length of the tree, the elevation index is first moved downwards, till the bottom of the tree cut by the horizontal wires is observed through the sights, and the feet and inches marked by the index upon the altimeter below the point of sight or horizontal line are noted down: then the index is moved upwards till the part to which you would measure, cut by the horizontal wires, is seen, and the feet and inches marked on the altimeter above the point of sight are noted:

ndrometer.

noted: these two quantities added together give the exact length of the tree, which is inserted in a field-book. For the girth of the tree, the circumference in that part where the horizontal distance was taken, is measured with the tape line; and a sixth part of this circumference is added to the distance on the radius, which was before cut by the inside of the diameter, because the tape-line, in taking the distance, cannot be applied to the centre of the body of the tree; then the elevation index is lowered to that part of the tree, of which the diameter is to be taken, and screwed fast. Set the moveable limb of the sliding piece quite straight, and the edge of the horizontal index upon the first division of it. Turn the whole instrument about to the left hand till you see through the sights the left side of the tree cut exactly by the perpendicular wires; then the instrument being fixed, move the sights only upon the sliding piece, till you see the right side of the tree cut also by the perpendicular wires; and you will find the true diameter marked by the horizontal index upon the sliding piece, which is to be entered in a distinct column of the field-book.

For the boughs: let the distance on the radius be now reduced to its former quantity, and the elevation index moved upwards till the bough is seen through the sights, and screwed fast. Set the moveable part of the sliding piece in a position parallel to the bough, and the edge of the horizontal index on the first division of it. Turn the whole instrument about till you see through the sights the shoot of the bough close to the trunk cut by the perpendicular wires; then move the sights till you see the other end of the bough cut by the said wires, and note the feet and inches marked by the horizontal index on the moveable limb of the sliding piece, which will give the true length of the bough to be inserted in the field-book. And the girth of the bough may be obtained by directing the sights to that part of it whose girth is desired; then by moving the elevation index downwards till you see the under side of the bough cut by the horizontal wires, and there noting the feet and inches marked by the said index on the altimeter; after which, let the elevation index be moved upwards, till the upper side of the bough cut by the horizontal wires is seen; the feet and inches marked upon the altimeter are to be noted as before. The former quantity subtracted from the latter will give the true diameter of the bough, which is entered in the field book. The true solidity both of the body of the tree and of the boughs may be found from the diameter and lengths in tables calculated for this purpose.

The dendrometer, fitted to a theodolite, may be applied to measuring the heights and distances of objects, accessible or inaccessible, whether situated in planes parallel or oblique to the plane in which the instrument is placed. It may be also used for taking all angles, whether vertical, horizontal, or oblique, in any position of the planes in which they are formed; and thus for facilitating the practical operations of engineering, land-surveying, levelling, mining, &c. and for performing the various cases of plane trigonometry without calculation; of which the inventors have subjoined to their account of this instrument many examples.

Dendrometer.

DENDROMETER, an instrument for measuring distances by a single observation, which has been proposed by Mr Pitt of Pendeford, near Wolverhampton, and of which the following is the description in the words of the author.

"The idea of an instrument to measure distances by a single observation, has sometimes been discussed, both in conversation and upon paper; and, though the subject has generally been treated with neglect, and even with a kind of contempt, by sound mathematicians, upon an idea of its extravagance and eccentricity, or upon a supposition of its being founded upon false principles, yet I cannot but strongly recommend it to the attention of the ingenious mathematical instrument maker, as an article perhaps capable of being brought to a higher degree of perfection than has generally been supposed.

"The method of determining distances by two observations, from either end of a base line, is well known to every one in the least degree conversant with plane trigonometry: that of determining such distances by one observation has been less explained and understood; and to this I wish to call the attention of the ingenious, whose local circumstances of situation may enable them to investigate and improve the subject.

"To determine distances by one observation, two methods may be proposed, founded on different principles; the one, on the supposition of the observer being in the centre, and the object in the circumference, of a circle; the other, on the contrary supposition, of the observer being in the circumference, and the object in the centre.

"To determine the distance of any object on the first supposition, of the observer being in the centre, the bulk or dimensions of such object must be known, either by measure or estimation; and the angle formed by lines drawn to its extremities being taken, by an accurate instrument, the distance is easily calculated; and such calculations may be facilitated by tables, or theorems adapted to that purpose. For this method our present instruments, with a nonius, and the whole very accurately divided, are sufficient; the only improvement wanting seems to be, the application of a micrometer to such instrument, to enable the observer to read his angle with more minute accuracy, by ascertaining not only the degrees and parts of a degree, but also the minutes and parts of a minute.

"As, in this method, the bulk of inaccessible objects can only be estimated, the error in distance will be exactly in the proportion of the error in such estimation; little dependence can therefore be placed on distances thus ascertained. For the purposes of surveying, indeed, a staff of known length may be held by an assistant; and the angle from the eye of the observer to its two ends being measured by an accurate instrument, with a micrometer fitted to ascertain minutes and parts of a minute, distances may be thus determined with great accuracy; the application of a micrometer to the theodolite, if it could be depended upon, for thus determining the minute parts of a degree, in small angles, is very much a desideratum with the practical surveyor.

"This method of measuring distances, though plain and simple enough, I shall just beg leave to illustrate by an example; suppose A, (fig. 3.) the place of the instrument;

Plate CLXVIII. fig. 3.

instrument; BC, the assistant's staff, with a perpendicular pin at D, to enable the assistant to hold it in its right position; now, if the angle BAC could, by the help of a micrometer, be ascertained to parts of a minute, the distance from A to B, or to C, may be, with little trouble, calculated as follows.

"Suppose the length of the staff BC be 100 inches, or other parts; divide the number 343,500 by the minutes contained in the angle A, the quotient will be the distance AB, or AC, in the same parts.

"The number 343,500 becomes the dividend in this case, because the arch of a circle subtending an angle of 3435 minutes, or 57° 15′, is equal in length to the radius, and the object staff BC is supposed divided into 100 equal parts.

"Thus, suppose the angle A be 1°, or 60′, then, 60)343500(=5725 inches = distance AB.

"Or, if the angle A be 60′ $\frac{1}{10}$, then 60.1) 343500(= 5715.5 inches.

"Hence it appears, that an error of $\frac{1}{10}$ of a minute in the angle A, would cause an error of 9 inches and a half in the distance AB, or about $\frac{1}{600}$ part of the whole; the accuracy, therefore, of thus taking distances, depends upon the accuracy wherewith angles can be ascertained; and the error in distance will bear the same proportion to the actual distance, as the error in taking the angle does to the actual angle.

"But this method of ascertaining distances cannot be applied to inaccessible objects, and it is moreover subject to the inconvenience of an assistant being obliged to go to the object whose distance is required, (an inconvenience almost equal to the trouble of actual admeasurement), therefore the perfection of the second method proposed (if attainable) is principally to be desired; namely, that of conceiving the observation made on the circumference of a circle, whose centre is in the object whose distance is to be ascertained; and none of our instruments now in use being adapted to this mode of observation, a new construction of a mathematical instrument is therefore proposed, the name intended for which is the *Dendrometer*.

"This name is not now used for the first time, it was applied in the same way by a gentleman who had, as I have been informed, turned his thoughts to this particular subject; but I do not find that he ever brought his instrument into use, or explained its principles; nor do I understand that this principle has ever been applied in practice, for the familiar purpose of ascertaining terrestrial distances in surveying, or otherwise; though the same principle has been so generally, and successfully, applied, in determining the distance of the heavenly bodies by means of their parallax.

Fig. 4.

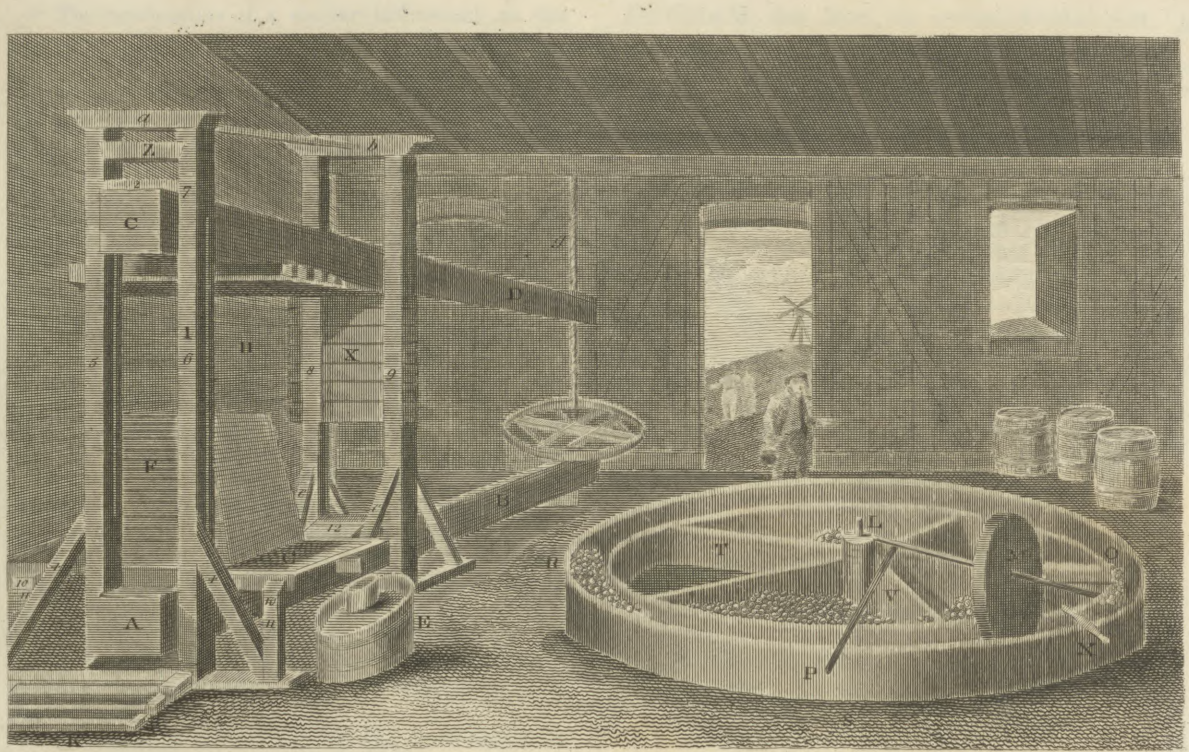
"The following principles of construction are proposed, which may perhaps be otherwise varied and improved. O, fig. 4. the object whose distance is required; ABCDE the instrument *in plano*; BC, a telescope, placed exactly parallel to the side AE; CE, an arch of a circle, whose centre is at A, accurately divided from E, in degrees, &c.; AD, an index, moveable on the centre A, with a nonius scale at the end D, graduated to apply to the divisions of the arch; also with a telescope, to enable the observer to discriminate the object, or any particular part or side thereof, the more accurately. The whole should be mounted on three legs, in the manner of a plain table, or theodolite, and furnished with spirit-tubes to adjust it to an horizontal position. The instrument being placed in such position, the telescope BC must be brought upon the object O, or rather upon some particular point or side thereof; when, being there fastened, the index AD must be moved, till its telescope exactly strikes the same point of the object; then the divisions, on the arch ED, mark out the angle DAE; which will be exactly equal to the angle BOA, as is demonstrated in the 15th and 29th propositions of Euclid, Book I.; and the side BA being already known, the distance BO, or AO, may be easily determined in two different ways; viz. first, by supposing the triangle BOA, an isosceles triangle; then multiply the side BA by 3435, as before, and divide the product by the minutes contained in the angle DAE = the angle BOA; the quotient will be the distance BO = AO, very nearly; or, secondly, by supposing the triangle ABO right-angled at B, then, as the sine of the angle found DAE=BOA is to the side known BA, so is the radius to the side AO, or so is the sine of the angle BAO to the side BO. To illustrate this by an example, suppose the side BA = 1 yard, the angle found DAE = BOA = 0° 15′, then, per first method, 15)3435(= 229 yards = the distance BO, or AO. Or, by the second method,

As the sine of the angle found 0° 15′=	7.6398160
Is to the side BA=1 yard =	0.0000000
So is radius 90° 0′=	10.0000000
To the log. of the side AO=229 yards=	2.3601840

Or,

As to the sine of the angle found 0° 15′ =	7.6398160
Is to the side BA=1 yard= -	0.0000000
So is the sine of the angle BAO=89° 45′=	9.9999959
To the log. of the side BO = 229 yards =	2.3601799

"As the perfection of this instrument depends totally upon its accuracy in taking small angles, which accuracy must depend, for its minute divisions, upon its being fitted with a micrometer; and as the writer of this cannot doubt that the particular mode of doing this must be familiar to the intelligent instrument maker, he cannot but strongly recommend it to the attention of the ingenious of that profession, as an object which, when perfected, would be a real and considerable improvement in their art, and an useful instrument to the practical surveyor. Its accuracy would also, in some measure, depend upon the length of the line BA in the figure; that line might therefore be extended, by the instrument being constructed to fold or slide out to a greater length, when in use; upon which principle, connected with the application of a micrometer, an accurate and useful instrument might certainly be constructed. To adjust such instrument for use, let a staff be held up at a distance, in the manner of fig. 1. exactly equal in length to the distance of the two telescopes, and the index AD being brought exactly upon the side AE, if the two telescopes accurately strike either end of the staff, the instrument is properly adjusted.



DENDROMETER.

Fig. 1.

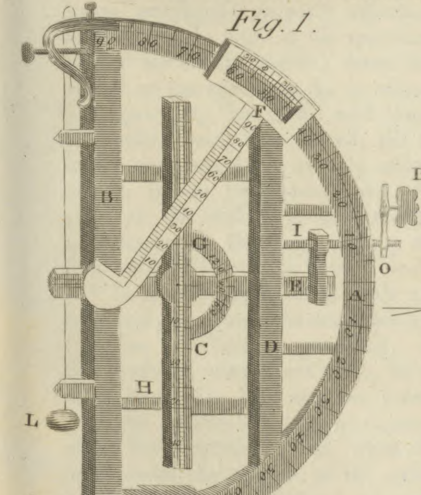


Fig. 2.

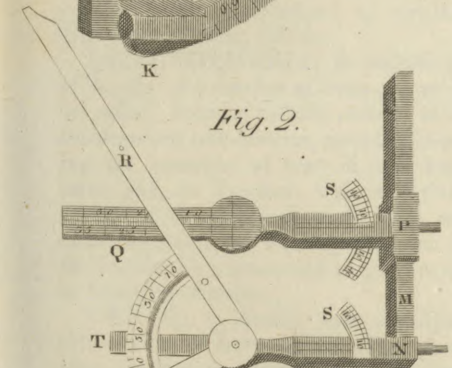


Fig. 3.

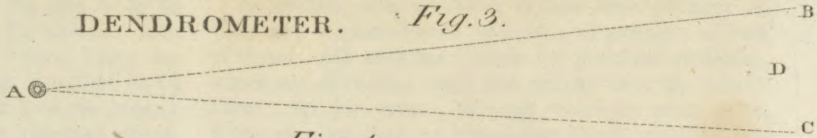


Fig 4.

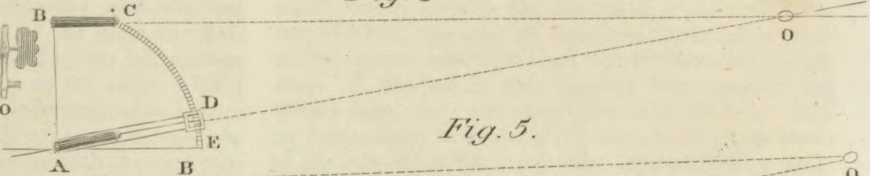
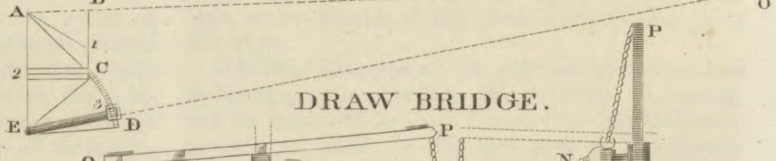
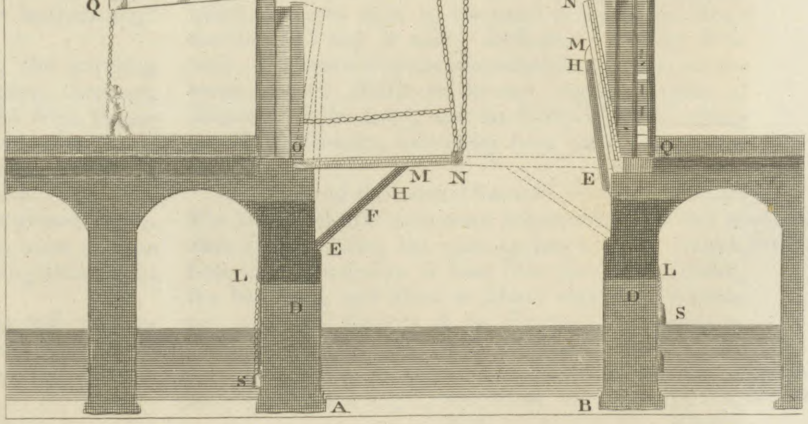


Fig. 5.



DRAW BRIDGE.



E. Mitchell sculp.^t

Dendr
te
Den

Fig. 5.

"The construction of a similar instrument, on the principles of Hadley's quadrant, for naval observations, would also doubtless be an acceptable object in navigation, by enabling the mariner to ascertain the distances of ships, capes, and other objects, at a single observation; and that, perhaps, with greater accuracy than can be done by any method now in use.

g. 5.

"For this purpose, the following construction is proposed: ABCDE, fig. 5. the instrument *in plano*; O, the object whose distance is required; at A, at C, at E, and at 3, are to be fixed speculums, properly framed and fitted, that at 3 having only its lower part quicksilvered, the upper part being left transparent, to view the object; the speculum at A being fixed obliquely, so that a line A 1, drawn perpendicular to its surface, may bisect the angle BAC in equal parts; that at C being perpendicular to the line C 2; those at E and 3 being perpendicular to the index E 3, and that at E being furnished with a sight; the arch DC to be divided from D, in the manner of Hadley's quadrant; the movement of the index to be measured, as before, by a micrometer; and, as the length of the line AE would tend to the perfection of the instrument, it may be constructed to fold in the middle, on the line C 2, into less compass, when not in use; the instrument may be adjusted for use by holding up a staff at a distance, as before proposed, whose length is exactly equal to the line AE.

"To make an observation by this instrument, it being previously properly adjusted, the eye is to be applied at the sight in the speculum E, and the face turned toward the object; when the object, being received on the speculum A, is reflected into that at C, and again into that at E, and that at 3 on the index; the index being then moved, till the reflected object, in the speculum at 3, exactly coincides with the real object, in the transparent part of the glass, the divisions on the arch D 3, subdivided by the micrometer, will determine the angle DE 3 = the angle AOE; from which the distance O may be determined as before.

"It is very probable that this arrangement may be improved, by those who are familiar with the best construction of Hadley's quadrant; which the writer of this professes himself not to be, farther than its general principle. He has not the least doubt that useful practical instruments may be constructed on the principles here described; and, upon this idea, cannot but recommend the subject to the attention of those concerned in the manufacture of similar instruments." *Repertory of Arts*, vol. i.

DENDROPHORIA, in antiquity, the carrying of boughs or branches of trees; a religious ceremony so called, because certain priests, called from thence *dendrophori*, tree-bearers, marched in procession, carrying the branches of trees in their hands in honour of some god, as Bacchus, Cybele, Sylvanus, &c. The college of the dendrophori is often mentioned in ancient marbles; and we frequently see in basso relievos the bacchanals represented as men carrying little shrubs or branches of trees.

DENEB, an Arabic term signifying *tail*, used by astronomers to denote several fixed stars. Thus, *deneb eleet*, signifies the bright star in the lion's tail. *Deneb adigege*, that in the swan's tail.

DENHAM, Sir John, an eminent English poet, the only son of Sir John Denham, chief baron of the exchequer in Ireland, and one of the lords commissioners there, was born in Dublin in 1615: but his father, in 1617, being made a baron of the exchequer in England, he received his education in that country. In his youth he followed gaming more than any thing else; but in 1641, published a tragedy called the *Sophy*, which was much admired by the best judges; and, in 1643, wrote his famous poem called *Cooper's Hill*, which Mr Dryden pronounces will ever be the standard of good writing for majesty of style. Denham was sent ambassador from Charles II. to the king of Poland; and at the Restoration was made surveyor-general of his majesty's buildings, and created knight of the Bath. On obtaining this post, he is said to have renounced his poetry for more important studies. He died at his office in Whitehall in 1668; and his works have been often since printed.

DENIER, a small French copper coin, of which 12 make a sol. There are two kinds, the one tournois, the other parisois, whereof the latter was worth a fourth part more than the former.

DENINA, C. J. M. an eminent Italian writer. See Supplement.

DENIZEN, in *Law*, an alien made a subject by the king's letters patent; otherwise called *donaison*, because his legitimation proceeds *ex donatione regis*, "from the king's gift."

A denizen is in a kind of middle state between an alien and a natural-born subject, and partakes of both of them. He may take lands by purchase or devise, which an alien may not; but cannot take by inheritance; for his parent, through whom he must claim, being an alien, had no inheritable blood, and therefore could convey none to the son; and, upon a like defect of blood, the issue of a denizen born before denization, cannot inherit to him; but his issue born after may. A denizen is not excused from paying the alien's duty, and some other mercantile burdens. And no denizen can be of the privy-council, or either house of parliament, or have any office of trust civil or military, or be capable of any grant of lands, &c. from the crown.

DENMARK, one of the most ancient monarchies in Europe, comprehending the peninsula of Jutland, and the islands of Zealand, Funen, &c. But Denmark, properly so called, is only that part of Scandinavia which formerly went by the name of *Cimbrica Chersonesus*, and now is called *Jutland*. Including Holstein, it is bounded by the sea called the *Categate* on the north; by the Baltic on the east; by the kingdom of Hanover on the south, and the duchy of Mecklenburg on the south-east; extending from 53. 30. to 57. 30. N. Lat.

1
Name whence derived.

The origin of the name *Denmark* is very uncertain. The most probable conjecture concerning it is that of *Saxo-Grammaticus*, the most ancient and best Danish historian. He derives it from *Dan* the son of *Humble*, the first king, and *Mark* or *Marc*, signifying a country in several dialects of the Teutonic; according to which etymology, the word *Denmark* signifies the land or country of *Dan*. This *Dan* is thought to have lived about 1038 years before the Christian era.

2
Dan the first king.

Almost all historians agree that he was the son of *Humble*, a native of Zealand. His possessions and influence were very considerable not only in Zealand, but in the islands of Langland and Mona. It was his courage, however, and skill in the art of war, that induced the inhabitants of Denmark to choose him for their king. He was called to the assistance of the Jutlanders upon an irruption of the Saxons into their territories, and promised the sovereignty of the country if he drove out the enemy. On this he immediately raised an army, gained a complete victory over the Saxons, and obliged them to leave the country; and he was accordingly elected king.

3 History of this country fabulous for many ages.

In such early ages as these, we are not to look for any authentic history either of this or any other kingdom. The history of Denmark, for a great number of ages after the reign of *Dan*, is filled with fabulous exploits of heroes, encounters with giants, dragons, &c. One of their kings named *Frotho*, who reigned about 761 years before Christ, is said to have conquered all Britain, Sleswick, Russia, Pomerania, Holstein, &c. an assertion which cannot easily be credited, considering the difficulty which succeeding warriors, even the greatest in the world, found to subdue the inhabitants of those countries.—It is certain, however, that anciently the kingdom of Denmark made a much more conspicuous figure than it does at present. The Danes appear to have had a very considerable naval force almost from the foundation of their empire; and the conquests they undoubtedly made in our island are certain proofs of their valour.

4 Valdemar I. a great monarch.

The natural enemies of the Danes, were the Swedes, Norwegians, and Saxons; especially the first. With one or other of these nations almost perpetual war was carried on. The kingdom was also often rent by civil dissensions; which the neighbouring monarchs did not fail to take advantage of, in order to reduce the kingdom of Denmark under their subjection. As neither party, however, generally came off with advantage, the history of the wars affords nothing interesting or entertaining. One of the greatest of the Danish monarchs was *Valdemar I.* who obtained the throne in 1157; having defeated and killed his competitor *Sweyn*, after a ten years civil war. He maintained a long war with the Vandals, whose power he at last entirely broke, and reduced under his subjection the island of Rugen. He also proved victorious over the Norwegians, so that their king and queen came in person to submit to him. In 1165, he also laid the foundations of the city of Dantzic, which, though it hath since become a place of much consequence, consisted at first only of a few poor fishermen's huts; but the privileges and immunities conferred upon it by this monarch, soon proved the means of its becoming a flourishing city. In 1169, he entirely subdued the Courlanders; and, soon after, was invested with the duchy of Holstein, by the emperor Frederic Barbarossa. He is said to have been poisoned by a quack medicine, given with a design to recover him from a distemper with which he was seized in 1182.

5 Power of Denmark, in 1195.

In the year 1195, Canute, Valdemar's successor, caused a muster to be made of all the men fit to bear arms in his dominions; and ordered each province to fit out its proportion of shipping, every way equipped, and ready for action. The whole force of Denmark, at that time, consisted of 670 ships of war, besides the squadrons supplied by vassals, tributary states, and allies. The number of the land forces is not mentioned. In the reign of this prince, the Danish dominions were enlarged by the entire conquest of Stromar, the districts of Lubec and Hamburgh, formerly known by the name of *Nordalbingia*, but now included under the general name of *Holstein*. He died in 1203, and was succeeded by Valdemar II. who proved a very great and warlike prince. In 1211, he founded the city of Stralsund, opposite to the isle of Rugen. The same year his queen died in childbed; and in memory of her he built the castle of *Droningholm*, that name importing the *Queen's Island*. In 1218, he undertook an expedition against the Livonians, having received advice that they, assisted by the Lithuanians, Muscovites, and other barbarous nations, had driven from their habitations all those in the neighbourhood who had embraced Christianity, and taken an oath of allegiance to the crown of Denmark. Fitting out a powerful fleet, therefore, he immediately set sail for that country; but his troops were no sooner landed, than they were seized with a panic at the sight of such a powerful army of savages as were assembled to oppose them. The king himself was dismayed at the unusual spectacle of a whole army clothed in skins, and resembling beasts more than human creatures. Encouraged, however, by the bishops who attended him, he ventured an engagement, and overthrew the barbarians with incredible slaughter. This victory was gained near the fortress of *Valdemar*, which received its name on that account.

6 Expeditio of Valdemar II. against the Livonians.

7 Flourishin state of th kingdom.

How potent and flourishing the kingdom of Denmark was at this time, appears from an estimate of the revenues of the tributary provinces, those countries conquered by Valdemar, and the standing forces of the whole kingdom. This account was copied by Pontanus from Witfield, a writer of those days, who had it from a register kept by Valdemar's steward. From the provinces were daily sent in 24 lasts of oats, 24 lasts of rye, and half that quantity of wheat, 13 *talents* of cheese and butter, and nine of honey; 24 oxen, 300 sheep, 200 hogs; and 600 marks of coined money. This was the certain revenue: but to this was added near an equal sum from adventitious circumstances; such as fines, forfeitures, taxes on law-suits and pleadings, with a variety of other contingencies; the whole amounting to upwards of 100,000 marks a-day, or 23,730,000l. per annum; a sum in those days almost incredible. With this revenue were kept for constant service 1400 great and small ships for the king's use, each of which at a medium carried 121 soldiers; making the whole of the standing forces, besides garrisons, consist of 169,400 fighting men.

In 1223, a very great misfortune befel Valdemar, notwithstanding all his power. Henry earl of Swerin, otherwise called *Henry Palatine*, a German prince, having been deprived of part of his dominions by Valdemar, surprised and carried off the king himself, and kept him close prisoner for three years. The conditions on which he at last obtained his liberty were very hard. He was obliged to pay a prodigious sum of money; to relinquish Holstein, Swerin, Hamburgh, and all his possessions on the other side of the Elbe; and lastly, solemnly to swear that he would maintain this

8 Valdemar taken prisoner.

9 Released on condition of ce ing part his territories.

this compulsive contract, and never take any measures to punish Henry or his associates. This treaty was signed on the 25th of March 1226.

10
e breaks
e treaty,
t is de-
ted.

Besides these territories which the Danish monarch had been obliged to cede by treaty, many tributary princes took the opportunity of his captivity to recover their liberty; and among the rest, the inhabitants of Lubec revolted, and entered into alliance with Albert duke of Saxony against Valdemar. The latter, however, was not of a disposition to submit tamely to such treatment. He obtained a dispensation from the pope to break his engagements with Henry, and immediately entered Holstein at the head of a numerous army. Here he was met by several German princes, at the head of a very numerous army; and a desperate engagement ensued. Valdemar at first had the advantage; but being wounded in the eye, his troops were at last defeated with great slaughter. It doth not appear that ever the king of Denmark was able to revenge himself of his enemies, or to recover the dominions he had lost. So far from this, he was obliged, in 1128, to cede Lauenburg to the duke of Saxony, who had already seized on Ratzburg and Molna. Soon after this, his eldest son Valdemar was accidentally killed as he was hunting, and his two other sons married the daughters of his two greatest enemies. Abel, the third son, married the daughter of Adolphus duke of Holstein; and Eric, the second, married the duke of Saxony's daughter. These misfortunes are supposed to have hastened his death, which happened in the month of April 1242.

11
ivil war
between
the two
s.

On the death of Valdemar, the kingdom was divided between the two young princes; and between them a war commenced the very next year. A peace was concluded the year following, and war renewed the year after: but how long it continued, we are not informed. In 1250, Eric paid a visit to his brother Abel, intreating his mediation between him and the princes of Holstein, with whom he was then at war. Abel received him, in appearance, with great kindness, and promised that his utmost endeavours to procure a reconciliation should not be wanting; but in the meantime, laid a plan for having him murdered at sea: this was effected, and Abel became master of the whole kingdom.

The new king did not long enjoy the sovereignty he had so wickedly obtained. He was tormented by his own conscience; especially when he found among his brother's papers, one by which he was left heir to the whole kingdom on the death of Eric, and many kind expressions with regard to himself. He was at last killed in a battle with his own subjects in 1252, on account of some taxes he intended to impose.

12
Kingdom
divided
among
a number
of petty ty-
rants.

From this time to the year 1333, the kingdom of Denmark gradually declined. Usurpers established themselves in different provinces; while the kings of Sweden did not fail to avail themselves of the distracted state of the Danish affairs. In 1333, died Christopher II. who possessed only the cities of Scanderburg in Jutland and Neoburg in Fionia, with some few other inconsiderable places, of all the hereditary dominions of Denmark. Halland, Holbec, Calemburg, and Samsoe, were held by Canute Porsius; Schonen, Lystre, and Bleking, by the king of Sweden, to whom they had been lately sold; John earl of Wagria had the jurisdiction of Zealand, Falstre, Laaland, and Femerin; Gerhard, of Jutland and Fionia; and Lawrence Jonea of Longland and Arras.

After the death of Christopher, an interregnum of seven years ensued.—The first attempt for the sovereignty was made by Otho, second son to the late king, who laid a scheme for driving Gerhard out of Jutland; but not being able to accomplish it, he was taken prisoner, and closely confined by Gerhard. The king of Sweden next wrote to Pope Benedict XIII. beseeching his Holiness to confirm to him the provinces of Schonen and others which he possessed; and to allow him to subdue the rest of the kingdom, which was now usurped and rendered miserable by a set of petty princes, who knew not how to govern. To influence him the more powerfully, he also promised to hold this kingdom of the pope; and to pay him the usual tax collected by the church. This request, however, was refused. Valdemar of Sleswick, nephew to Gerhard, then aspired to the sovereignty. He had formerly been elected king; but had given over all thoughts of enjoying the sovereignty, on account of the superior influence of Christopher; but now resumed his ambitious views at the instigation of his uncle. Several of his nobility also cast their eyes on young Valdemar, Christopher's son, now at the emperor's court. But while each of these princes were laying schemes to aggrandise themselves, the unhappy Danes were distressed by exorbitant taxes, famine, and pestilence; the two last in consequence of the former. The peasants neglected to cultivate the lands, which they held on a very precarious tenure; the consequence of this was poverty and an unwholesome diet; and this, co-operating with the peculiar disposition of the air, produced a plague, which destroyed more than half the inhabitants of the country. The poor dropped down dead on the streets with disease and hunger, and the gentry themselves were reduced to a state of wretchedness; yet, though the whole of the kingdom was evidently on the verge of ruin, ambitious projects employed the great, as if every thing had been in the most profound tranquillity.

13
Distressed
state of the
kingdom.

14
Nicholas
Norevi recovers
the liberties of
Jutland.

In the midst of these grievous calamities, Gerhard sovereign of Jutland, proposed to his nephew Valdemar an exchange of territories, which he believed would prove favourable to the designs of the latter on the crown. A treaty for this purpose was actually drawn up and signed; but the inhabitants, notwithstanding their distressed situation, so highly resented their being disposed of like cattle from one master to another, that they refused to pay the usual taxes. Gerhard resolved to compel them; and therefore led 10,000 men, whom he had levied in Germany, into the heart of the province. Providence, however, now raised up an enemy to this tyrant. One Nicholas Norevi, a man greatly esteemed for his courage, public spirit, and prudence, beheld with sorrow the condition to which Denmark was reduced. He had long meditated a variety of projects for his relief, and at last imagined things were in such a situation that the whole depended on his single arm. Young Valdemar, Christopher's son, had a number of adherents in the kingdom; his most dangerous enemy was Gerhard; and could he be removed, the Jutlanders would at least be free from an oppressor, and might choose Valdemar, or any other they thought proper,

proper, for their sovereign. Collecting a body of chosen horse, therefore, he marched in the night to Randershusen, where Gerhard had fixed his head quarters; and having forced open the tyrant's quarters, immediately put him to death. He then fled with the utmost expedition; but was pursued and overtaken by a party of the enemy's horse, through which he forced his way and escaped. Gerhard's sons, hearing of his death, retired into Holstein, from whence they had come; leaving the army, composed chiefly of Holsteiners, to be cut in pieces by the enraged peasants, who fell upon them from every quarter.

Still, however, the Holsteiners kept possession of the citadels and fortified places, from whence Nicholas resolved to dislodge them. He accordingly raised a body of forces; attacked and took Landen, a castle situated on the river Scherne: After which he laid siege to Albeg; but the garrison making an obstinate defence, he turned the siege into a blockade, by which they were soon reduced to great extremity. The governor sent an express to the sons of Gerhard, acquainting them with the impossibility of his holding out more than a few days, without being relieved. This determined them to march to the relief of so important a place. They came up with Nicholas just as the governor was ready to surrender, but were defeated; though Nicholas was unfortunately killed in the engagement.

15
He is killed.

Jutland having thus regained its liberty, the rest of the kingdom followed its example. Zealand first openly declared itself. Here Henry, Gerhard's son, maintained several garrisons; and resolved to defend his possessions in spite of all the power of the inhabitants. For this purpose he drew together an army: but, in the mean time, a tumult arose among the peasants on account of a Danish nobleman slain by the Holsteiners. By this the people were at last so irritated, that falling upon the Holsteiners sword in hand, they killed 300 of them, drove the rest out of the island, and chose Valdemar, Christopher's son, for their sovereign.

16
Margaret unites the crowns of Denmark, Sweden, and Norway.

The Danes now resumed their courage; the lands were cultivated, the famine and pestilence ceased, and the kingdom began to flourish as formerly. Matters continued in a prosperous way till 1387, when Margaret mounted the throne. She raised the kingdom to its highest pitch of glory, as partly by her address, and partly by hereditary right, she formed the union of Calmar, by which she was acknowledged sovereign of Sweden, Denmark, and Norway. She held her dignity with such firmness and courage, that she was justly styled the *Semiramis of the North.* Her successors being destitute of her great qualifications, the union of Calmar fell to nothing: but Norway still continued annexed to Denmark. About the year 1448, the crown of Denmark fell to Christian count of Oldenburg, from whom the present royal family of Denmark is descended; and, in 1536, the Protestant religion was established in Denmark by that wise and politic prince Christian III.

Christian IV. of Denmark, in 1629, was chosen for the head of the Protestant league formed against the house of Austria: but, though brave in his own person, he was in danger of losing his dominions; when he was succeeded in that command by the famous Gustavus Adolphus, king of Sweden. The Dutch having obliged Christian, who died in 1648, to lower the duties of the Sound, his son Frederic III. consented to accept of an annuity of 150,000 florins for the whole. The Dutch, after this, persuaded him to declare war against Charles Gustavus king of Sweden, which had almost cost him his crown in 1657. Charles stormed the fortress of Fredericstadt; and in the succeeding winter, he marched his army over the ice to the island of Funen, where he surprised the Danish troops, took Odensee and Nyburg, and marched over the Great Belt to besiege Copenhagen itself. Cromwell, the English usurper, interposed: and Frederic defended his capital with great magnanimity till the peace of Roschild; by which Frederic ceded the provinces of Halland, Bleking, and Sconia, the island of Bornholm, Bahus, and Drontheim, in Norway, to the Swedes. Frederic sought to elude those severe terms; but Charles took Cronenburg, and once more besieged Copenhagen by sea and land. The steady intrepid conduct of Frederic under these misfortunes endeared him to his subjects; and the citizens of Copenhagen made an admirable defence, till a Dutch fleet arrived in the Baltic, and beat the Swedish fleet. The fortune of war was now entirely changed in favour of Frederic, who showed on every occasion great abilities, both civil and military: and having forced Charles to raise the siege of Copenhagen, might have carried the war into Sweden, had not the English fleet, under Montague, appeared in the Baltic. This enabled Charles to besiege Copenhagen a third time; but France and England offering their mediation, a peace was concluded in that capital; by which the island of Bornholm returned to the Danes; but the island of Rugen, Bleking, Halland, and Schonen, remained with the Swedes.

17
Several provinces ceded to Sweden.

18
Remarkable revolution, by which the king is rendered absolute.

The year 1660 affords us an example of a revolution almost unequalled in the annals of history, viz. that of a free people resigning their liberty into the hands of their sovereign; and of their own accord, and without the least compulsion, rendering him despotic. This was occasioned by the great character which Frederic had acquired by his prudent and valiant conduct when Copenhagen was besieged by the king of Sweden; and at that time he had also taken care to ingratiate himself with the commonalty, by obliging the nobility to allow them some immunities which they did not enjoy before; allowing them also, by a special edict, to possess lands, and enjoy all the privileges of nobility. After the conclusion of the treaty with Sweden, a diet was summoned at Copenhagen, to take into consideration the state of the kingdom, which was now very much exhausted, both by reason of the debts in which it was involved, and by the calamities of war. This distressed state of affairs was, by the commons, attributed to the nobility; who on the other hand, took no care to conciliate the affections of the inferior classes, but rather increased the discontents by their arrogance. They had even the imprudence to remonstrate against the immunities above mentioned, which had been granted by the king during the siege. In consequence of this the deputies of the commons and clergy united against them; and being joined by the citizens of Copenhagen, formed a very considerable party. On bringing forward in the assembly the sums necessary for the

the national exigencies, a general excise was proposed by the nobles on every article of consumpt; and to which they themselves were willing to submit, though, by an express law, their order was to be exempted from all taxes. This offer was accompanied with a remonstrance to the king; in which they endeavoured, not only to reclaim many obsolete privileges, but to add fresh immunities, and introduce many other regulations, all of them tending to diminish the royal prerogative, and check the rising influence of the commons and clergy. This proposal occasioned great disputes in the diet; and the two inferior orders insisted that they would not admit of any tax which should not be levied equally upon all ranks, without reserve or restriction. The nobles not only refused to comply with this proposal, but even to be subject to the tax for more than three years; pretending that all taxes whatever were infringements on their privileges. By way of compensation, however, they proposed new duties upon leather and stamped paper, and at last offered to pay a poll-tax for their peasants. This exchange seemed at first to be agreeable to the two inferior estates; but they suddenly altered their mind, and demanded that the fiefs and domains, which the nobles had hitherto possessed exclusively, and at a very moderate rent, should be let to the highest bidder.

Such a proposal appeared to the nobles to be to the last degree unreasonable. They said it was an infraction of their dearest privileges; as, by the 46th article of the coronation oath taken by Frederic, the possession of the royal fiefs was guaranteed to their order; but, in the heat of dispute, one of the chief senators having imprudently thrown out some reproachful expressions against the commons, a general ferment ensued, and the assembly was broken up in confusion. This gave occasion to the interposition of the king's friends; and an idea of rendering the crown hereditary, and enlarging the royal prerogative, began to be suggested as the proper method of humbling the nobility. This was first broached by the bishop of Zealand, at whose house a numerous meeting was held on the 6th of October 1660, where the scheme was fully laid open and approved; an act for rendering the crown hereditary drawn up; and the best method of publicly producing it taken into consideration. All this time the king seemed quite inactive, nor could he be prevailed upon to take any part in an affair which so nearly concerned him. But this indolence was abundantly compensated by the alertness and diligence of the queen; between whom and the heads of the party matters were soon concerted. On the morning of the 8th of October, therefore, the bishop of Zealand having obtained the consent and signature of the ecclesiastical deputies, delivered it to Nausen, burgomaster of Copenhagen and speaker of the commons. The latter, in a most persuasive speech, expatiated upon the wretched state of the kingdom, the oppressive power of the nobles, and the virtues of the king; concluding with an exhortation to the commons, to subscribe the act, as the only means of saving their country.

The exhortations of the speaker had such an effect upon the assembly, that they subscribed it without a single dissent; the nobles being all the while in perfect security, and entirely ignorant of the transaction. Next day it was presented to the king by the bishop and Nausen; and as they were returning from the palace, they met the senator who had already given offence to the commons. With him they had a violent altercation, and were threatened with imprisonment for presuming to approach the king without acquainting the order of nobles. This threat was now altogether nugatory. The nobles having got some intelligence of what was going forward, had just assembled in order to consider of what was to be done, when the deputies of the two other estates entered, and informed them of their proceedings, and delivered to them the proposal for rendering the crown hereditary. By this declaration the nobles were thrown into the utmost consternation; but judging it improper to put a negative on the proposal at present, they endeavoured to gain time, and replied, that though they willingly gave their assent to the declaration, yet that, as it was a matter of great consequence, it deserved the most serious discussion. Nausen, however, replied, that the other estates had already taken their resolution; that they would lose no time in debate; and that if the nobles would not concur with them, they would immediately repair to the palace by themselves, where they had not the least doubt that the king would graciously accept their proffer.

In the mean time the nobles had privately dispatched a message to the king, intimating, that they were willing to render the crown hereditary to the male line of his issue, provided it was done with all the usual formalities. But this proposal did not prove agreeable to his majesty, unless they would confirm the right of succession in the female line also. He added, however, with great appearance of moderation, that he by no means wished to prescribe rules for their conduct; they were to follow the dictates of their own judgment; but as for his part, he would owe every thing to their free consent. While the nobles were waiting for this answer, the other deputies, perceiving that they wished to keep the matter in suspense, lost all patience, and repaired in solemn procession to the court; where, being admitted into the royal presence, the matter was opened by the bishop of Zealand. He addressed his majesty on the resolution taken by the clergy and commons, offering in their name to render the crown hereditary, and to invest him with absolute authority; adding, that they were ready to sacrifice their lives in the defence of an establishment so salutary to their country. His majesty thanked them for their favourable intentions; but mentioned the concurrence of the nobles as a necessary condition; though he had no doubt of this when they should have time to accompany the declaration with all the necessary formalities; he assured them of his protection, promised a redress of all grievances, and dismissed them with an exhortation to continue their sittings, until they should have brought their design to perfection, and he could receive their voluntary submission with all due solemnity.

On departure of the commons from the place where they had been conferring with the nobles, the latter had been so distracted and confused, that they broke up without coming to any resolution, designing, however, to decide the matter finally at their meeting on the afternoon of the following day. But while they were thus wavering and irresolute, the court and the popular party took the necessary measures to force them to a concurrence. This was effectually done by an order to shut the gates; for by this they were so much dispirited, that they instantly dispatched deputies to the court, with a message that they were ready to concur with the commons, and subscribe to all the conditions of the royal pleasure.

Nothing now remained but to ratify the transaction with all proper solemnity. Accordingly, on the 16th of October, the estates annulled, in the most solemn manner, the capitulation or charters signed by the king on his accession to the throne; absolved him from all his engagements; and cancelled all the limitations imposed upon his sovereignty. The whole was concluded by the ceremony of doing homage, taking the new oath with great ceremony; after which a new form of government was promulgated under the title of *The Royal Law of Denmark.*

Frederic was succeeded in 1670 by his son Christian V. who obliged the duke of Holstein Gottorp to renounce all the advantages he had gained by the treaty of Roschild. He then recovered a number of places in Schonen; but his army was defeated in the bloody battle of Lunden by Charles XI. of Sweden. This defeat did not put an end to the war, which Christian obstinately continued, till he was defeated entirely at the battle of Landscroon; and he had almost exhausted his dominions in his military operations, till he was in a manner abandoned by all his allies, and forced to sign a treaty on the terms prescribed by France, in 1679. Christian, however, did not desist from his military attempts; and at last he became the ally and subsidiary of Louis XIV. who was then threatening Europe with chains. Christian, after a vast variety of treating and fighting with the Holsteiners, Hamburghers, and other northern powers, died in 1699. He was succeeded by Frederic IV. who, like his predecessors, maintained his pretensions upon Holstein; and probably must have become master of that duchy, had not the English and Dutch fleets raised the siege of Tonningen; while the young king of Sweden, Charles XII. who was no more than 16 years of age, landed within eight miles of Copenhagen, to assist his brother-in-law the duke of Holstein. Charles probably would have made himself master of Copenhagen, had not his Danish majesty agreed to the peace of Travendahl, which was entirely in the duke's favour. By another treaty concluded with the states-general, Frederic obliged himself to furnish a body of troops, who were to be paid by the confederates; and who afterwards did great service against the French.

19
Perpetual wars with Sweden.

Notwithstanding this peace, Frederic was perpetually engaged in a war with the Swedes; and while Charles was an exile at Bender, he marched through Holstein into Swedish Pomerania; and in the year 1712 into Bremen, and took the city of Stade. His troops, however, were totally defeated by the Swedes at Gadesbusch, who laid his favourite city of Altena in ashes. Frederick revenged himself, by seizing great part of the ducal Holstein, and forcing the Swedish general, Count Steinbock, to surrender himself prisoner, with all his troops. In the year 1716, the successes of Frederic were so great, by taking Tonningen and Stralsund, by driving the Swedes out of Norway, and reducing Wismar and Pomerania, that his allies began to suspect he was aiming at the sovereignty of all Scandinavia. Upon the return of Charles of Sweden from his exile, he renewed the war against Denmark with a most embittered spirit; but on the death of that prince, who was killed at the siege of Fredericshal, Frederic durst not refuse the offer of his Britannic majesty's mediation between him and the crown of Sweden; in consequence of which, a peace was concluded at Stockholm, which left him in possession of the duchy of Sleswick. Frederic died in the year 1730, after having, two years before, seen his capital reduced to ashes by an accidental fire. His son and successor, Christian Frederic, made no other use of his power, and the advantages with which he mounted the throne, than to cultivate peace with all his neighbours, and to promote the happiness of all his subjects, whom he eased of many oppressive taxes.

In 1734, after guaranteeing the Pragmatic Sanction, Christian sent 6000 men to the assistance of the emperor, during the dispute of the succession to the crown of Poland. Though he was pacific, yet he was jealous of his rights, especially over Hamburgh. He obliged the Hamburghers to call in the mediation of Prussia, to abolish their bank, to admit the coin of Denmark as current, and to pay him a million of silver marks. He had, two years after, viz. in 1738, a dispute with his Britannic majesty about the little lordship of Steinhorst, which had been mortgaged to the latter by the duke of Holstein Lauenburg, and which Christian said belonged to him. Some blood was spilt during the contest; in which Christian, it is thought, never was in earnest. It brought on, however, a treaty, in which he availed himself of his Britannic majesty's predilection for his German dominions; for he agreed to pay Christian a subsidy of 70,000l. sterling a-year, on condition of keeping in readiness 7000 troops for the protection of Hanover: this was a gainful bargain for Denmark. And two years after, he seized some Dutch ships for trading without his leave to Iceland: but the difference was made up by the mediation of Sweden. Christian had so great a party in that kingdom, that it was generally thought he would revive the union of Calmar, by procuring his son to be declared successor to his then Swedish majesty. Some steps for that purpose were certainly taken: but whatever Christian's views might have been, the design was frustrated by the jealousy of other powers, who could not bear the thoughts of seeing all Scandinavia subject to one family. Christian died in 1746, with the character of being the father of his people.

20
An advantageous treaty with Great Britain.

His son and successor, Frederic V. had, in 1743, married the princess Louisa, daughter to his Britannic majesty. He improved upon his father's plan for the happiness of his people; but took no concern, except that of a mediator, in the German war. For it was by his intervention that the treaty of Closterseven was concluded between his royal highness the duke of Cumberland and the French general Richelieu. Upon the death of his first queen, the mother of his successor, he married a daughter of the duke of Brunswick Wolfenbuttle; and died in 1766.

He was succeeded on the throne by his son Christian VII. who married the princess Carolina, Matilda of England. But this alliance proved extremely

Denmark.

21
trigues of
e dowa-
r, and
isfortunes
the young
een.

tremely unfortunate, which is generally ascribed to the intrigues of the queen-dowager, who is represented as ambitious, artful, and designing, and as one who wished to have set aside the king himself in favour of her own son Frederic. On the arrival of the young queen, however, she received her with much apparent affection, telling her the faults of her husband, at the same time promising to assist her on all occasions in reclaiming him from his vicious courses. Thus, under pretence of kindness and friendship, she sowed the seeds of dissension betwixt the royal pair, before the unfortunate princess had the least suspicion of her danger; and while the unthinking queen revealed to the dowager all her secrets, the latter is said to have placed spies about the king to keep him constantly engaged in riot and debauchery, to which he was at any time too much inclined. At last it was contrived to throw a mistress in his way, whom he was advised to keep in his palace.—It was impossible that any woman could pass such a piece of conduct unnoticed; however, in this affair, the queen dowager behaved with her usual duplicity. In the absence of the king, she pretended great resentment against him, and even advised the queen not to live with him; but as soon as he returned, when his consort reproached him, though in a gentle manner, with his conduct, she not only took his part, but insisted that it was presumptuous in a queen of Denmark to pretend to direct her husband's conduct. Notwithstanding this incendiary behaviour, the queen was in a short time reconciled to her husband, and lived on very good terms with him until she again excited the jealousy of the dowager. For some time it seemed to be difficult for her to form any effectual plan of revenge, as the king had displaced several of her friends who had for some time had a share in the administration. Two new favourites, Brandt and Struensee, had now appeared; and as these paid great court to the queen, the dowager took occasion to insinuate, not only that the queen was harbouring improper designs with regard to the government, but that she had an intrigue with Struensee. A plan was even spoken of, to supersede the king as being incapable of governing, to declare the queen regent during the minority of her son, and to make Struensee prime minister.

Thus a very formidable opposition was formed against Brandt and Struensee; and as the latter had made some innovations in the military department as well as the civil, some of the principal officers who were the creatures of the dowager, represented him as designing to overthrow the whole system of government. When matters were brought to a proper bearing, it was at last resolved to surprise the king in the middle of the night, and force him instantly to sign an order, which was to be ready prepared, for committing the obnoxious persons to separate prisons, accuse them of high treason in general, and particularly with a design to dethrone or poison the king. If this could not be properly authenticated, it was determined to suborn witnesses to confirm the report of a criminal correspondence between the queen and Count Struensee. This design was executed on the night of the 16th of January 1772, when a masked ball was given at the court of Denmark. The queen, after having danced most part of the night with Count Struensee, retired to her chamber about two in the morning. About four the same morning Prince Frederic got up, and went with the queen-dowager to the king's bed-chamber, accompanied by General Eichstedt and Count Rantzau. Having ordered the king's valet de chambre to awake him, they informed his majesty, that the queen, with Count Struensee, his brother, and Brandt one of the new ministers, were at that moment busy in drawing up an act of renunciation of the crown, which they would immediately after compel him to sign; and therefore there was a necessity for him to give an order for their arrestment. The king after some hesitation consented. Count Rantzau was dispatched at that untimely hour into the queen's apartments, and immediately executed the orders of the king. The unfortunate princess was conveyed in one of the king's coaches to the castle of Cronenburgh, together with the infant princess, attended by Lady Mostyn, and escorted by a party of dragoons. Struensee and Brandt were seized in their beds and imprisoned, as well as several other members of the new administration, to the number of 18. The queen-dowager and her adherents seemed to assume the government entirely into their own hands, and a total change took place in the departments of administration. Struensee and Brandt were put in irons, and very severely treated: they underwent long and frequent examinations; and Struensee at last confessed that he had a criminal intercourse with the queen.

22
Execution
of Struensee
and Brandt.

Both their heads were struck off on the 28th of April; but many of their partisans were set at liberty. The confession of Struensee is by many, and indeed with no small degree of probability, supposed to have been extorted by fear of the torture, and to have no foundation in truth; but as no means were used by the court of Britain to clear up the queen's character, the affair must undoubtedly wear a suspicious aspect. At last, however, his Britannic majesty interfered so far as to send a small squadron of ships to convey the unhappy princess to Germany. Here the city of Zell was appointed for her residence; and in this place she died of a malignant fever on the 10th of May 1775, aged 23 years and 10 months.

23
Change in
the admini-
stration.

The inhuman treatment of this princess did not long prove advantageous to the queen-dowager and her party: A new revolution took place in April 1784, when the queen-dowager's friends were removed, a new council was formed under the auspices of the prince royal, and no instrument deemed authentic unless signed by the king and countersigned by the prince. Since that time, the king, who from the beginning of his administration showed a great degree of incapacity, was entirely laid aside from public business. He died in 1808, and was succeeded by the crown-prince, now Frederick IV.

Denmark wisely took no part in the wars which arose out of the French revolution. But about 1800, she concurred with Sweden and Russia in making loud complaints against the conduct of British cruizers, and at length the three powers entered into an association for the common protection of their commercial rights. This was speedily followed by hostilities. Admiral Parker, with Lord Nelson under him, sailed to the Baltic with a strong fleet, and attacked the Danish squadron in the road of Copenhagen, supported by formidable batteries, on the 30th March 1801. After a very obstinate battle, seventeen Danish ships of the line were taken or destroyed, and about 4000 Danes fell in the action. An armistice followed, which terminated in a peace, the emperor Paul, the chief supporter of the confederacy, having been assassinated a few days before this battle.

After the overthrow of the Prussians at the battle of Jena, France possessed herself of part of the southern shores of the Baltic; and as it was feared she would thus be in a condition to get the naval means of Denmark into her power, a secret expedition was fitted out in August 1807, consisting of 27 sail of the line under Lord Gambier, and 20,000 land troops under Lord Cathcart. This force appeared suddenly before Copenhagen; and the British agent, Mr Jackson, demanded that the Danes should deliver up their fleet to be held as a deposit by the British government, and to be restored at the general peace in the same condition. This demand was met with a peremptory refusal. The fleet then advanced, the town was surrounded, and a furious bombardment began, on the 2d of September, which continued till the 5th, and destroyed 400 houses. The town was surrendered on the 7th, when the British carried away 16 sail of the line and several frigates, besides a quantity of naval stores. A great outcry was raised against this assault on a neutral nation then at peace with us; the British nation generally condemned the measure; and as it was eventually the cause of involving Britain in a war with Russia, it was undoubtedly upon the whole rather productive of loss than advantage.

Denmark continued to adhere firmly to Bonaparte till 1813. Lubec being taken, and the greater part of Holstein overrun by the Swedes, she was reduced to the necessity of making peace on terms dictated by her enemies. She gave up Norway to Sweden; as a compensation for which she received Pomerania, and this was exchanged for a part of the duchy of Lauenburg.

24 Division of the kingdom. The kingdom of Denmark at present is divided into six grand districts or provinces; viz. 1. Denmark properly so called, comprehending the islands of Zealand, Funen, Langland, Laaland, Falstria, Mona, Samsoe, Arroe, Bornholm, Anholt, Lessaw, and that part of the continent called *North Jutland*. 2. The duchy of Sleswick, or South Jutland. 3. The duchy of Holstein. 4. The duchy of Lauenburg; and, 5. Iceland, with the islands lying in the northern seas; for a particular description of which see these articles.

25 Language, religion, &c. The language of Denmark is a dialect of the Teutonic, and bears a strong affinity to the Norwegian tongue; but is disagreeable to strangers, on account of the drawling tone with which it is pronounced. They have borrowed many words from the German; and indeed the High Dutch is used in common discourse by the court, the gentry, and the burghers. The better sort likewise understand French, and speak it fluently. The Lutheran doctrine is universally embraced through all Denmark, Sweden, and Norway; so that there is not another sect in these kingdoms. Denmark is divided into six dioceses, one in Zealand, one in Funen, and four in Jutland: but the bishops are, properly speaking no other than superintendants, or *primi inter pares*. They have no cathedrals, ecclesiastical courts, or temporalities. Their business is to inspect the doctrine and morals of the inferior clergy. The revenue of the bishop of Copenhagen amounts to about 2000 rix-dollars; and this is the richest benefice in the kingdom. The clergy are wholly dependent on the government. They never intermeddle, and are never employed or consulted in civil affairs. They nevertheless have acquired great influence, and erected a sort of spiritual tyranny over the minds of the common people, by whom they are much revered. They are, generally speaking, men of exemplary lives, and some erudition. Their churches are kept more clean, and better adorned, than those of England; the people are great lovers of music, and their organists commonly entertain the congregation for half an hour before and after service. The state of literature is very low in Denmark. There is, indeed, an university at Copenhagen; but meanly endowed, and very ill supplied with masters. Taste and the belles lettres are utterly unknown in this country, which yet has produced some men of great eminence in mathematics and medicine; such as Tycho Brahe, Borrichius, and the Bartholines.

26 Government. The constitution of Denmark was heretofore of the free Gothic original. The convention of the estates, even including the representatives of the boors or peasants, elected a king for his personal virtues, having still a regard to the son of their late monarch, whom, however, they made no scruple of setting aside, if they deemed him unworthy of the royal dignity. They enacted laws; conferred the great offices of state; debated all affairs relating to commerce, peace, war, and alliances; and occasionally gave their consent to the imposition of necessary taxes. The king was no other than chief magistrate, generalissimo, and as it were, prime minister to his people. His business was to see justice administered impartially; to command the army in time of war; to encourage industry, religion, arts, and sciences; and to watch over the interests of his subjects.

In 1660, however, the constitution was new modelled, as has been already related, and which was to the following purport. "The hereditary kings of Denmark and Norway should be in effect, and ought to be esteemed by their subjects, the only supreme head upon earth; they shall be above all human laws, and shall acknowledge, in all ecclesiastical and civil affairs, no higher power than God alone. The king shall enjoy the right of making and interpreting the laws, of abrogating, adding to, and dispensing with them. He may also annul all the laws which either he or his predecessors shall have made, excepting this royal law, which must remain irrevocable, and be considered as the fundamental law of the state. He has the power of declaring war, making peace, imposing taxes, and levying contributions of all sorts, &c. &c.

Then follow the regulations for the order of succession, the regency in case of minority, the majority of the king, the maintenance of the royal family; and, after having enumerated all the possible prerogatives of regal uncircumscribed authority, as if sufficient had not yet been laid down, it is added in the 26th article: "All that we have hitherto said of power and eminence, and sovereignty, and if there is any thing further which has not been expressly specified, shall all be comprised in the following words: 'The king of Denmark and Norway shall be the hereditary monarch, and endued with the highest authority; insomuch, that all that can be said and written to the advantage of of a Christian, hereditary, and absolute king, shall be extended under the most favourable interpretation to the hereditary king and queen of Denmark and Norway," &c. &c.

27 aws, &c.

The laws of Denmark are so concise, that the whole body is contained in one quarto volume, written in the language of the country. Every man may plead his own cause, without employing either counsel or attorney; but there are a few advocates for the benefit of those who cannot or will not speak in their own defence. The proceedings are so summary, that a suit may be carried through all the courts, and finally decided in 13 months. There are three courts in Denmark, and an appeal lies from the inferior to the superior tribunal. The lowest of these is, in cities and towns, denominated the *Byfoglids Court;* and in the country, the *Herredsfougds.* Causes may be appealed from this to the *Lanstag*, or general head court for the province; but the final appeal lies to the court of *High-right* in Copenhagen, where the king presides in person, assisted by the prime nobility. The judges of the two other courts are appointed by his majesty's letters patent, to sit and determine causes *durante bene placito.* These are punishable for any misdemeanours of which they may be guilty; and when convicted of having passed an unjust sentence, they are condemned to make reparation to the injured party. Their salaries are very inconsiderable, and paid out of the king's treasury, from the fines of delinquents, besides a small gratuity from the plaintiff and defendant when sentence is passed. Such is the peculiar privilege enjoyed by the city of Copenhagen, that causes appealed from the Byfoglids court, instead of passing through the provincial court, are tried by the burgomaster and common council; from whence they proceed immediately to the highest court as the last resource. Affairs relating to the revenue are determined in the rent-chamber of Denmark, which is analogous to our court of exchequer. To another tribunal, composed of some members from this rent-chamber, from the admiralty, and college of commerce, merchants appeal for redress when their commodities are seized for non-payment of duties. All disputes relating to the sea are determined by the court of admiralty, constituted of commissioners appointed for these purposes. The chancellary may be more properly termed a *secretary's office.* It consists of clerks, who write and issue all the king's decrees and citations, transcribe papers, and according to the directions they receive, make draughts of treaties, and alliances with other nations. The government of Denmark is very commendable for the excellent police it maintains. Justice is executed upon criminals with great severity; and such regulations are established as effectually prevent those outrages that are daily committed in other countries. No man presumes to wag his tongue against the government, far less to hatch schemes of treason. All the subjects are, or seem to be, attached to their sovereign by the ties of affection. Robbery on the highway, burglary, coining or clipping, are crimes seldom or never heard of in Denmark. The capital crimes usually committed are theft and manslaughter. Such offenders are beheaded very dexterously with one stroke of a sword. The executioner, though infamous, is commonly rich; because, beside the proper functions of his office, he is employed in other mean occupations, which few other persons will undertake. He, by means of his understrapper, called the *pracher*, empties all the jakes, and removes from houses, stables, or streets, dead dogs, horses, &c. which no other Dane would vouchsafe to touch on any consideration whatever.

28 Slavish condition of the Danish subjects.

The Danish nobility and gentry are all included in the term *noblesse;* and formerly there were no distinctions of title; but within these 60 or 70 years some few favourites have been dignified with the titles of *count* and *baron.* These, and these only, enjoy the privilege of disposing of their estates by will; though others may make particular dispositions, provided they have sufficient interest to procure the king's approbation and signature. The noblesse of Denmark formerly lived at their own seats with great magnificence; and at the conventions of estates met the king with numerous and superb retinues; but since he became absolute, they are so impoverished by exorbitant taxes, that they can hardly procure subsistence; but, for the most part live obscurely in some corner of their ruined country palaces, unless they have interest enough to procure some employment at court. They no longer inherit the spirit and virtues of their ancestors; but are become servile, indolent, ostentatious, extravagant, and oppressive.

Their general character is a strange composition of pride and meanness, insolence and poverty. If any gentleman can find a purchaser for his estate, the king, by the Danish laws, has a right to one third of the purchase-money; but the lands are so burdened with impositions, that there would be no danger of an alienation, even though this restriction was not in force.—Nay, some gentlemen in the island of Zealand have actually offered to make a surrender to the king of large tracts of very fertile land in the island of Zealand, if his majesty would be pleased to accept of them in place of the impositions laid on them. The reason of this is, because, by the law of Denmark, if any estate is burdened beyond what it can bear, the owner must make up the deficiency out of his other estates, if he has any. Hence the king generally refuses such offers; and some gentlemen have been transported with joy when they heard that his majesty had been "graciously pleased to accept their whole estates."

This oppression of the nobles by the king produces in them a like disposition to oppress the commons; and the consequence of all this is, that there is no part of the world where extravagance and dissipation reign to such a degree. The courtiers maintain splendid equipages, wear fine clothes, drink a vast quantity of French wine, and indulge themselves with eating to excess. Such as derive money from their employment, instead of purchasing land in Denmark, remit their cash to the banks of Hamburgh and Amsterdam. The merchants and burghers tread in the steps of their superiors; they spend all their gains in luxury and pleasure, afraid of incurring the suspicion of affluence, and being stripped by taxation. The peasant, or boor, follows the same example. No sooner has he earned a rix-dollar than he makes haste to expend it in brandy, lest it should fall into the hands of his oppressive landlord. This lower class of people are as absolute slaves as the negroes in the West Indies, and subsist upon much harder fare. The value of estates is not computed by the number of acres, but by the stock of boors, who, like the timber, are reckoned a parcel of the freehold; and nothing can be more wretched than the state of these boors; they feed upon stock-fish, salted meats, and other coarse diet; there is not the least piece of furniture of any value in their houses, except feather-beds, of which there is great plenty in Denmark, and which are used not only as beds to lie on, but as blankets for covering. After the boor has toiled like a slave to raise the king's taxes, he must pay the overplus of his toil to his needy landlord. Should he improve his ground and repair his farm house, his cruel master will immediately transplant him to a barren farm and a naked habitation, that he may let the improved ground to another tenant at a higher price. The peasants likewise sustain a great deal of damage and violence from the licentious soldiers that are quartered in their houses. They are moreover obliged to furnish horses and waggons for the royal family and all their attendants, when the king makes a progress through the country, or removes his residence from one place to another. On such occasions the neighbouring boors are summoned to assemble with their cattle and carriages, and not only to live at their own expence, but to bear every species of outrage from the meanest lacquies of those who attend his majesty. The warlike spirit of the Danes no longer subsists; the common people are mean-spirited, suspicious, and deceitful, nor have they that talent for mechanics, so remarkable in some northern nations. While the peasants are employed in their labour without doors, the women are occupied at home in spinning yarn for linen, which is here made in great perfection.

29 Dress, &c. In Denmark all persons of any rank above the vulgar dress in the French taste, and affect finery; the winter-dress of the ladies is peculiar to the country, very neat, warm, and becoming. The common people are likewise remarkably neat, and pride themselves in different changes of linen. They are very little addicted to jollity and diversion; their whole amusements consist in running at the goose on Shrove Tuesday, and in winter in being drawn in sledges upon the ice. With respect to marriage, the man and woman frequently cohabit together in contract long before the ceremony is performed; the nobility and gentry pique themselves on sumptuous burials and monuments for the dead: the corpse is very often kept in a vault, or in the chancel of a church, for several years, before an opportunity offers of celebrating the funeral.

The taverns in this country are poorly supplied; and he who diets in them must be contented to eat in a public room, unless he will condescend to pay an extravagant price for a private apartment; the metropolis is but indifferently furnished with game; the wild ducks and plover are hardly eatable: but the hares are good, and the markets sometimes produce tolerable roebuck; their sea-fish are not to be commended; but the rivers produce plenty of delicious carp, perch, and craw-fish; the gardens of the gentry are well provided with melons, grapes, peaches, and all sorts of greens and salads in perfection.

30 Army of Denmark. The army of Denmark is composed of the troops of Denmark and Holstein.

The forces of Denmark and Holstein are divided into regulars and national or militia. These forces (the foot and horse guards excepted, who are all regulars) are not separated, as in our army, into distinct regiments, but are formed in the following manner: Before the late augmentation, every regiment of infantry, when complete, consisted of 26 officers and 1632 privates, divided into ten companies of fusileers and two of grenadiers. Of these 1632 privates, 480, who are chiefly foreigners enlisted in Germany, are regulars. The remaining 1152 are the national militia, or peasants who reside upon the estates of their landholders, each estate furnishing a certain number in proportion to its value. These national troops are occasionally exercised in small corps upon Sundays and holidays; and are embodied once every year for about 17 days in their respective districts. By a late addition of ten men to each company, a regiment of infantry is increased to 1778, including officers. The expence of each regiment which before amounted to 6000l. has been raised by the late augmentation to 8000l. The cavalry is upon the same footing; each regiment consisting of 17 officers, including serjeants and corporals, and 565 privates, divided into five squadrons. Of these about 260 are regular, and the remainder national troops. The regiments of foot and horse guards are regulars: the former is composed of 21 officers and 465 men, in five companies; and the latter of 7 officers and 154 men, in two squadrons.

From their insular situation, the Danes have always excelled as a maritime people. In the earlier ages, when piracy was an honourable profession, they were a race of pirates, and issued from the Baltic to the conquests of England and Normandy. And though, since the improvement of navigation by the invention of the compass, other nations have risen to a greater degree of naval eminence, still, however, the Danes, as they inhabit a cluster of islands, and possess a large tract of sea-coast, are well versed in maritime affairs, and are certainly the most numerous, as well as the most experienced, sailors of the north.

The greatest part of the Danish navy is stationed in the harbour of Copenhagen, which lies within the fortifications; the depth of water being only 20 feet, the ships have not their lower tier of guns on board, but take them in when they get out of port. Besides large magazines, each vessel has a separate storehouse on the water's edge, opposite to which she is moored when in harbour, and may by this means be instantly equipped; the number of registered seamen is near 40,000, and are divided into two classes; the first comprises those inhabiting the coasts, who are allowed to engage in the service of merchant-ships trading to any part of the world. Each receives 8s. annually from the crown, as long as he sends a certificate of his being alive; but is subject to a recal in case of war. The second comprehends the fixed sailors, who are constantly in the employ of the crown, and amount to about 4000, ranged under four divisions, or 40 companies: they are stationed at Copenhagen for the ordinary service of the navy, and work in the dock-yard. Each of them, when not at sea, receives 8s. per month, beside a sufficient quantity of flour and other provisions; every two years a complete suit of clothes; and every year breeches, stockings, shoes, and a cap. Some of them are lodged in barracks. When they sail, their pay is augmented to 20s. per month.

Published by A. Constable & C^o. Edinburgh, 1819.

Engraved by Sid^y. Hall.

month. The marine artillery consists of 800 men, in four divisions.

31 avy. The Danish navy was formerly estimated at 38 ships of the line, besides frigates. It may be doubted, however, whether the whole of these were at any one time fit for service. Seventeen ships of war were destroyed in Admiral Parker's attack in 1801; and Lord Gambier brought away, in 1807, 16 ships of the line and 15 frigates. No authentic account of the strength of the Danish navy has been published since the late peace.

The population of Denmark in 1811 was stated to be 1,800,000; and that of Iceland is estimated at 53,000. The revenue of the country is estimated at 1,700.000l. sterling. Norway, when Denmark lost it, contained 950,00 inhabitants.

32 evenue. The revenue of his Danish majesty arises from taxes laid on his own subjects, from the duties paid by foreigners, from his own estate, crown lands, and confiscations. The taxes are altogether arbitrary, and therefore fluctuating; but they are always grievous to the subject. They commonly consist of customs or toll, for export and import; of excise upon the consumption of wine, salt, tobacco, and all kinds of provisions; of taxes upon marriages, paper, brewing, or grinding, and the exercise of different professions; of impositions on land, poll-money, ground-rent for all houses in Copenhagen and elsewhere; of money raised for maintaining fortifications, and for a portion to the king's daughter when she happens to be married; but this seldom exceeds 100,000 rix dollars. One considerable article in the revenue is the toll paid by foreign ships that pass through the Sound, or *Ore Sound* (the strait between Schonen and Zealand), into the Baltic. This was originally no other than a small contribution, which trading nations agreed to make for maintaining lights at certain places, to direct their course through the passage in dark and stormy weather. In process of time the Danes converted this voluntary contribution, into an exorbitant toll, and even exacted arbitrary sums in proportion to the weakness of the nation whose ships they visited. These exactions sometimes involved them in quarrels, and the toll was regulated in repeated treaties. See DENMARK, SUPPLEMENT.

DENNIS, JOHN, the celebrated critic, was the son of a reputable tradesman in London, and born in the year 1657. He received the first branches of education at the great school in Harrow on the Hill, where he commenced acquaintance and intimacy with many young noblemen and gentleman, who afterwards made considerable figures in public affairs, whereby he laid the foundation of a very strong and extensive interest, which might, but for his own fault, have been of infinite use to him in future life. From Harrow he went to Caius-college Cambridge; where, after his proper standing, he took the degree of batchelor of arts. When he quitted the university, he made the tour of Europe; in the course of which he conceived such a detestation for despotism, as confirmed him still more in those Whig principles which he had from his infancy imbibed.

On his return to England he became early acquainted with Dryden, Wycherly, Congreve, and Southerne; whose conversation inspiring him with a passion for poetry, and a contempt for every attainment that had not something of the *belles lettres*, diverted him from the acquisition of any profitable art, or the exercise of any profession. This, to a man who had not an independent income, was undoubtedly a misfortune: however his zeal for the Protestant succession having recommended him to the patronage of the duke of Marlborough, that nobleman procured him a place in the customs worth 120l. per annum; which he enjoyed for some years, till from profuseness and want of economy, he was reduced to the necessity of disposing of it to satisfy some very pressing demands. By the advice of Lord Halifax, however, he reserved to himself, in the sale of it, an annuity for a term of years; which term he outlived, and was, in the decline of his life, reduced to extreme necessity.

Mr Theo. Cibber relates an anecdote of him, which we cannot avoid repeating, as it is not only highly characteristic of the man whose affairs we are now considering, but also a striking and melancholy instance, among thousands, of the distressful predicaments into which men of genius and literary abilities are perhaps apter than any others to plunge themselves, by paying too slight an attention to the common concerns of life, and their own most important interests. "After that he was worn out (says that author) with age and poverty, he resided within the verge of the court, to prevent danger from his creditors. One Saturday night he happened to saunter to a public house, which in a short time he discovered to be without the verge. He was sitting in an open drinking-room, when a man of a suspicious appearance happened to come in. There was something about the man which denoted to Mr Dennis that he was a bailiff. This struck him with a panic; he was afraid his liberty was at an end; he sat in the utmost solicitude, but did not offer to stir lest he should be seized upon. After an hour or two had passed in this painful anxiety, at last the clock struck twelve; when Mr Dennis, in an ecstacy, cried out, addressing himself to the suspected person, "Now, Sir, bailiff or no bailiff, I do'nt care a farthing for you, you have no power now." The man was astonished at his behaviour; and when it was explained to him, was so much affronted with the suspicion, that had not Mr Dennis found his protection in age, he would probably have smarted for his mistaken opinion. A strong picture of the effects of fear and apprehension, in a temper naturally so timorous and jealous as Mr Dennis's; of which the following is a still more whimsical instance. In 1704 came out his favourite tragedy, "Liberty Asserted;" in which were so many strokes on the French nation, that he thought they were never to be forgiven. He had worked himself into a persuasion that the king of France would insist on his being delivered up, before he would consent to a peace; and full of this idea of his own importance, when the congress was held at Utrecht, he is said to have waited on his patron the duke of Marlborough, to desire that no such article might be stipulated. The duke told him he had really no interest then with the ministry; but had made no such provision for his own security, though he could not help thinking he had done the French as much injury as Mr Dennis himself. Another story relating to this affair is, that being at a gentleman's house on the coast of Sussex, and walking one day on the sea-shore, he saw a ship sailing, as he fancied, towards him; he instantly set out for London, in in the fancy that he was betrayed; and congratulating himself on his escape, gave out that his friend had decoyed him down to his house, to surrender him up to the French.

Mr Dennis, partly through a natural peevishness and petulance of temper, and partly perhaps for the sake of procuring the means of subsistence, was continually engaged in a paper-war with his contemporaries, whom he ever treated with the utmost severity: and, though many of his observations were judicious, yet, he usually conveyed them in language so scurrilous and abusive, as destroyed their intended effect; and as his attacks were almost always on persons of superior abilities to himself, viz. Addison, Steele, and Pope, their replies usually turned the popular opinion so greatly against him, that, by irritating his testy temper the more, it rendered him a perpetual torment to himself; till at length, after a long life of vicissitudes, disappointments, and turmoils, rendered wretched by indiscretion, and hateful by malevolence, having outlived the reversion of his estate, and reduced to distress, from which his having been daily creating enemies had left him scarcely any hopes of relief, he was compelled to what must be the most irksome situation that can be conceived in human life, the receiving obligations from those whom he had been continually treating ill. In the very close of his days, a play was acted for his benefit at the little theatre in the Hay-market, procured through the united interests of Messrs Thomson, Mallet, and Pope; the last of whom, notwithstanding the gross manner in which Mr Dennis had on many occasions used him, and the long warfare that had subsisted between them, interested himself very warmly for him; and even wrote an occasional prologue to the play, which was spoken by Mr Cibber. Not long after this, viz. on the 6th of January 1733, he died, being then in the 77th year of his age.

Mr Dennis certainly was possessed of much erudition, and a considerable share of genius. In prose, he is far from a bad writer, where abuse or personal scurrility does not mingle itself with his language. In verse, he is extremely unequal; his numbers being at some times spirited and harmonious, and his subjects elevated and judicious; and at others flat, harsh, and puerile.—As a dramatic author, he certainly deserves not to be held in any consideration. It was justly said of him by a wit, that he was the most complete instructor for a dramatic poet, since he could teach him to distinguish good plays by his *precepts*, and bad ones by his *examples*.

DENOMINATION (from *denomino*, of *de* and *nomen*, "a name);" a name imposed upon any thing, usually expressing some quality predominant therein.

DENOMINATOR, in *Arithmetic*, a term used in speaking of fractions. See ARITHMETIC, N° 21.

DENOMINATOR of a Ratio, is the quotient arising from the division of the antecedent by the consequent. Thus 6 is the denominator of the ratio 30 to 5; because 30 divided by 5 gives 6. This is otherwise called the *exponent of the ratio*.

DENSITY *of* BODIES, is that property directly opposite to rarity, whereby they contain such a quantity of matter under such a bulk.

Accordingly, a body is said to have double or triple the density of another body, when their bulk being equal, the quantity of matter is in the one double or triple the quantity of matter in the other.

DENSITY of the Air, is a property that has employed the later philosophers, since the discovery of the Torricellian experiment.

It is demonstrated, that in the same vessel, or even in vessels communicating with each other, at the same distance from the centre, the air has everywhere the same density. The density of air, *cæteris paribus*, increases in proportion to the compressing power. Hence the inferior air is denser than the superior; the density, however, of the lower air is not proportional to the weight of the atmosphere, on account of heat and cold, and other causes perhaps, which make great alterations in density and rarity. However, from the elasticity of the air, its density must be always different at different heights from the earth's surface; for the lower parts being pressed by the weight of those above, will be made to accede nearer to each other, and the more so as the weight of the incumbent air is greater. Hence the density of the air is greatest at the earth's surface, and decreases upwards in geometrical proportion to the altitudes taken in arithmetical progression.

If the air be rendered denser, the weight of bodies in it is diminished; if rarer, increased, because bodies lose a greater part of their weight in denser than in rarer mediums. Hence, if the density of the air be sensibly altered, bodies equally heavy in a rarer air, if their specific gravities be considerably different, will lose their equilibrium in the denser, and the specifically heavier body will preponderate. See PNEUMATICS.

DENTALIUM, a shell-fish, belonging to the order of vermes testacea. See CONCHOLOGY *Index*.

DENTARIA, TOOTH-WORT, or *Tooth-violet*; a genus of plants belonging to the tetradynamia class; and in the natural method ranking under the 39th order, *Siliquosæ*. See BOTANY *Index*.

DENTATUS, CURIUS, a renowned disinterested Roman general, whose virtues render him more memorable than even his great military reputation, flourished 272 years B. C. He was thrice consul; he conquered the Samnites, Sabines, and Lucanians; and gave each citizen 40 acres of land, allowing himself no more. The ambassadors of the Samnites making him a visit, found him boiling turnips in a pipkin; upon which they offered him gold to come over to their interest; but he told them, his design was not to grow rich, but to command those who were so. He defeated Pyrrhus near Tarentum, and received the honour of a triumph.

DENTELLA, in *Botany*, a genus of plants belonging to the pentandria class. See BOTANY *Index*.

DENTILES, or DENTILS, in *Architecture*, an ornament in corniches bearing some resemblance to teeth, particularly used in the Ionic and Corinthian orders. See ARCHITECTURE.

DENTIFRICE, in *Medicine*, a remedy for the teeth. There are various kinds; generally made of earthy substances finely pounded, and mixed with alum, or some other saline substances; but these are pernicious on account of their wearing away the enamel of the teeth, but more especially by the septic quality with which these earthy substances are endowed. On this account, a portion of Peruvian bark finely pounded is now commonly added, which answers the double purpose of cleaning the teeth, and preserving them afterwards from corruption.

DENTISCALPRA, in *Surgery*, an instrument for scouring yellow, livid, or black teeth; to which being applied near the gums, it scrapes off the foul morbid crust.

DENTITION, the breeding or cutting the teeth in children. See MEDICINE *Index*.

DENUNCIATION, a solemn publication or promulgation of any thing.

All vessels of enemies are lawful prizes, after denunciation or proclamation of war. The design of the denunciation of excommunicated persons is, that the sentence may be the more fully executed by the person's being more known.

DENUNCIATION at the Horn, in *Scots Law*. See LAW *Index*.

DENYS THE LITTLE. See DIONYSIUS.

DENYS, *St*, a famous town of France, in the department of Paris. Here is an ancient and magnificent church, in which were the tombs of many of the French kings; and in the treasury, among other curiosities, the swords of St Lewis and the Maid of Orleans, and the sceptre of Charlemagne. The abbey of the late Benedictines, a magnificent piece of modern architecture, has more the appearance of a palace than a convent. In 1793, after the abolition of royalty, the royal tombs in the church were all destroyed; and the name of the town was changed to that of Franciade. It is seated on the river Crould, near the Seine, five miles north of Paris. E. Long. 2. 26. N. Lat. 48. 56.

DEOBSTRUENTS, in *Pharmacy*, such medicines as open obstructions.

DEODAND, in our customs, a thing given or forfeited as it were to God, for the pacification of his wrath in a case of misadventure, whereby a Christian soul comes to a violent end without the fault of any reasonable creature.

As, if a horse strike his keeper and kill him; if a man, in driving a cart, falls so as the cart-wheel runs over him, and presses him to death; if one be felling a tree, and gives warning to the standers by to look to themselves, yet a man is killed by the fall thereof; in the first case, the horse; in the second, the cart-wheel, cart, and horses; and in the third, the tree, is *Deo dandus*, "to be given to God," that is, to the king, to be distributed to the poor by his almoner, for expiation of this dreadful event; though effected by irrational, nay, senseless and deadly creatures.

Omnia quæ movent ad mortem sunt Deodanda:
What moves to death, or kills him dead,
Is *Deodand*, and forfeited.

This law seems to be an imitation of that in Exodus, chap. xxi. "If an ox gore a man or a woman with his horns, so as they die; the ox shall be stoned to death, and his flesh not be eaten; so shall his owner be innocent."

Fleta says the Deodand is to be sold, and the price distributed to the poor, for the soul of the king, his ancestors, and all faithful people departed this life.

DEPHLEGMATION, is an operation by which the superabundant water of a body is taken from it; and it is principally effected by evaporation or distillation. Dephlegmation is also called *Concentration*, particularly when acids are the subject. See CONCENTRATION.

DEPHLOGISTICATED, in *Chemistry*, any thing deprived of the phlogiston supposed to be contained in it.

DEPHLOGISTICATED Air, is the same with oxygen gas of modern chemistry, and is an invisible elastic fluid, of somewhat greater specific gravity than that of common atmospheric air, and capable of supporting animal life and flame for a much longer time than the air we commonly breathe. See OXYGEN, CHEMISTRY *Index*.

DEPILATORY MEDICINES, are those applied in order to take off the hair: such are known to be the effects of lime and orpiment, but they ought to be used with great caution.

DEPONENT, in Latin grammar, a term applied to verbs which have active significations, but passive terminations or conjugations, and want one of their participles passive.

DEPONENT, in the *Law of Scotland*, a person who makes a deposition. See DEPOSITION.

DEPOPULATION, the act of diminishing the number of people in any country, whether by war, disease, or political causes.

DEPORTATION, a sort of banishment used by the Romans, whereby some island or other place was allotted to a criminal for the place of his abode, with a prohibition not to stir out of the same on pain of death.

DEPOSIT, among civilians, something that is committed to the custody of a person, to be kept without any reward, and to be returned again on demand.

DEPOSITARY, in *Law*, a person intrusted as keeper or guardian of a deposit.

DEPOSITION, in *Law*, the testimony given in court by a witness upon oath.

DEPOSITION is also used for the sequestrating or depriving a person of his dignity and office.

This deposition only differs from abdication, in that the latter is supposed voluntary, and the act of the dignitary or officer himself; and the former of compulsion, being the act of a superior power, whose authority extends thereto. Some say the deposition, and some the abdication, of King James II.

Deposition does not differ from deprivation: we say, indifferently, a deposed or deprived bishop, official, &c.

Deposition differs from suspension, in that it absolutely and for ever strips or divests a priest, &c. of all dignity, office, &c. whereas suspension only prohibits, or restrains, the exercise thereof.

Deposition only differs from degradation, in that the latter is more formal, and attended with more circumstances, than the former: but in effect and substance they are the same; those additional circumstances being only matter of show, first set on foot out of zeal and indignation, and kept up by custom, but not warranted by the laws or canons. See DEGRADATION.

DEPRECATION, in *Rhetoric*, a figure whereby the orator invokes the aid and assistance of some one; or or prays for some great evil or punishment to befal him who speaks falsely, either himself or his adversary.

DEPRECATORY, or DEPRECATIVE, in *Theology*, a term applied to the manner of performing some ceremonies in the form of prayer.

The form of absolution is deprecative in the Greek church, being conceived in these terms, *May God absolve you:* whereas it is in the declarative form in the Latin church, and in some of the reformed churches, *I absolve you.*

DEPRESSION *of the* POLE. When a person sails or travels towards the equator, he is said to depress the pole; because as many degrees as he approaches nearer the equator, so many degrees will the pole be nearer the horizon. This phenomenon arises from the spherical figure of the earth.

DEPRESSION of a Star, or *of the Sun*, is its distance below the horizon; and is measured by an arc of a vertical circle, intercepted between the horizon and the place of the star.

DEPRESSION of the Visible Horizon, or *Dip of the Horizon*, denotes its sinking or dipping below the true horizontal plane, by the observer's eye being raised above the surface of the sea; in consequence of which, the observed altitude of an object is by so much too great.

DEPRESSOR, or DEPRIMENS, in *Anatomy*, a name applied to several muscles, because they depress the parts they are fastened to.

DEPRIVATION, in the common law, the act of bereaving, divesting, or taking away a spiritual promotion or dignity: as when a bishop, vicar, prebend, or the like, is deposed or deprived of his preferment, for some matter or fault, in fact or in law. See DEPOSITION.

Deprivation is of two kinds; *à beneficio, et ab officio.*

DEPRIVATION *à beneficio* is, when for some great crime a minister is wholly and for ever deprived of his living or preferment; which differs from suspension, in that the latter is only temporary.

DEPRIVATION *ab officio* is, when a minister is for ever deprived of his order; which is the same, in reality, with what we otherwise call *deposition* and *degradation;* and is usually for some heinous crime deserving death, and is performed by the bishop in a solemn manner. See DEGRADATION.

DEPTFORD, a town of Kent in England, considerable for its fine docks and for the king's yard and storehouses. It was anciently called West Greenwich. It is divided into Upper and Lower Deptford, and has two parish churches. Here is an hospital incorporated by Henry VIII. called Trinity House of Deptford Strond. The brethren of the Trinity House hold their corporation by this hospital, and are obliged, at certain times, to meet here for business. Both these are for decayed pilots, or masters of ships, or for their widows, who have a handsome monthly allowance. The town is handsomely built, and contained 19,833 inhabitants in 1811. It is four miles east of London. E. Long. 0. 4. N. Lat. 51. 30.

DEPTH, the measure of any thing from the surface downwards.

Measuring of DEPTHS by the Barometer, depends on the same principles on which heights are measured by the same instrument. The mensuration of depths being chiefly applied to mines, is still more precarious than the mensuration of heights, on account of the various kinds of vapours with which the subterraneous regions are filled. But for a particular account of these difficulties, with the best methods of obviating them, see BAROMETER and MINES.

DEPTH of a Squadron or *Battalion*, is the number of men in a file; which in a squadron is three, and in a battalion generally six. See SQUADRON, FILE, &c.

We say, the battalion was drawn up six *deep;* the enemy's horse was drawn up five *deep.*

DEPURATION, is the freeing of any fluid from its heterogeneous matter or feculence. It is of three kinds; 1. Decantation; which is performed by letting the liquor to be depurated stand for some time in a pretty deep vessel, till the gross sediment has fallen to the bottom; after which the clear fluid is poured off. 2. Despumation; which is performed by means of the whites of eggs, or other viscid matter, and is also called CLARIFICATION. 3. Filtration; which is effected by passing the fluid through cloth or porous paper.

DEPURATORY FEVER, a name given by Sydenham to a fever which prevailed much in the years 1661, 1662, 1663, and 1664. He called it depuratory, because he supposed that nature regulated all the symptoms in such a manner, as to fit the febrile matter, prepared by proper concoction, for expulsion in a certain time, either by a copious sweat or a freer perspiration.

DEPUTATION, a mission of select persons, out of a company or body, to a prince or assembly, to treat of matters in their name.

DEPUTY, a person sent upon some business by some community.

DEPUTY is also one that exercises an office in another's right; and the forfeiture or misdemeanour of such deputy shall cause the person whom he represents to lose his office.

DEPUTATUS, among the ancients, a name applied to persons employed in making armour; and likewise to brisk active people, whose business was to take care of the wounded in engagements, and carry them off the field.

DER, a syllable frequently prefixed to the names of places in England. It is said to signify that such were formerly places where wild beasts herded together, so called from the Saxon, *deop, fera*, unless the situation was near some river.

DERBEND, a strong town of Asia, in Persia, said to have been founded by Alexander the Great. The walls are built with stones as hard as marble; and near it are the remains of a wall which reached from the Caspian to the Black sea. It is situated near the Caspian sea, at the foot of Mount Caucasus. E. Long. 50. 0. N. Lat. 42. 8.

DERBY, the capital of a county of the same name in England. It is thought to have received its name from being formerly a park or shelter for deer; and what makes this supposition more probable is, that the arms of the town consist of a buck couchant in a park. It is very ancient, having been a royal borough in the time of Edward the Confessor. At present it is a handsome town, and sends two members to parliament.

liament. In digging for foundations of houses, human bones of a monstrous size have sometimes been found. The trade consists in wool, corn, malt, and ale, of which considerable quantities are sent to London. Here also is that curious machine for throwing silk, the model of which Sir Thomas Lombe, at the hazard of his life, brought from Italy. Before that time, the English merchants used to purchase thrown silks of the Italians for ready money. But by the help of this wonderful machine, one hand-mill will twist as much silk as 50 people could do without it. It works 73,726 yards of silk every time the water-wheel goes round, which is thrice in a minute. The house in which it is contained is five or six stories high, and half a quarter of a mile in length. When Sir Thomas's patent expired in 1732, the parliament were so sensible of the value and importance of the machine, that they granted him a farther recompense of 14,000l. for the hazard and expence he had incurred in introducing and erecting it, upon condition he should allow an exact model of it to be taken. This model is deposited in the Tower of London, in order to prevent so curious and important an art from being lost. The town of Derby is watered by a river and a brook; the latter of which has nine bridges over it, the former only one. Derby gives title of earl to the noble family of Stanley. Population 13,043 in 1811. W. Long. 1. 45. N. Lat. 52. 57.

DERBYSHIRE, a county of England, bounded on the east by Nottinghamshire, and a part of Leicestershire, which last bounds it also on the south. On the west it is bounded by Staffordshire, and part of Cheshire; and on the north by Yorkshire. It is 56 miles long by 33 broad, and contains 972 square miles, or 622,080 acres.—The air is pleasant and healthful, especially on the east side; but on the west, about the Peak, it is sharper and more subject to wind and rain. The soil varies much. In the east and south parts it is very fruitful in all kinds of grain; but in the west, beyond the Derwent, it is barren and mountainous, producing nothing but a little oats. There is, however, plenty of grass in the valleys, which afford pasture to a great number of sheep. This part of the county is called the *Peak*, from a Saxon word signifying "an eminence." Its mountains are bleak, high, and barren; but yield abundance of lead, copper, iron, grindstones, marble, alabaster, a coarse sort of crystal, fluor or Derbyshire spar, as it is called, which is extensively manufactured into various ornaments, and pit-coal. In these mountains are two remarkable caverns, named *Pool's Hole*, and *Elden-Hole*. See these articles. The population of Derbyshire in 1811 was 185,487. See DERBYSHIRE, SUPPLEMENT.

DEREHAM, a town of Norfolk in England, situated in E. Long. 1. 0. N. Lat. 52. 40. It contained 2888 inhabitants in 1811. The market is noted for woollen yarn.

DERELICTS (from *de*, and *relinquo*, "I leave"), in the civil law, are such goods as are wilfully thrown away, or relinquished by the owner.

DERELICT is also applied to such lands as the sea receding from leaves dry, and fit for cultivation. If they are left by a gradual recess of the sea, they are adjudged to belong to the owner of the adjoining land; but when an island is formed in the sea, or a large quantity of new land appears, such derelict lands belong to the king.

DERHAM, DR WILLIAM, a very celebrated English philosopher and divine, born in 1657. In 1682, he was presented to the vicarage of Wargrave in Berkshire; and in 1689, to the valuable rectory of Upminster in Essex; which latter lying at a convenient distance from London, afforded him an opportunity of conversing and corresponding with the greatest virtuosos of the nation. Applying himself there with great eagerness to natural and experimental philosophy, he soon became a distinguished member of the Royal Society, whose Philosophical Transactions contain a great variety of curious and valuable pieces, the fruits of his laudable industry. In his younger years he published his Artificial Clockmaker, which has been often printed: and in 1711, 1712, and 1714, he preached those sermons at Boyle's lecture, which he afterwards digested under the well known titles of *Physico-Theology* and *Astro-Theology*, and enriched with valuable notes and copper-plates. The last thing he published of his own composition was *Christo-Theology*, a demonstration of the divine authority of the Christian religion, being the substance of a sermon preached at Bath in 1729. This great good man, after spending his life in the most agreeable as well as improving study of nature, died at Upminster in 1735: and besides many other works, left a valuable collection of curiosities, particularly specimens of birds and insects of this island.—It may be necessary just to observe, that Dr Derham was very well skilled in medical as well as in physical knowledge; and was constantly a physician to the bodies as well as the souls of his parishioners.

DERIVATION, in *Medicine*, is when a humour which cannot conveniently be evacuated at the part affected, is attracted from thence, and discharged elsewhere; thus a blister is applied to the neck to draw away the humour from the eyes.

DERIVATION, in *Grammar*, the affinity one word has with another, by having been originally formed from it. See DERIVATIVE.

DERIVATIVE, in *Grammar*, a word which takes its origin from another word, called its *primitive*.—Such is the word derivative itself, which takes its origin from the primitive *rivus*, a rivulet or channel, out of which lesser streams are drawn; and thus *manhood*, *deity*, *lawyer*, &c. are *derived* from *man*, *deus*, *law*, &c.

DERMESTES, a genus of insects belonging to the order of coleoptera. See ENTOMOLOGY *Index*.

DERNIER RESORT. See RESORT.

DEROGATION, an act contrary to a preceding one, and which annuls, destroys, and revokes it, either in whole or in part.

DEROGATORY, a clause importing derogation. A derogatory clause in a testament, is a certain sentence, cipher, or secret character, which the testator inserts in his will, and of which he reserves the knowledge to himself alone, adding a condition, that no will he may make hereafter is to be reckoned valid, if this derogatory clause is not inserted expressly and word for word. It is a precaution invented by lawyers against latter-wills extorted by violence, or obtained by suggestion.

DERP, a town of Livonia, and capital of a palatinate of the same name, with a bishop's see, and an university. It is subject to the Russians, and lies near the river Ambeck. E. Long. 31. 55. N. Lat. 30. 40.

DERTONA, Derton, or *Derthon*, in *Ancient Geography*, a colony of the Cispadana; called *Julia Augusta* on inscriptions and coins; midway between Genoa and Placentia, and situated to the east of the Tanarus in Liguria. Now Tortona, a city of Milan. E. Long. 9. 12. N. Lat. 45.

DERTOSA, in *Ancient Geography*, the capital of the Hercaones, in Tarraconensis, or the Hither Spain: a municipium and colony; surnamed *Julia Ilergavonia* (Coins). *Dertosani*, the people. Now Tortosa, in Catalonia, on the Ebro. E. Long. 0. 15. N. Lat. 40. 45.

DERVENTIO, in *Ancient Geography*, a river of the Brigantes in Britain. Now the Darwent in the east of Yorkshire, falling into the Ouse. Also a town of the Brigantes on the same river. Now called *Auldby*, seven miles from York, to the north-east (Camden).

DERVIS, or Dervich, a name given to a sort of monks among the Turks, who lead a very austere life, and profess extreme poverty, though they are allowed to marry. The word is originally Persian, דרויש, signifying a "beggar," or "person who has nothing:" and because the religious, and particularly the followers of Mevelava, profess not to possess any thing, they call both the religious in general, and the Mevelavites in particular, *Dervises* or *Derviches*.

The dervises, called also *Mevelavites*, are a Mahometan order of religious; the chief or founder whereof was one Mevelava. They are now very numerous. Their chief monastery is that near Cogna in Natolia, where the general makes his residence, and where all the assemblies of the order are held; the other houses being all dependent on this, by a privilege granted to this monastery under Ottoman I.

The dervises affect a great deal of modesty, patience, humility, and charity. They always go bare-legged and open-breasted, and frequently burn themselves with hot irons, to inure themselves to patience. They always fast on Wednesdays, eating nothing on those days till after sunset. Tuesdays and Fridays they hold meetings, at which the superior of the house presides. One of them plays all the while on a flute, and the rest dance, turning their bodies round and round with the greatest swiftness imaginable. Long custom to this exercise from their youth has brought them to such a habitude, that it does not discompose them at all. This practice they observe with great strictness, in memory of Mevelava their patriarch's turning miraculously round, as they pretend, for the space of four days, without any food or refreshment; his companion Hamsa playing all the while on the flute; after which he fell into an ecstasy, and therein received wonderful revelations for the establishment of his order. They believe the flute an instrument consecrated by Jacob and the shepherds of the Old Testament, because they sang the praises of God upon it. They profess poverty, chastity, and obedience, and really observe them while they remain dervises: but if they choose to go out and marry, they are always allowed.

The generality of dervises are mountebanks; some apply themselves to legerdemain, postures, &c. to amuse the people; others give in to sorcery and magic: but all of them, contrary to Mahomet's precept, are said to drink wine, brandy, and other strong liquors, to give them the degree of gaiety their order requires.

Beside their great saint Mevelava, there are particular saints honoured in some particular monasteries: as Kiderele, greatly revered in the monasteries of Egypt, and held by some to be St George; and by others, with more probability, the prophet Elias.

The dervises are great travellers; and, under pretence of preaching, and propagating their faith, are continually passing from one place to another: on which account they have been frequently used as spies.

There are also dervises in Persia, called in that country *Abdals*, q. d. *servants of* God. They lead a very penurious, austere life, and preach the Alcoran in the streets, coffee-houses, and wherever they can meet with auditors. The Persian dervises retail little but fables to the people, and are in the utmost contempt among the men of sense and letters.

There are in Egypt two or three kinds; those that are in convents, are in a manner of the religious order, and live retired; though there are of these some who travel and return again to their convents. Some take this character, and yet live with their families, and exercise their trades; of this kind are the dancing dervises at Damascus, who go once or twice a-week to a little uninhabited convent, and perform their extraordinary exercises; these also seem to be a good people: but there is a third sort of them who travel about the country, and beg, or rather oblige people to give, for whenever they sound their horn something must be given them. The people of these orders, in Egypt, wear an octagonal badge, of a greenish white alabaster, at their girdles, and a high stiff cap without any thing round it.

DESAGUILIERS, John Theophilus, who introduced the practice of reading public lectures in experimental philosophy, in the metropolis, and who made several improvements in mechanics; was the son of the reverend John Desaguiliers, a French Protestant refugee, and was born at Rochelle in 1683. His father brought him to England an infant; and at a proper age placed him at Christ-Church College, Oxford; where he succeeded Dr Keil in reading lectures on experimental philosophy at Hart-Hall. The magnificent duke of Chandos made Dr Desaguiliers his chaplain, and presented him to the living of Edgeware, near his seat at Cannons: and he was afterwards chaplain to Frederic prince of Wales. He read lectures with great success to the time of his death in 1749. He communicated many curious papers printed in the Philosophical Transactions; published a valuable *Course of Experimental Philosophy*, in 2 vols 4to; and gave an edition of *Gregory's Elements of Catoptrics and Dioptrics*, with an Appendix on reflecting telescopes, 8vo. He was a member of the Royal Society, and of several foreign academies.

DESART, a large extent of country entirely barren, and producing nothing. In this sense some are sandy desarts; as those of Lop, Xamo, Arabia, and several others in Asia; in Africa, those of Libya and Zara: others are stony, as the desart of Pharan in Arabia Petrea.

The DESART, properly so called, is that part of Arabia, south of the Holy Land, where the children of Israel wandered forty years.

DESCANT, in *Music*, the art of composing in several parts. See COMPOSITION.

Descant is threefold, viz. plain, figurative, and double.

Plain DESCANT is the ground-work and foundation of all musical compositions, consisting altogether in the orderly placing of many concords, answering to simple counterpoint. See COUNTERPOINT.

Figurative or *Florid* DESCANT, is that part of an air of music wherein some discords are concerned, as well, though not so much, as concords. This may be termed the ornamental and rhetorical part of music, in regard that there are introduced all the varieties of points, syncopes, diversities of measures, and whatever is capable of adorning the composition.

DESCANT *Double*, is when the parts are so contrived, that the treble, or any high part, may be made the bass; and, on the contrary, the bass the treble.

DESCARTES. See CARTES.

DESCENDANT. The issue of a common parent, *in infinitum*, are called his descendants. See the article DESCENT.

DESCENSION, in *Astronomy*, is either right or oblique.

Right DESCENSION, is an arch of the equinoctial, intercepted between the next equinoctial point and the intersection of the meridian, passing through the centre of the object, at its setting, in a right sphere.

Oblique DESCENSION, an arch of the equinoctial, intercepted between the next equinoctial point and the horizon, passing through the centre of the object, at its setting, in an oblique sphere.

DESCENT, in general, is the tendency of a body from a higher to a lower place; thus all bodies, unless otherwise determined by a force superior to their gravity, descend towards the centre of the earth. See GRAVITY and MECHANICS.

DESCENT, or *Hereditary Succession*, in *Law*, is the title whereby a man, on the death of his ancestor, acquires his estate by right of representation, as his heir at law. An heir, therefore, is he upon whom the law casts the estate immediately on the death of the ancestor: and an estate so descending to the heir is in law called the *inheritance*.

Descent is either *lineal* or *collateral*. The former is that conveyed down in a right line from the grandfather to the father, and from the father to the son, and from the son to the grandson. The latter is that springing out of the side of the line or blood; as from a man to his brother, nephew or the like.

The doctrine of descents, or law of inheritances in fee-simple, is a point of the highest importance: (See the article FEE). All the rules relating to purchases, whereby the legal course of descents is broken and altered, perpetually refer to this settled law of inheritance, as a *datum* or first principle universally known, and upon which their subsequent limitations are to work. Thus a gift in tail, or to a man and the heirs of his body, is a limitation that cannot be perfectly understood without a previous knowledge of the law of descents in fee-simple. One may well perceive, that this is an estate confined in its descent to such heirs only of the donee as have sprung or shall spring from his body: but who those heirs are, whether all his children both male and female, or the male only, and (among the males) whether the eldest, youngest, or other son alone, or all the sons together, shall be his heir; this is a point that we must result back to the standing law of descents in fee-simple to be informed of.

And as this depends not a little on the nature of kindred, and the several degrees of consanguinity, it will be necessary to refer the reader to the article CONSANGUINITY, where the true notion of this kindred or alliance in blood is particularly stated.

We shall here exhibit a series of rules or canons of inheritance, with illustrations, according to which, by the law of England, estates are transmitted from the ancestor to the heir.

1. "Inheritances shall lineally descend to the issue of the person last actually seised *in infinitum*, but shall never lineally ascend."

To understand both this and the subsequent rules, it must be observed, that by law no inheritance can vest, nor can any person be the actual complete heir of another, till the ancestor is previously dead. *Nemo est hæres viventis.* Before that time, the person who is next in the line of succession is called *heir apparent*, or *heir presumptive*. Heirs apparent are such whose right of inheritance is indefeasible, provided they outlive the ancestor; as the eldest son or his issue, who must, by the course of the common law, be heirs to the father whenever he happens to die. Heirs presumptive are such, who, if the ancestor should die immediately, would in the present circumstances of things be his heirs; but whose right of inheritance may be defeated by the contingency of some nearer heir being born: as a brother or nephew, whose presumptive succession may be destroyed by the birth of a child; or a daughter, whose present hopes may be hereafter cut off by the birth of a son. Nay, even if the estate hath descended, by the death of the owner, to such a brother, or nephew, or daughter; in the former cases, the estate shall be divested and taken away by the birth of a posthumous child; and, in the latter, it shall also be totally divested by the birth of a posthumous son.

We must also remember, that no person can be properly such an ancestor as that an inheritance in lands or tenements can be derived from him, unless he hath had actual seisin of such lands, either by his own entry, or by the possession of his own or his ancestor's lessee for years, or by receiving rent from a lessee of the freehold: or unless he hath what is equivalent to corporal seisin in hereditaments that are incorporal; such as the receipt of rent, a presentation to the church in case of an advowson, and the like. But he shall not be accounted an ancestor who hath had only a bare right or title to enter or be otherwise seised. And therefore all the cases which will be mentioned in the present article, are upon the supposition that the deceased (whose inheritance is now claimed) was the last person actually seised thereof. For the law requires this notoriety of possession, as evidence that the ancestor had that property in himself, which is now to be transmitted to his heir. Which notoriety hath succeeded in the place of the ancient feodal investiture, whereby, while feuds were precarious, the vassal on the descent of lands was formerly admitted to the lord's court (as

Blackst. Comment.

Descent.

(as is still the practice in Scotland); and therefore received his seisin, in the nature of a renewal of his ancestor's grant, in the presence of the feodal peers: till at length, when the right of succession became indefeasible, an entry on any part of the lands within the county (which if disputed was afterwards to be tried by those peers), or other notorious possession, was admitted as equivalent to the formal grant of seisin, and made the tenant capable of transmitting his estate by descent. The seisin therefore of any person, thus understood, makes him the root or stock from which all future inheritance by right of blood must be derived, which is very briefly expressed in this maxim, *sesina facit stipitem.*

When therefore a person dies so seised, the inheritance first goes to his issue: as if there be Geoffrey, John, and Matthew, grandfather, father, and son; and John purchases lands and dies; his son Matthew shall succeed him as heir, and not the grandfather Geoffrey; to whom the land shall never ascend, but shall rather escheat to the lord.

2. "The male issue shall be admitted before the female."—Thus sons shall be admitted before daughters; or, as our male lawgivers have somewhat uncomplaisantly expressed it, the worthiest of blood shall be preferred. As if John Stiles had two sons, Matthew and Gilbert, and two daughters, Margaret and Charlotte, and dies; first Matthew, and (in case of his death without issue) then Gilbert shall be admitted to the succession in preference to both the daughters.

3. "Where there are two or more males in equal degree, the eldest only shall inherit; but the females all together." As if a man hath two sons, Matthew and Gilbert, and two daughters, Margaret and Charlotte, and dies; Matthew his eldest son shall alone succeed to his estate, in exclusion of Gilbert the second son and both the daughters; but if both the sons die without issue before the father, the daughters Margaret and Charlotte shall both inherit the estate as coparceners.

4. "The lineal descendants *in infinitum*, of any person deceased, shall represent their ancestor; that is, shall stand in the same place as the person himself would have done had he been living." Thus the child, grand-child, or great-grand-child (either male or female), of the eldest son, succeeds before the younger son, and so *in infinitum.* And these representatives shall take neither more nor less, but just so much as their principals would have done. As if there be two sisters, Margaret and Charlotte; and Margaret dies, leaving six daughters; and then John Stiles the father of the two sisters dies without other issue; these six daughters shall take among them exactly the same as their mother Margaret would have done, had she been living; that is, a moiety of the lands of John Stiles in coparcenary: so that, upon partition made, if the land be divided into twelve parts, thereof Charlotte the surviving sister shall have six, and her six nieces, the daughters of Margaret, one a-piece.

5. "On failure of lineal descendants, or issue of the person last seised, the inheritance shall descend to the blood of the first purchaser; subject to the three preceding rules." Thus, if Geoffrey Stiles purchases land, and it descends to John Stiles his son, and John dies seised thereof without issue; whoever succeeds to this inheritance must be of the blood of Geoffrey, the first purchaser of this family. The first purchaser, *perquisitor*, is he who first acquired the estate to his family, whether the same was transferred to him by sale, or by gift, or by any other method, except only that of descent.

6. "The collateral heir of the person last seized must be his next collateral kinsman of the whole blood."

First, he must be his next collateral kinsman either personally or *jure representationis;* which proximity is reckoned according to the canonical degrees of consanguinity: See CONSANGUINITY. Therefore the brother being in the first degree, he and his descendants shall exclude the uncle and his issue, who is only in the second.—Thus, if John Stiles dies without issue, his estate shall descend to Francis his brother, who is lineally descended from Geoffrey Stiles, his next immediate ancestor or father. On failure of brethren or sisters and their issue, it shall descend to the uncle of John Stiles, the lineal descendant of his grandfather George; and so on *in infinitum.*

But, secondly, the heir need not be the nearest kinsman absolutely, but only *sub modo;* that is, he must be the nearest kinsman of the *whole* blood; for if there be a much nearer kinsman of the *half* blood, a distant kinsman of the whole blood shall be admitted, and the other entirely excluded. A kinsman of the whole blood is he that is derived, not only from the same ancestor, but from the same couple of ancestors. For as every man's own blood is compounded of the bloods of his respective ancestors, he only is properly of the whole or entire blood with another who hath (so far as the distance of degrees will permit) all the same ingredients in the composition of his blood that the other hath. Thus, the blood of John Stiles being composed of those of Geoffrey Stiles his father, and Lucy Baker his mother, therefore his brother Francis, being descended from both the same parents, hath entirely the same blood with John Stiles; or he is his brother of the whole blood. But if, after the death of Geoffrey, Lucy Baker the mother marries a second husband, Lewis Gay, and hath issue by him: the blood of this issue, being compounded of the blood of Lucy Baker (it is true) on the one part, but that of Lewis Gay (instead of Geoffrey Stiles) on the other part, it hath therefore only half the same ingredients with that of John Stiles; so that he is only his brother of the half blood, and for that reason they shall never inherit to each other. So also, if the father has two sons, A and B, by different venters or wives; now these two brethren are not brethren of the whole blood, and therefore shall never inherit to each other, but the estate shall rather escheat to the lord. Nay, even if the father dies, and his lands descend to his eldest son A, who enters thereon, and dies seised without issue; still B shall not be heir to this estate, because he is only of the half blood to A, the person last seised: but had A died without entry, then B might have inherited; not as heir to A his half-brother, but as heir to their common father, who was the person last actually seised.

The rule then, together with its illustration, amounts to this, That in order to keep the estate of John Stiles as nearly as possible in the line of his purchasing ancestor, it must descend to the issue of the nearest couple of ancestors that have left descendants behind them; because

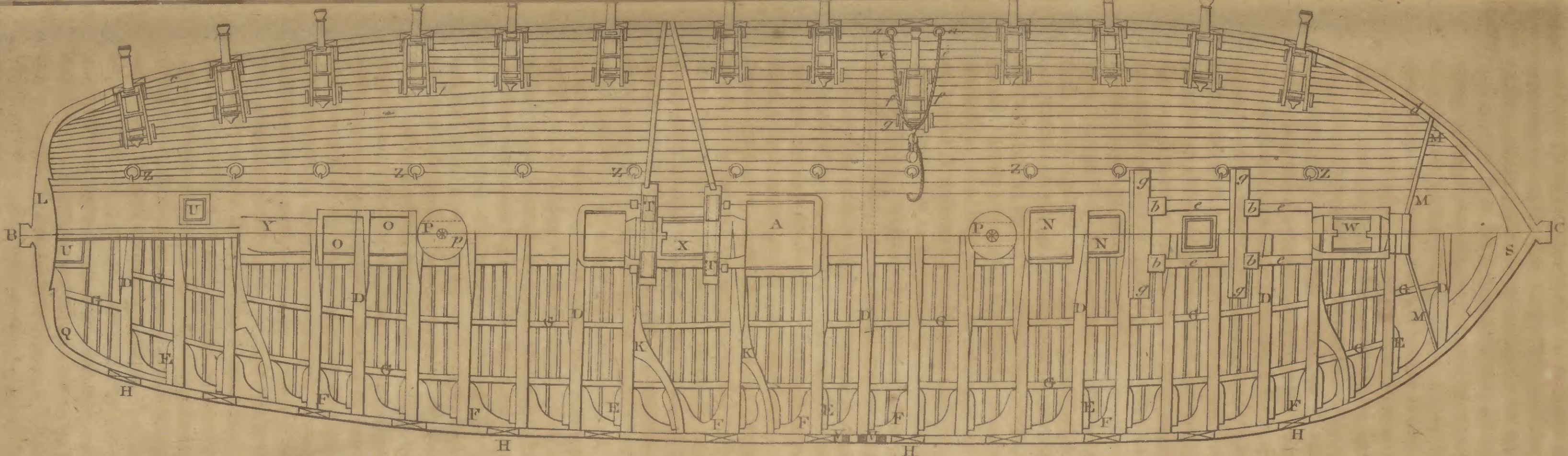
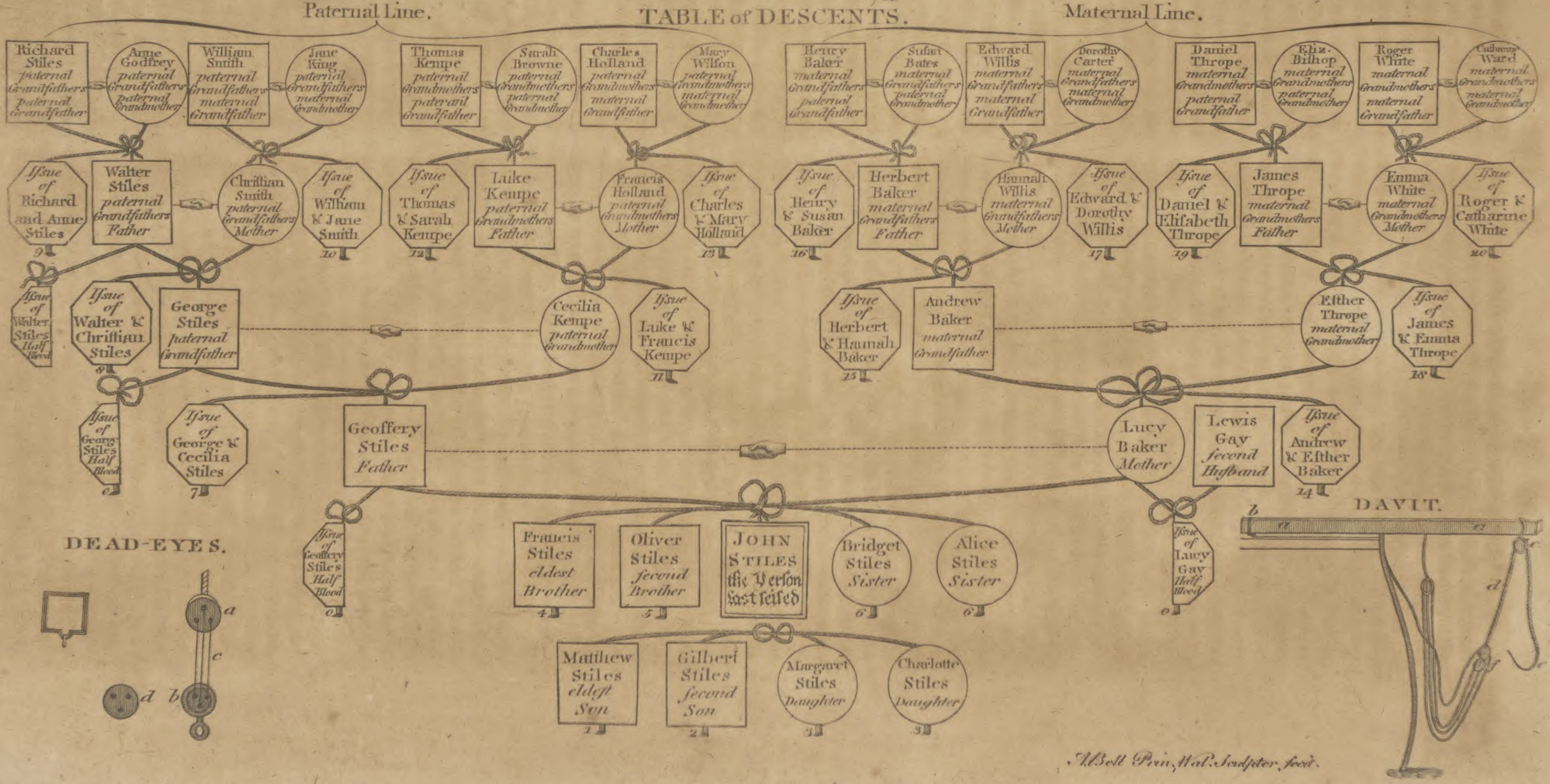


TABLE of DESCENTS.



DEAD-EYES.

DAVIT.

A. Bell Prin. Wal. Sculptor, fecit.

Descent.

because the descendants of one ancestor only are not so likely to be in the line of that purchasing ancestor as those who are descended from two.

But here a difficulty arises. In the second, third, fourth, and every superior degree, every man has many couples of ancestors, increasing according to the distances in a geometrical progression upwards, the descendants of all which respective couples are (representatively) related to him in the same degree. Thus, in the second degree, the issue of George and Cecilia Stiles and of Andrew and Esther Baker, the two grandsires and grandmothers of John Stiles, are each in the same degree of propinquity; in the third degree, the respective issues of Walter and Christian Stiles, of Luke and Frances Kempe, of Herbert and Hannah Baker, and of James and Emma Thorpe, are (upon the extinction of the two inferior degrees) all equally entitled to call themselves the next kindred of the whole blood to John Stiles. To which therefore of these ancestors must we first resort, in order to find out descendants to be preferably called to the inheritance? In answer to this, and to avoid the confusion and uncertainty that might arise between the several stocks wherein the purchasing ancestor may be sought for,—

7. The seventh and last rule or canon is, "That in collateral inheritances the male stocks shall be preferred to the female (that is, kindred derived from the blood of the male ancestors shall be admitted before those from the blood of the female);—unless where the lands have in fact descended from a female."—Thus the relations on the father's side are admitted *in infinitum*, before those on the mother's side are admitted at all; and the relations of the father's father, before those of the father's mother; and so on.

For the origin and progress of the above canons, the reasons upon which they are founded, and their agreement with the laws of other nations, the curious reader may consult *Blackstone's Commentaries*, vol. ii. p. 208—237.

We shall conclude with exemplifying the rules themselves by a short sketch of the manner in which we must search for the heir of a person, as John Stiles, who dies seised of land which he acquired, and which therefore he held as a feud of indefinite antiquity. See the *Table of* DESCENTS on Plate CLXIX.

In the first place succeeds the eldest son, Matthew Stiles, or his issue, (N° 1.):—If his line be extinct, then Gilbert Stiles and the other sons respectively, in order of birth, or their issue, (N° 2.):—in default of these, all the daughters together, Margaret and Charlotte Stiles or their issue, (N° 3.):—On the failure of the descendants of John Stiles himself, the issue of Geoffrey and Lucy Stiles, his parents, is called in; viz. first, Francis Stiles, the eldest brother of the whole blood, or his issue, (N° 4.):—then Oliver Stiles, and the other whole brothers respectively, in order of birth, or their issue, (N° 5.):—then the sisters of the whole blood altogether, Bridget and Alice Stiles, or their issue, (N° 6.):—In defect of these, the issue of George and Cecilia Stiles, his father's parents; respect being still had to their age and sex, (N° 7.):—then the issue of Walter and Christian Stiles, the parents of his paternal grandfather, (N° 8.):—then the issue of Richard and Anne Stiles, the parents of his paternal grandfather's father, (N° 9.):—and so on in the paternal grandfather's paternal line, or blood of Walter Stile, *in infinitum*. In defect of these the issue of William and Jane Smith, the parents of his paternal grandfather's mother, (N° 10.):—and so on in the paternal grandfather's maternal line, or blood of Christian Smith, *in infinitum*; till both the immediate bloods of George Stiles, the paternal grandfather, are spent.—Then we must resort to the issue of Luke and Frances Kempe, the parents of John Stiles's paternal grandmother, (N° 11.):—then to the issue of Thomas and Sarah Kempe, the parents of his paternal grandmother's father, (N° 12.):—and so on in the paternal grandmother's paternal line, or blood of Luke Kempe, *in infinitum*. In default of which, we must call in the issue of Charles and Mary Holland, the parents of his paternal grandmother's mother, (N° 13.):—and so on in the paternal grandmother's maternal line, or blood of Frances Holland, *in infinitum*; till both the immediate bloods of Cecilia Kempe, the paternal grandmother, are also spent.—Whereby the paternal blood of John Stiles entirely failing, recourse must then, and not before, be had to his maternal relations; or the blood of the Bakers, (N° 14, 15, 16.), Willis's (N° 17.), Thorpe's (N° 18, 19.), and White's (N° 20.); in the same regular successive order as in the paternal line.

The student should bear in mind, that during this whole process, John Stiles is the person supposed to have been last actually seised in the estate. For if ever it comes to vest in any other person, as heir to John Stiles, a new order of succession must be observed upon the death of such heir; since he, by his own seisin, now becomes himself an ancestor, or *stipes*, and must be put in the place of John Stiles. The figures therefore denote the order in which the several classes would succeed to John Stiles, and not to each other; and before we search for an heir in any of the higher figures, (as N° 8.) we must first be assured that all the lower classes from (N° 1. to 7.) were extinct at John Stiles's decease.

DESCENT, or *Succession*, in the *Law of Scotland*. See LAW *Index*.

DESCENT of the Crown. See SUCCESSION.

DESCENT of Dignities. A dignity differs from common inheritances, and goes not according to the rules of the common law: for it descends to the half-blood; and there is no coparcenership in it, but the eldest takes the whole. The dignity of peerage is personal, annexed to the blood; and so inseparable that it cannot be transferred to any person, or surrendered even to the crown; it can move neither forward nor backward, but only downward to posterity; and nothing but corruption of blood, as if the ancestor be attainted of treason or felony, can hinder the descent to the right heir.

DESCENT, in genealogy, the order or succession of descendants in a line or family; or their distance from a common progenitor: Thus we say, one descent, two descents, &c.

DESCENT, in *Heraldry*, is used to express the coming down of any thing from above; as, a lion *en descent* is a lion with his head towards the base points, and his heels towards one of the corners of the chief, as if he were leaping down from some high place.

DESCHAMPS,

DESCHAMPS, Francis, a French poet, born in Champagne, was the author of a tragedy entitled Cato of Utica, and a history of the French theatre. He died at Paris in 1747.

DESCRIPTION, in literary composition, is such a strong and beautiful representation of a thing, as gives the reader a distinct view and satisfactory notion of it. See Narration *and Description.*

DESEADA, or Desiderada, one of the Caribbee islands, about ten miles long and five broad, lying eastward of Guadaloupe.

DESERT, or Desart. See Desart.

DESERTER, in a military sense, a soldier who, by running away from his regiment or company, abandons the service.

A deserter is, by the articles of war, punishable by death; which, after conviction, is executed upon him at the head of the regiment he formerly belonged to, with his crime written on his breast.

DESERTION, in *Law*. See Law *Index*.

DESHABILLE, a French term, naturalized of late. It properly signifies a night-gown, and other necessaries, made use of in dressing or undressing. Mr —— is not to be spoken with, he is yet in his *desshabille*, i. e. undressed, or in his night-gown. The word is compounded of the privative *de*, and *s'habiller*, "to dress one's self."

DESHACHE', in *Heraldry*, is where a beast has its limbs separated from its body, so that they still remain on the escutcheon, with only a small separation from their natural places.

DESIDERATUM, is used to signify the desirable perfections in any art or science; thus, it is a desideratum with the blacksmith, to render iron fusible by a gentle heat, and yet preserve it hard enough for ordinary uses; with the glassman and looking-glass-maker, to render glass malleable; with the clock-maker, to bring pendulums to be useful where there are irregular motions, &c.

DESIGN, in a general sense, the plan, order, representation, or construction of a building, book, painting, &c. See Architecture, Painting, Poetry, Oratory, History.

Design, in the manufactories, expresses the figures wherewith the workman enriches his stuff or silk, and which he copies after some painter or eminent draughtsman, as in diaper, damask, and other flowered silk and tapestry, and the like.

In undertaking of such kinds of figured stuffs, it is necessary, says Mons. Savary, that before the first stroke of the shuttle, the whole design be represented on the threads of the warp, we do not mean in colours, but with an infinite number of little packthreads, which, being disposed so as to raise the threads of the warp, let the workmen see, from time to time, what kind of silk is to be put in the eye of the shuttle for woof. This method of preparing the work is called *reading the design*, and *reading the figure*, which is performed in the following manner? A paper is provided, considerably broader than the stuff, and of a length proportionate to what is intended to be represented thereon. This they divide lengthwise by as many black lines as there are intended threads in the warp; and across these lines by others drawn breadthwise, which, with the former, make little equal squares; on the paper thus squared, the draughtsman designs his figures, and heightens them with colours as he sees fit. When the design is finished, a workman reads it, while another lays it on the simblot.

To read the design, is to tell the person who manages the loom the number of squares or threads comprised in the space he is reading, intimating at the same time, whether it is ground or figure. To put what is read on the simblot, is to fasten little strings to the several packthreads, which are to raise the threads named: and this they continue to do till the whole design is read.

Every piece being composed of several repetitions of the same design, when the whole design is drawn, the drawer, to re-begin the design afresh, has nothing to do but to raise the little strings, with slip-knots, to the top of the simblot, which he had let down to the bottom; this he is to repeat as often as is necessary, till the whole be manufactured.

The ribbon-weavers have likewise a design, but far more simple than that now described. It is drawn on paper with lines and squares, representing the threads of the warp and woof. But instead of lines, whereof the figures of the former consist, these are constituted of points only, or dots, placed in certain of the little squares formed by the intersection of the lines. These points mark the threads of the warp that are to be raised, and the spaces left blank denote the threads that are to keep their situation; the rest is managed as in the former.

Design is also used, in *Painting*, for the first idea of a large work, drawn roughly, and in little, with an intention to be executed and finished in large.

In this sense, it is the simple contour or outlines of the figures intended to be represented, or the lines that terminate and circumscribe them: such design is sometimes drawn in crayons or ink, without any shadows at all; sometimes it is hatched, that is, the shadows are expressed by sensible outlines, usually drawn across each other with the pen, crayon, or graver. Sometimes, again, the shadows are done with the crayon rubbed so as that there do not appear any lines; at other times, the grains or stroke of the crayon appear, as not being rubbed: sometimes the design is washed, that is, the shadows are done with a pencil in Indian ink, or some other liquor; and sometimes the design is coloured, that is, colours are laid on much like those intended for the grand work.

Design, in *Music*, is justly defined by Rousseau to be the invention and the conduct of the subject, the disposition of every part, and the general order of the whole.

It is not sufficient to form beautiful airs, and a legitimate harmony; all these must be connected by a principal subject, to which all the parts of the work relate, and by which they become one. Thus unity ought to prevail in the air, in the movement, in the character, in the harmony, and in the modulation. All these must indispensably relate to one common idea which unites them. The greatest difficulty is, to reconcile the observation of those precepts with an elegant variety, which, if not introduced, renders the whole piece irksome and monotonic. Without question, the musician, as well as the poet and the painter, may risk every thing in favour of this delightful variety; if, under

under the pretext of contrasting, they do not endeavour to cheat us with false appearances, and instead of pieces justly and happily planned, present us with a musical minced meat, composed of little abortive fragments, and of characters so incompatible, that the whole assembled forms a heterogeneous monster.

> *Non ut placidis coeant immitia, non ut*
> *Serpentes avibus geminentur, tigribus agni.*

Translated thus:

> But not that nature should revers'd appear;
> Mix mild with fierce, and gentle with severe;
> Profane her laws to contradiction's height:
> Tygers with lambs, with serpents birds unite.

It is therefore in a distribution formed with intelligence and taste, in a just proportion between all the parts, that the perfection of design consists; and it is above all, in this point, that the immortal Pergoleso has shown his judgment and his taste, and has left so far behind him all his competitors. His *Stabat Mater*, his *Orfeo*, his *Serva Padrona*, are, in three different species of composition, three masterpieces of *design* equally perfect.

This idea of the general design of a work is likewise particularly applicable to every piece of which it consists: thus the composer plans an air, a duet, a chorus, &c. For this purpose, after having invented his subject, he distributes it, according to the rules of a legitimate modulation, into all the parts where it ought to be perceived, in such a proportion, that its impression may not be lost on the minds of the audience; yet that it may never be reiterated in their ears, without the graces of novelty. The composer errs in designing, who suffers his subject to be forgot; he is still more culpable who pursues it till it becomes trite and tiresome.

DESIGNATION, the act of marking or indicating, and making a thing known. The designation of such an estate is made by the tenants, butments, and boundings. Among the Romans, there were designations of the consuls and other magistrates, some time before their election.

DESIGNATOR, a Roman officer, who assigned and marked each person his place and rank in public ceremonies, shows, processions, &c. The word is formed from the verb *designare*, "to design."

The designator was a kind of marshal, or master of the ceremonies, who regulated the seats, march, order, &c. There were designators at funeral solemnities, and at the games, theatre, and shows, who not only assigned every one his place, but also led him to it; as appears from the prologue to the Pœnulus of Plautus. Much of the same nature were the *agonathetæ* of the Greeks.

DESIGNING, the art of delineating or drawing the appearance of natural objects, by lines on a plane. To design, according to the rules of mathematics, makes the object of perspective. See PERSPECTIVE.

DESPOT, a term sometimes used for an absolute prince: (see next article). The word, in its first origin, signified the same with the Latin *herus*, and the English *master*: but in time it underwent the same fate on medals, as, among the Latins, Cæsar did with regard to Augustus: ΒΑCΙΛΕΥC answering to Augustus, and ΔΕCΠΟΤΗC, *despotes*, to Cæsar. See CÆSAR. Thus, Nicephorus having ordered his son Stauracius to be crowned, the son, out of respect, would only take the name ΔΕCΠΟΤΗC, leaving to his father that of ΒΑCΙΛΕΥC. For it is to be noted, that it was just about the time that the emperors began to cease to use Latin inscriptions. This delicacy, however, did not last long; for the following emperors preferred the quality of ΔΕCΠΟΤΗC to that of ΒΑCΙΛΕΥC, particularly Constantine, Michael Ducas, Nicephorus Botoniates, Romanus Diogenes, the Comneni, and some others. In imitation of the princes, the princesses likewise assumed the title of ΔΕCΠΟΙΝΑ.

It was the emperor Alexius, surnamed the angel, that created the dignity of despot, and made it the first after that of emperor, above that of Augustus or Sebastocrator and Cæsar. See AUGUST.

The despots were usually the emperor's sons or sons-in-law, and their colleagues or copartners in the empire, as well as their presumptive heirs. The despots that were sons of the emperors had more privileges and authority than those that were only sons-in-law. Codin, p. 58. describes the habits and ornaments of the despot. See the notes of Father Goar on that author. Under the successors of Constantine the Great, the title *despot of Sparta* was given to the emperor's son or brother, who had the city of Sparta or Lacedemon by way of apannege.

DESPOT is at present a title of quality given to Wallachia, Servia, and some of the neighbouring countries.

DESPOTICAL, in general, denotes any thing that is uncontrouled and absolute; but is particularly used for an arbitrary government, where the power of the prince is unlimited, and his will a law to his subjects; such as those of Turkey, Persia, and most of the eastern governments; and even those of Europe, if we except the republics, our own, and of late the French government.

DESPOUILLE, in *Heraldry*, the whole case, skin, or slough of a beast, with the head, feet, tail, and all appurtenances, so that being filled and stuffed it looks like the entire creature.

DESPREAUX. See BOILEAU.

DESSAULT, PETER JOSEPH, a distinguished French surgeon, was born at Magny Vernois, a village of Franche Comté, in the year 1744. He was descended of parents of a humble rank in life. He received the early part of his education in a school of the Jesuits, and was destined for the church; but his own inclination tended to the study of medicine, and in this he was at length indulged and settled as an apprentice in the military hospital of Befort. Here he acquired some knowledge of anatomy and surgery; and having previously made considerable progress in mathematical studies, he applied this knowledge, after the example of Borelli and others, to the investigation of physiological subjects. He translated the work of Borelli, *De Motu Animalium*, and added notes and illustrations, in which, although he proceeded upon wrong principles, he discovered at a very early period strong proofs of his zeal and industry.

About his 20th year he went to Paris, where he enjoyed the best opportunities of storing his mind with the knowledge of surgery and anatomy, which he prosecuted

secuted with the utmost ardour and success. He spent almost the whole of his time at the anatomical theatres and hospitals; but by this close attendance his health suffered greatly. He was seized with a cachectical disease, which confined him to bed for a twelvemonth; and he was indebted for his recovery to the vigour of his constitution, and the kind offices of a young friend who constantly watched the progress of his disorder. His health being re-established, neither his circumstances nor the activity of his mind would permit him to indulge in repose. He commenced teacher of anatomy in the winter of 1766, and was soon attended by 300 pupils, a great proportion of whom was older than himself. But this success excited the jealousy of the established teachers and professors, who exerted all the influence of authority to silence him; and although he was patronised and protected by some surgeons of great eminence, the opposition which he met with would have obliged him to renounce public teaching, had he not been permitted to go on by the expedient of adopting the name of another as a sanction. His reputation was now greatly extended; but still he declined private practice, till he was established in some distinguished public station. In the year 1776, he was admitted a member of the corporation of surgeons, and it would appear that his finances were at this time extremely limited, from the circumstance of his being indulged by that body in paying his fees when it should be convenient for himself. He successively filled the honourable stations in the corporation and academy of surgery, and in the year 1782, he was appointed surgeon-major to the hospital *De la Charité*.

Dessault was now regarded as one of the first surgeons of Paris. He succeeded to the next vacancy at the Hotel Dieu; and after the death of Moreau, almost the whole surgical department of that hospital was intrusted to him. Here he instituted a clinical school of surgery, on a liberal and extensive plan, which attracted a great concourse of students, not only from every part of France, but also from foreign countries. An audience composed of 600 students frequently met to hear his instructions, and most of the surgeons of the French army derived their knowledge from his lectures.

The surgical practice of Dessault was always distinguished for its efficacy and simplicity. Among the improvements which he introduced into surgery may be mentioned bandages for the retention of fractured limbs, the use of compressions in promoting the cure of ulcers, the use of ligature in umbilical hernia of children, the extraction of loose cartilages in joints, the use of bougies in schirrosities of the rectum, and that of elastic probes in contractions of the urethra. He also introduced essential improvements in the construction of various surgical improvements.

In the year 1791, he published a work entitled *Journal de Chirurgerie*, the object of which was to record the most interesting cases which occurred in his clinical school, with the remarks which he made upon them in the course of his lectures. The editing of this work was intrusted to his pupils. But in the midst of his valuable labours he became obnoxious to some of the prevailing parties of that turbulent period, and in 1792 he was denounced to the popular sections in the cant language of the times, as an *egotist* or *indifferent*. After being twice examined, he was seized while he was delivering a lecture, carried away from his theatre, and committed to the prison of the Luxembourg. But in three days he was liberated and permitted to resume all his functions. When the school of health was established, he was appointed clinical professor for external maladies; and it was through his means that the Evechè was converted into an hospital for surgical operations.

The horrid scenes which were exhibited in May 1795, made so deep an impression on his mind, from the apprehension of a renewal of the horrors which he had formerly experienced, that he was seized with a fever, accompanied with delirium; and this put an end to his life on the 1st of June, the same year, at the age of 51. He had attended the dauphin in the temple; and from the circumstance of his death having happened but a short time before that prince, an opinion was prevalent among the populace that he was poisoned, because he refused to do any thing against the dauphin's life. This story seems to have no foundation, but it affords a proof of the opinion held by the public of Dessault's integrity. A pension was settled on his widow by the republic. Fame, and not emolument, had been always the object of his ambition; for he neglected many opportunities of acquiring wealth. Indifferent to all other pleasures and pursuits, Dessault was solely and passionately attached to his profession. His temper was ardent, and sometimes rather violent; but his sentiments were always elevated and noble. The only work of which he is to be considered as the sole author, is entitled *Traité des Maladies chirurgicales, et des Operations qui leur conviennent*, in 2 vols 8vo.

DESSAW, a city of Upper Saxony, in Germany, situated on the river Elbe, 60 miles north-west of Dresden, and subject to the prince of Anhalt Dessaw. E. Long. 12. 40. N. Lat. 51. 50.

DESSERT, or DESERT, a service of fruits and sweetmeats, usually served up last at table.

DESSICCATIVE, or DESICCATIVE, in *Pharmacy*, an epithet applied to such topical medicines as dry up the humours flowing to a wound or ulcer.

DESTINIES, in *Mythology*. See PARCÆ.

DESTINY, among philosophers and divines. See FATE.

DESTRUCTION, in general, an alteration of any thing from its natural state to one contrary to nature, whereby it is deemed the same with CORRUPTION.

A chemical destruction, or corruption, is nothing but a resolution of the whole naturally mixt body into its parts.

DESUDATION, in *Medicine*, a profuse and inordinate sweat, succeeded by an eruption of pustules, called *sudamina*, or *heat pimples*.

DESULTOR, in antiquity, a vaulter or leaper, who, leading one horse by the bridle, and riding another, jumped from the back of one to the other, as the custom was after they had run several courses or heats. —This practice required great dexterity, being performed before the use of either saddles or stirrups. The custom was practised in the army when necessity required it; but chiefly amongst the Numidians, who always carried with them two horses at least for that purpose, changing them as they tired. The Greeks and

and Romans borrowed the practice from them; but only used it at races, games, &c. The Sarmatæ were great masters of this exercise, and the hussars have still some remains of it.

DETACHMENT, in military affairs, a certain number of soldiers drawn out from several regiments or companies equally, to be employed as the general thinks proper, whether on an attack, at a siege, or in parties to scour the country.

DETENTION (from *detineo*, "I detain,") the possession or holding of lands, or the like, from some other claimant. The word is chiefly used in an ill sense, for an unjust withholding, &c.

DETENTS, in a clock, are those stops which, by being lifted up or let fall down, lock and unlock the clock in striking.

Detent-Wheel, or *Hoop-Wheel*, in a clock, that wheel which has a hoop almost round it, wherein there is a vacancy, at which the clock locks.

DETERGENTS, in *Pharmacy*, such medicines as are not only softening and adhesive, but also, by a peculiar activity, conjoined with suitable configuration of parts, are apt to abrade and carry along with them such particles as they lay hold on in their passage.

DETERIORATION, the impairing or rendering any thing worse; it is just the reverse of melioration.

DETERMINATE PROBLEM, is that which has but one solution, or a certain limited number of solutions; in contradistinction to an indeterminate problem, which admits of infinite solutions.

Determinate Section, the name of a tract or general problem, written by the ancient geometrician Apollonius. None of this work has come down to us, excepting some extracts, and an account of it, by Pappus, in the Preface to the 7th book of his Mathematical Collections. He there says that the general problem was "To cut an infinite right line in one point so, that, of the segments contained between the point of section sought, and given points in the said line, either the square on one of them, or the rectangle contained by two of them, may have a given ratio, either to the rectangle contained by one of them and a given line, or to the rectangle contained by two of them."

DETERMINATION, in *Mechanics*, signifies much the same with the tendency or direction of a body in motion. See MECHANICS.

DETERMINATION, among school-divines, is an act of divine power, limiting the agency of second causes, in every instance, to what the Deity predestinated concerning them. See PREDESTINATION.

DETERSIVES, the same with DETERGENTS.

DETINUE, in *Law*, a writ or action that lies against one who has got goods or other things delivered to him to keep, and afterwards refuses to deliver them.—In this action, the thing detained is generally to be recovered, and not damages; but if one cannot recover the thing itself, he shall recover damages for the thing, and also for the detainer. Detinue lies for any thing certain and valuable, wherein one may have a property or right; as for a horse, cow, sheep, hens, dogs, jewels, plate, cloth, bags of money, sacks of corn, &c. It must be laid so certain, that the thing detained may be known and recovered: and therefore, for money out of a bag, or corn out of a sack, &c. it lies not; for the money or corn cannot in this case be known from other money or corn; so that the party must have an action on the case, &c. Yet detinue may be brought for a piece of gold of the price of 22s. though not for 22s. in money.

DETONATION, in *Chemistry*, signifies an explosion with noise made by the sudden inflammation of some combustible body: such are the explosions of *gunpowder*, *fulminating gold*, and *fulminating powder*. See CHEMISTRY *Index*.

DETRANCHE, in *Heraldry*, a line bend-wise, proceeding always from the dexter side, but not from the very angle, diagonally athwart the shield.

DETTINGEN, a village of Germany, in the circle of the Upper Rhine, and in the territory of Hanau. Here the Austrians and the British, in June 1743, were attacked by the French, who met with a repulse; but as the allies were inferior in number, they could not make the advantage of it they might otherwise have done. E. Long. 8. 45. N. Lat. 50. 8.

DEVA, or DEUNA, in *Ancient Geography*, a town of the Cornavii in Britain. Now *Chester*, on the Dee. W. Long. 3. 0. N. Lat. 53. 15.

DEUCALEDONIUS OCEANUS, supposed to be derived from the Gaelic words *Duah Gael*, the *northern Highlanders*: the sea on the north-west of Scotland.

DEUCALION, king of Thessaly. The flood said to have happened in his time (1500 B. C.), is supposed to have been only an inundation of that country, occasioned by heavy rains, and an earthquake that stopped the course of the river Peneus where it usually discharged itself into the sea. On these circumstances the fable of Deucalion's flood is founded. —According to the fable, he was the son of Prometheus. He governed his people with equity; but the rest of mankind being extremely wicked, were destroyed by a flood, while Deucalion and Pyrrha his queen saved themselves by ascending Mount Parnassus. When the waters were decreased, they went and consulted the oracle of Themis, on the means by which the earth was to be repeopled: when they were ordered to veil their heads and faces, to unloose their girdles, and throw behind their backs the bones of their great mother. At this advice Pyrrha was seized with horror; but Deucalion explained the mystery, by observing, that their great mother must mean the earth, and her bones the stones; when taking them up, those Deucalion threw over his head became men, and those thrown by Pyrrha, women.

Some have supposed that Deucalion, whom the Greeks have represented under a variety of characters, and concerning whom their poets have given many fabulous accounts, was the same with the patriarch Noah; and that Deucalion's flood in Thessaly, as well as that of Ogyges in Attica, and of Prometheus in Egypt, were the same with that of Noah recorded in scripture. Diodorus Siculus expressly says, that in the deluge which happened in the time of Deucalion almost all flesh died. Apollodorus having mentioned Deucalion εν λαρνακι, "consigned to the ark," takes notice upon his quitting it, of his offering up an immediate sacrifice, Διι φυξιω, "to the God who delivered him." As he was the father of mankind, the ancients have given him great dignity and universal monarchy; though sometimes he is reduced to a petty king

king of Thessaly. Apollonius Rhodius makes him a native of Greece, and the son of Prometheus. We may learn, however, from their confused history, that the person represented was the first of men, through whom religious rites were renewed, cities built, and civil polity established in the world; none of which circumstances are applicable to any king of Greece. Philo assures us, that the Grecians call the person Deucalion, but the Chaldeans style him Noe, in whose time there happened the great eruption of waters. But as Lucian has given the most particular history of the deluge, and that which comes nearest to the account given by Moses; and as he was a native of Samosata, a city of Commagene upon the Euphrates, a part of the world where memorials of the deluge were particularly preserved, and where an obvious reference to that history may be observed in the rites and worship of the country, we shall give the following extract of what he says on the subject. Having decribed Noah under the name of Deucalion, he says, that the present race of mankind are different from those who first existed: for those of the antediluvian world were all destroyed. The present world is peopled from the sons of Deucalion; having increased to so great a number from one person. In respect to the former brood, they were men of violence, and lawless in their dealings. They regarded not oaths, nor observed the rites of hospitality, nor showed mercy to those who sued for it. On this account they were doomed to destruction; and for this purpose there was a mighty eruption of waters from the earth, attended with heavy showers from above; so that the rivers swelled, and the sea overflowed, till the whole earth was covered with a flood, and all flesh drowned. Deucalion alone was preserved, to repeople the world. This mercy was shown to him on account of his justice and piety. His preservation was effected in this manner; he put all his family, both his sons and their wives, into a vast ark which he had provided, and he went into it himself. At the same time animals of every species, boars, horses, lions, serpents, whatever lived upon the face of the earth, followed him by pairs: all which he received into the ark, and experienced no evil from them; for there prevailed a wonderful harmony throughout by the immediate influence of the Deity. Thus were they wafted with him as long as the flood endured. After this he proceeds to mention, that upon the disappearing of the waters Deucalion went forth from the ark, and raised an altar to God.

De Dea Syria, vol. ii. p. 882.

Dr Bryant produces a variety of monuments that bear an obvious reference to the deluge in the Gentile history, besides this account of Deucalion and his flood. Analysis of Ancient Mythology, vol. ii. p. 193.—250.

DEVENSHRING. See Devonshering.

DEVENTER, a large, strong, trading, and populous town of the United Provinces, in Overyssel, with an university. It is surrounded with strong walls, flanked with several towers, and with ditches full of water. It is seated on the river Issel, 55 miles east of Amsterdam, and 42 west of Bentheim. E. Long. 5. 8. N. Lat. 52. 18.

DEVEREUX, Robert, earl of Essex, the son of Walter Devereux, Viscount Hereford, was born at Netherwood in Herefordshire, in the year 1567. He succeeded to the title of earl of Essex at ten years of age; and about two years after was sent by his guardian, Lord Burleigh, to Trinity-college in Cambridge. He took the degree of master of arts in 1582, and soon after retired to his seat at Lampsie in South Wales. He did not however continue long in this retreat; for we find him, in his seventeenth year, at the court of Queen Elizabeth, who immediately honoured him with singular marks of her favour. Authors seem very unnecessarily perplexed to account for this young earl's gracious reception at the court of Elizabeth. The reasons are obvious; he was her relation, the son of one of her most faithful servants, the son-in-law of her favourite Leicester, and a very handsome and accomplished youth. Towards the end of the following year, 1585, he attended the earl of Leicester to Holland; and gave signal proofs of his personal courage during the campaign of 1586, particularly at the battle of Zutphen, where the gallant Sidney was mortally wounded. On this occasion the earl of Leicester conferred on him the honour of knight banneret.

In the year 1587, Leicester being appointed lord steward of the household, Essex succeeded him in the honourable post of master of the horse; and the year following, when the queen assembled an army at Tilbury to oppose the Spanish invasion, Essex was made general of the horse. From this time he was considered as the happy favourite of the queen. And if there was any mark yet wanting to fix the people's opinion in that respect, it was shown by the queen's conferring on him the honour of the garter.

We need not wonder that so quick an elevation, and to so great a height, should affect so young a man as the earl of Essex; who showed from henceforwards a very high spirit, and often behaved petulantly enough to the queen herself, who yet did not love to be controlled by her subjects. His eagerness about this time to dispute her favour with Sir Charles Blunt, afterwards Lord Mountjoy and earl of Devonshire, cost him some blood; for Sir Charles, thinking himself affronted by the earl, challenged him, and after a short dispute wounded him in the knee. The queen, so far from being displeased with it, is said to have sworn a good round oath, that it was fit somebody should take him down, otherwise there would be no ruling him. However, she reconciled the rivals; who, to their honour, continued good friends as long as they lived.

The gallant Essex, however, was not so entirely captivated with his situation as to become insensible to the allurements of military glory. In 1589, Sir John Norris and Sir Francis Drake having sailed on an expedition against Spain, our young favourite, without the permission or knowledge of his royal mistress, followed the fleet; which he joined as they were sailing towards Lisbon, and acted with great resolution in the repulse of the Spanish garrison of that city. The queen wrote him a very severe letter on the occasion; but she was, after his return, soon appeased. Yet it was not long before he again incurred her displeasure, by marrying the widow of Sir Philip Sidney. In 1591, he was sent to France with the command of 4000 men to the assistance of Henry IV. In 1596, he was joined with the lord high admiral Howard in the command of the famous expedition against Cadiz, the success of which is universally known. In 1597 he was appointed

pointed master of the ordnance; and the same year commanded another expedition against Spain, called the *Island voyage*, the particulars of which are also well known.

Soon after his return, he was created earl marshal of England; and on the death of the great Lord Burleigh, in 1598, elected chancellor of the university of Cambridge. This is reckoned one of the last instances of this great man's felicity, who was now advanced too high to sit at ease; and those who longed for his honours and employments, very closely applied themselves to bring about his fall. The first great shock he received in regard to the queen's favour, arose from a warm dispute between her majesty and himself, about the choice of some fit and able person to superintend the affairs of Ireland. The affair is related by Camden; who tells us, that nobody was present but the lord admiral, Sir Robert Cecil secretary, and Windebank clerk of the seal. The queen looked upon Sir William Knolls, uncle to Essex, as the most proper person for that charge: Essex contended, that Sir George Carew was a much fitter man for it. When the queen could not be persuaded to approve his choice, he so far forgot himself and his duty, as to turn his back upon her in a contemptuous manner; which insolence her majesty not being able to bear, gave him a box on the ear, and bid him go and be hanged. Essex, like a blockhead, put his hand to his sword, and swore revenge. Where was his gallantry on this occasion? Could a stroke from an angry woman tinge the honour of a gallant soldier? This violent storm, however, soon subsided; and they were again reconciled, at least apparently.

The total reduction of Ireland being brought upon the tapis soon after, the earl was pitched upon as the only man from whom it could be expected. This was an artful contrivance of his enemies, who hoped by this means to ruin him. Nor were their expectations disappointed. He declined this fatal preferment as long as he could: but perceiving that he should have no quiet at home, he accepted; and his commission for lord lieutenant passed the great seal on the 12th of March 1598. His enemies now began to insinuate that he had sought this command, for the sake of greater things which he then was meditating; but there is a letter of his to the queen, preserved in the Harleian collections, which shows, that he was so far from entering upon it with alacrity, that he looked upon it rather as a banishment, and a place assigned him for a retreat from his sovereign's displeasure, than a potent government bestowed upon him by her favour.

“ *To the Queen.*

“ From a mind delighting in sorrow; from spirits
“ wasted with passion; from a heart torn in pieces
“ with care, grief, and travail; from a man that hateth
“ himself and all things else that keep him alive;
“ what service can your majesty expect, since any ser-
“ vice past deserves no more than banishment and pro-
“ scription to the cursedest of all islands? It is your
“ rebels pride and succession must give me leave to
“ ransom myself out of this hateful prison, out of my
“ loathed body; which if it happen so, your majesty
“ shall have no cause to mislike the fashion of my death,
“ since the course of my life could never please you.

“ Happy he could finish forth his fate,
“ In some unhaunted desert most obscure
“ From all society, from love and hate
“ Of worldly folk; then should he sleep secure.
“ Then wake again, and yield God ever praise,
“ Content with hips and haws, and bramhleberry;
“ In contemplation passing out his days,
“ And change of holy thoughts to make him merry.
“ Who when he dies, his tomb may be a bush
“ Where harmless robin dwells with gentle thrush.

“ Your majesty's exiled servant,
“ ROBERT ESSEX.”

The earl met with nothing in Ireland but ill success and crosses: in the midst of which, an army was suddenly raised in England, under the command of the earl of Nottingham; nobody well knowing why, but in reality from the suggestions of the earl's enemies to the queen, that he rather meditated an invasion on his native country, than the reduction of the Irish rebels. This and other considerations made him resolve to quit his post, and come over to England; which he accordingly did without leave. He burst into her majesty's bed-chamber as she was rising, and she received him with a mixture of tenderness and severity: but she soon after thought fit to deprive him of all his employments, except that of master of the horse. He was committed to the custody of the lord-keeper, with whom he continued six months. No sooner had he regained his liberty, than he was guilty of many extravagancies; to which he was instigated by knaves and fools, but perhaps more powerfully by his own passions. He first determined to obtain an audience of the queen by force. He refused to attend the council when summoned. When the queen sent the lord-keeper, the lord chief-justice, and two others, to know his grievances, he confined them; and then marched with his friends into the city, in expectation that the people would rise in his favour; but in that he was disappointed. He was at last besieged and taken in his house in Essex-street; committed to the Tower; tried by his peers, condemned, and executed. Thus did this brave man, this favonrite of the queen, this idol of the people, fall a sacrifice to his want of that dissimulation, that cunning, that court-policy, by which his enemies were enabled to effect his ruin. He was a polite scholar, and a generous friend to literature.

To those who have not taken the trouble to consult and compare the several authors who have related the story of this unfortunate earl, it must appear wonderful, if, as hath been suggested, he was really beloved by Queen Elizabeth, that she should consent to his execution. Now that she had conceived a tender passion for him, is proved beyond a doubt by Mr Walpole in his very entertaining and instructive Catalogue of Noble Authors:—“ I am aware (says that author) that it is become a mode to treat the queen's passion for him as a romance. Voltaire laughs at it; and observes, that when her struggle about him must have been the greatest (the time of his death), she was sixty-eight.—Had *he* been sixty-eight, it is probable she would *not* have been in love with him.”—“ Whenever Essex acted a fit of sickness, not a day passed without the queen's sending often to see him; and once went so far as to sit

Devereux.

long by him, and order his *broths and things.* It is recorded by a diligent observer of that court, that in one of his sick moods, he took the liberty of going up to the queen in his night-gown. In the height of these fretful fooleries, there was a mask at Black Fryars on the marriage of Lord Herbert and Mrs Russel. Eight lady maskers chose eight more to dance the measures. Mrs Fitton, who led them, went to the queen, and wooed her to dance. Her majesty asked what she was? *Affection,* she said. *Affection!* said the queen; *Affection is false.* Were not these the murmurs of a heart ill at ease? Yet her majesty rose, and danced. She was then sixty-eight. Sure it was as natural for her to be in love."

Mr Walpole farther observes, that her court and contemporaries had an uniform opinion of her passion for Essex, and quotes several instances from a letter written by Sir Francis Bacon to the earl; in which, among other things, he advises him to consult her taste in his very apparel and gestures, and to give way to any other inclination she may have. Sir Francis advised the queen herself, knowing her inclination, to keep the earl about her for *society.* What Henry IV. of France thought of the queen's affection for Essex, is evident from what he said to her ambassador—" *Que sa majesté ne laisseroit jamais son cousin d'Essex eloigner de son cotillon.*"—After his confinement, on hearing he was ill, she sent him word, with tears in her eyes, that if she might with her honour, she would visit him.

" If (says Mr Walpole) these instances are problematic, are the following so? In one of the curious letters of Rowland White, he says, *the queen hath of late used the fair Mrs Bridges with words and blows of anger.* In a subsequent letter, he says, *the earl is again fallen in love with his fairest B. It cannot choose but come to the queen's ear, and then he is undone.*"—Essex himself says, that her fond parting with him when he set out for Ireland, pierced his very soul.

Probably the reader has now very little doubt as to Queen Elizabeth's affection for the unfortunate Essex; but, in proportion to our belief of the existence of the affection, her motives for consenting to his execution became more inexplicable. Queen Elizabeth had a very high opinion of her beauty and personal attractions, and probably expected more entire adoration than the earl's passion for variety would suffer him to pay. Towards the latter end of her life, she was certainly an object of disgust. He had too much honest simplicity in his nature to feign a passion which he did not feel. She foolishly gave credit to the stories of his ambitious projects incompatible with her safety; and was informed that he had once inadvertently said, that *she grew old and cankered, and that her mind was become as crooked as her carcase.* If this be true, where is the woman that would not sacrifice such a lover to her resentment?

It is said, however, that, concerning his execution, her majesty was irresolute to the last, and sent orders to countermand it: but, considering his obstinacy in refusing to ask her pardon, afterwards directed that he should die. It is reported that the queen, in the height of her passion for the earl of Essex, had given him a ring, ordering him to keep it, and that whatever crime he should commit, she would pardon him when he should return that pledge. The earl, upon his condemnation, applied to Admiral Howard's lady, his relation, desiring her, by a person whom she could trust, to return it into the queen's own hands; but her husband, who was one of the earl's greatest enemies, and to whom she had imprudently told the circumstance, would not suffer her to acquit herself of the commission; so that the queen consented to the earl's death, being full of indignation against so proud and haughty a spirit, who chose rather to die than implore her mercy. Some time after, the admiral's lady fell sick, and being near her death, she sent word to the queen that she had something of great consequence to communicate before she died. The queen came to her bedside, and having ordered all her attendants to withdraw, the lady returned, but too late, the ring, desiring to be excused that she did not return it sooner: on which, it is said, the queen immediately retired, overwhelmed with grief.

Devereux ‖ Device.

The earl of Essex died in the thirty-fourth year of his age; leaving by his lady one son and two daughters.

DEVICE, among painters. See Devise.

DEVIL (*Diabolus*), an evil angel, one of those celestial spirits cast down from heaven for pretending to equal himself with God. The Ethiopians paint the devil white, to be even with the Europeans who paint him black.

There is no mention of the word *devil* in the Old Testament, but only of the word *Satan* and *Belial:* nor do we meet with it in any heathen authors, in the sense it is taken among Christians, that is, as a creature revolted from God. Their theology went no farther than to evil genii or dæmons.

Some of the American idolaters have a notion of two collateral independent beings, one of whom is good and the other evil: which last they imagine has the direction and superintendence of this earth, for which reason they chiefly worship him: whence those that give us an account of the religion of these savages give out with some impropriety, that they worship the devil. The Chaldeans, in like manner, believed both a good principle and an evil one; which last they imagined was an enemy to mankind.

Isaiah, speaking, according to some commentators, of the fall of the devil, calls him *Lucifer,* from his former elevation and state of glory: but others explain this passage of Isaiah in reference to the king of Babylon, who had been precipitated from his throne and glory. The Arabians call Lucifer, *Eblis;* which some think is only a diminutive or corruption of the word *Diabolus.*

Devil on the Neck, a tormenting engine made of iron, straitening and wincing the neck of a man, with his legs together, in a horrible manner; so that the more he stirreth in it, the straiter it presseth him; formerly in use among the persecuting papists.

DEVINCTION (*Devinctio*), in antiquity, was used to signify a love charm or incantation to gain the affection of a person beloved.

It was done by tying knots; and is thus described by Virgil in his eighth Eclogue:

Necte tribus nodis ternos, Amarylli, colores:
Necte, Amarylli, modo; et Veneris, dic, vincula necto.

DEVISE, or Device, in *Heraldry, Painting,* and *Sculpture,*

Sculpture, any emblem used to represent a certain family, person, action, or quality; with a suitable motto, applied in a figurative sense. See MOTTO.

The essence of a device consists in a metaphorical similitude between the things representing and represented: thus, a young nobleman, of great courage and ambition, is said to have borne for his devise, in a late carousal at the court of France, a rocket mounted in the air, with this motto in Italian, "*poco duri purche m'inalzi*;" expressing, that he preferred a short life, provided he might thereby attain to glory and eminence.

The Italians have reduced the making of devises into an art, some of the principal laws of which are these; 1. That there be nothing extravagant or monstrous in the figures. 2. That figures be never joined which have no relation or affinity with one another; excepting some whimsical unions established in ancient fables, which custom has authorised. 3. That the human body be never used. 4. The fewer figures the better. 5. The motto should be every way suitable.

DEVISE, in *Law*, the act whereby a person bequeathes his lands or tenements to another by his last will or testament.

DEUNX, in Roman antiquity, 11 ounces, or $\frac{11}{12}$ of the LIBRA.

DEVOLVED, something acquired by right of devolution. Such a right is devolved to the crown; such an estate devolved on M—— by the death of N——.

The word is also used for a right, acquired by a superior, of conferring a benefice, when the inferior and ordinary collator has neglected to confer, or has conferred it on an unqualified person.

If a person neglects to present to a benefice in six months, the presentation lapses or devolves upon the bishop, from thence to the primate, and from thence to the king.

DEVOLUTION, in *Law*, a right acquired by succession from one to another.

DEVONSHERING, a term used by the farmers to express the burning of land by way of manure: the method is to cut off the turf about four inches thick, and burn it in heaps, and then spread the ashes upon the land. The name is probably derived from its having been earliest practised in Devonshire.

DEVONSHIRE, a county of England, bounded on the south by the English channel, on the north by the Bristol channel, on the east by Somersetshire, and on the west by Cornwall. It is about 72 miles long and 71 broad. The soil is various; in the western parts of the county it is coarse and moorish, bad for sheep, but proper for black cattle. In the northern parts, the dry soil and downs are well adapted to sheep, with numerous flocks of which they are well covered. Tolerable crops of corn are also produced there when the land is well manured. The soil of the rest of the country is rich and fertile both in corn and pasture, yielding also in some places plenty of marle for manuring it. In other places they pare off and burn the surface, making use of the ashes as a manure. It has mines of lead, iron, and silver, in which it formerly exceeded Cornwall, though now it is greatly inferior. On the coast also they have herring and pilchard fisheries. Devonshire sends two members to parliament, and gives title of duke to the noble family of Cavendish. It contains 464 parishes; and in 1811 the population amounted to 383,308. See DEVONSHIRE, SUPPLEMENT.

DEVOTION, (*Devotio*), a sincere ardent worship of the Deity.

Devotion, as defined by Jurieu, is a softening and yielding of the heart, with an internal consolation, which the souls of believers feel in the practice or exercise of piety. By devotion is also understood certain religious practices, which a person makes it a rule to discharge regularly; and with reason, if the exactitude be founded on solid piety, otherwise it is vanity or superstition. That devotion is vain and trifling, which would accommodate itself both to God and to the world. *Trevoux*.

The character of devotion has frequently suffered from the forbidding air which has been thrown over it, by the narrowness of bigotry on the one hand, or the gloom of superstition on the other. When freer and more cheerful minds have not had occasion to see it accompanied with those feelings of delight and benevolence which naturally attend it, they are apt to be prejudiced against piety at large, by mistaking this ungracious appearance for its genuine form. Nor has the rant of vulgar enthusiasts contributed a little to beget or strengthen the same aversion, in persons of a cool and speculative temper; who have happened to meet with such images and phrases among religionists of a certain strain, as ill suit the rational, pure, and spiritual nature of true devotion. It may likewise be remarked, on the other side, that people of taste and sensibility have not seldom been disgusted with the insipid style too often employed on such subjects, by those who possess neither, or who purposely avoid every thing of that kind, from an aim at simplicity misunderstood, or perhaps from a fear of being thought too warm, in an age of fashionable indifference and false refinement.

Wherever the vital and unadulterated spirit of Christian devotion prevails, its immediate object will be to please him whom we were made to please, by adoring his perfections; by admiring his works and ways; by entertaining with reverence and complacence the various intimations of his pleasure, especially those contained in holy writ; by acknowledging our absolute dependence, and infinite obligations; by confessing and lamenting the disorders of our nature and the trangressions of our lives; by imploring his grace and mercy through Jesus Christ; by interceding for our brethren of mankind; by praying for the propagation and embellishment of truth, righteousness, and peace on earth; in fine, by longing for a more entire conformity to the will of God, and breathing after the everlasting enjoyment of his friendship. The effects of such a spirit habitually cherished, and feelingly expressed before him, with conceptions more or less enlarged and elevated, in language more or less emphatical and accurate, sententious or diffuse, must surely be important and happy. Among these effects may be reckoned, a profound humility in the sight of God, a high veneration for his presence and attributes, an ardent zeal for his worship and honour, an affectionate faith in the Saviour of the world, a constant imitation of his divine example, a diffusive charity for men of all

denominations,

denominations, a generous and unwearied self-denial for the sake of virtue and society, a total resignation to Providence, an increasing esteem for the gospel, with clearer and firmer hopes of that immortal life which it has brought to light.

Devotion, among the Romans, was a kind of sacrifice or ceremony, whereby they consecrated themselves to the service of some person. The ancients had a notion, that the life of one might be ransomed by the death of another; whence those devotions became frequent for the lives of the emperors. Devotion to any particular person was unknown among the Romans till the time of Augustus. The very day after the title of Augustus had been conferred upon Octavius, Pacuvius, a tribune of the people, publicly declared, that he would devote himself to Augustus, and obey him at the expence of his life (as was the practice among barbarous nations), if he was commanded. His example was immediately followed by all the rest; till at length it became an established custom never to go to salute the emperor, without declaring that they were devoted to him. Before this, the practice of the Romans was that of devoting themselves to their country. See Decius.

DEUTEROCANONICAL, in the school theology, an appellation given to certain books of holy Scripture, which were added to the canon after the rest; either by reason they were not wrote till after the compilation of the canon, or by reason of some dispute as to their canonicity. The word is Greek, being compounded of δευτερος, *second*, and κανονικος, *canonical*.

The Jews, it is certain, acknowledged several books in their canon, which were put there later than the rest. They say, that under Esdras, a great assembly of their doctors, which they call by way of eminence the *great synagogue*, made the collection of the sacred books which we now have in the Hebrew Old Testament. And they agree that they put books therein which had not been so before the Babylonish captivity; such are those of Daniel, Ezekiel, Haggai, &c. and those of Esdras and Nehemiah.

And the Romish church has since added others to the canon, that were not, and could not be, in the canon of the Jews, by reason some of them were not composed till after. Such is the book of Ecclesiasticus, with several of the apocryphal books, as the Maccabees, Wisdom, &c. Others were added still later, by reason their canonicity had not been yet examined; and till such examen and judgment they might be set aside at pleasure.—But since that church has pronounced as to the canonicity of these books, there is no more room now for her members to doubt of them, than there was for the Jews to doubt of those of the canon of Esdras. And the deuterocanonical books are with them as canonical as the protocanonical; the only difference between them consisting in this, that the canonicity of the one was not generally known, examined, and settled, so soon as that of the others.

The deuterocanonical books in the modern canon, are the book of Esther, either the whole, or at least the seven last chapters thereof; the Epistle to the Hebrews; that of James; and that of Jude; the second of St Peter; the second and third of St John; and the Revelation. The deuterocanonical parts of books are in Daniel, the hymn of the three children; the prayer of Azariah; the histories of Susannah, of Bel and the Dragon; the last chapter of St Mark; the bloody sweat, and the appearance of the angel, related in St Luke, chap. xxii.; and the history of the adulterous woman in St John, chap. viii.

DEUTERONOMY, one of the sacred books of the Old Testament; being the last of those written by Moses; (see Pentateuch). The word is Greek, compounded of δευτερος, *second*, and νομος, *law*.

Deuteronomy was written in the 40th year after the delivery from Egypt, in the country of the Moabites, beyond Jordan; Moses being then in the 120th year of his age. It contains, in Hebrew, 11 paraches; though only 10 in the edition of the rabbins at Venice; 20 chapters, and 955 verses. In the Greek, Latin, and other versions, it contains 34 chapters. The last is not of Moses. Some say, it was added by Joshua immediately after Moses's death; which is the most probable opinion. Others will have it added by Esdras.

DEUTEROPOTMI, in Grecian antiquity, a designation given to such of the Athenians as had been thought dead, and, after the celebration of the funeral rites, unexpectedly recovered. It was unlawful for the deuteropotmi to enter into the temple of the Eumenides, or to be admitted to the holy rites, till after they were purified, by being let through the lap of a woman's gown, that they might seem to be new born.

DEUTEROSIS, the Greek name by which the Jews called their Mischnah or second law. See Mischnah.

DEUTZIA, a genus of plants belonging to the decandria class. See Botany *Index*.

DEW, a dense, moist vapour, found on the earth in spring and summer mornings, in form of a misling rain, being collected there chiefly while the sun is below the horizon.

It hath been disputed whether the dew is formed from the vapours *ascending* from the earth during the night time, or from the *descent* of such as have been already raised through the day. The most remarkable experiments adduced in favour of the first hypothesis are those of Dr Dufay of the Royal Academy of Sciences, at Paris. He supposed, that if the dew *ascended* it must wet a body placed low down sooner than one placed in a higher situation; and if a number of bodies were placed in this manner, the lowermost would be wetted first; and the rest in like manner, gradually up to the top.

To determine this, he placed two ladders against one another, meeting at their tops, spreading wide asunder at the bottom, and so tall as to reach 32 feet high. To the several steps of these he fastened large squares of glass like the panes of windows, placing them in such a manner that they should not overshade one another. On the trial it appeared exactly as Dr Dufay had apprehended. The lower surface of the lowest piece of glass was first wetted, then the upper, then the lower surface of the pane next above it; and so on, till all the pieces were wetted to the top. Hence it appeared plain to him, that the dew consisted of the vapours ascending from the earth during the night-time; which, being condensed by the coldness of the atmosphere,

atmosphere, are prevented from being dissipated as in the day-time by the sun's heat. He afterwards tried a similar experiment with pieces of cloth instead of panes of glass, and the result was quite conformable to his expectations. He weighed all the pieces of cloth next morning, in order to know what quantity of water each had imbibed, and found those that had been placed lowermost considerably heavier than such as had been placed at the top; though he owns that this experiment did not succeed so perfectly as the former.

M. Muschenbroek, who embraced the contrary opinion, thought he had invalidated all Dr Dufay's proofs, by repeating his experiments, with the same success, on a plane covered with sheet-lead. But to this Dr Dufay replied, that there was no occasion for supposing the vapour to rise through the lead, nor from that very spot; but that as it arose from the adjoining open ground, the continual fluctuation of the air could not but spread it abroad, and carry it thither in its ascent.

But though this experiment of M. Muschenbroek's is not sufficient to overthrow those of Dr Dufay, it must still remain dubious whether the dew rises or falls. One thing which seems to favour the hypothesis of its descent is, that in cloudy weather there is little or no dew to be observed, From this M. de Luc brings an argument in favour of the hypothesis just now mentioned. He accounts for it in the following manner: When there are no clouds in the air, the heat of the inferior air and that which rises from the earth dissipates itself into the superior regions; and then the vapours which are dispersed throughout the air condense, and fall down in dew: But, when the clouds continue, they separate the inferior from the superior part of the atmosphere, and thus prevent the dissipation of the heat, by which means the vapours remain snspended. When the sky grows cloudy, some hours after sunset, although the heat has been sensibly diminished, it is again increased; because continuing to rise out of the earth, it is accumulated in the inferior air. But neither can this be reckoned a positive proof of the descent of the dew; since we may as well suppose the heat of the atmosphere to be great enough to dissipate it in its ascent, as to keep it suspended after its ascent through the day.

Trans.
ii.
ii.

On the other hand, its being found in greater quantities on bodies placed low down than on such as are high up, is no proof of the ascent of the dew; because the same thing is observed of rain. A body placed low down receives more rain than one placed in an elevated situation; and yet the rain certainly descends from the atmosphere. The reason why the dew appears first on the lower parts of bodies may be, that, in the evening, the lower part of the atmosphere is first cooled, and consequently most disposed to part with its vapours. It is also certain, that part of the water contained in the air may be condensed at any time on the sides of a glass, by means of cold, so as to run down its sides in small drops like dew. It seems therefore, that this subject is not sufficiently determined by such experiments as have yet been made; nor indeed does it appear easy to make such experiments as shall be perfectly decisive on the matter.

Several substances exposed to the same dew receive and charge themselves with it in a very different manner; some more, others less, and some even not at all. The drops seem to make a sort of choice of what bodies they shall affix themselves to; glass and crystals are those to which they adhere in the most ready manner, and in the largest quantity; but metals of all kinds never receive them at all, nor do the drops ever adhere to them. The reason of this is, probably, because metals promote evaporation more than glass does. Thus, if a piece of metal and a piece of glass are both made equally moist, the former will be found to dry in much less time than the latter. Hence it would seem, that there is between metals and water some kind of repulsion; and this may be sufficient to keep off the very small quantity that falls in dew; for whatever tends to make water evaporate after it is actually in contact with any substance, also tends to keep the water from ever coming into contact with it. On this subject several curious particulars are mentioned by Dr Percival relative to the attraction and repulsion between dew and glass or metalline vessels. The experiments were made by M. Dufay, who, in order to determine with certainty whether the difference between vitrified substances and metals was the same in all cases, set a china saucer in the middle of a silver plate, and on one side, adjoining to it, was placed a china plate, with a silver dish very much resembling the saucer in the middle. In this experiment the china saucer was covered with dew, but the plate, though extending four inches round it, was not moistened in the least. The china plate also had become quite moist, while the silver vessel in the middle had not received the smallest drop. M. Dufay next endeavoured to ascertain whether a china saucer set upon a plate of metal, as already described, did not receive more dew than it would have done if exposed alone. To accomplish this design, he took two watch crystals of equal dimensions, and placed the one upon a plate of silver, the other upon a plate of china, each with its concavity uppermost. That which was upon the silver plate he surrounded with a ferrel of the same metal, well polished, that no watery particles might attach themselves to the convex surface of the glass. In this situation he exposed the crystals for several days successively, and always found five or six times more dew in that which was on the china plate than on the other placed on the silver. The repulsion between the dew and silver is further confirmed by the following experiment of M. Dufay, with regard to the crystal on the silver plate. He informs us, that the small quantity of dew on the side near the centre, was in minute drops; and that round the border there was a space of five or six lines perfectly dry; towards which the drops regularly decreased in magnitude, as if the silver ferrel had driven away the dew from that part of the glass which was contiguous to it. These experiments were repeated thirty times with invariable success. M. Dufay's experiments have received a remarkable confirmation, from some lately made by Dr Watson, now bishop of Llandaff, with a view to determine the quantity of vapour that ascsnds from a given surface of earth. "By means of a little bees-wax (says he), I fastened a half-crown very near, but not quite contiguous, to the side of the glass; and, setting the glass with its mouth downward on the grass, it presently became covered with vapour, except that part of it which was next the half-crown. Not only the-

the half-crown itself was free from vapour, but it had hindered any from settling on the glass which was near it; for there was a little ring of glass surrounding the half-crown, to the distance of a quarter of an inch, which was quite dry, as well as that part of the glass which was immediately under the half-crown; it seemed as if the silver had repelled the water to that distance. A large red wafer had the same effect as the half-crown; it was neither wetted itself, nor was the ring of glass contiguous to it wetted. A circle of white paper produced the same effect, so did several other substances, which it would be too tedious to enumerate."

Substances of a very different kind from the usual dew are said to have sometimes fallen from the atmosphere. In the Phil. Trans. we are told, that in the year 1695 there fell in Ireland, in the provinces of Leinster and Munster, for a considerable part of the winter and spring, a fatty substance resembling butter, instead of the common dew. It was of a clammy texture, and dark-yellow colour; and was, from its great resemblance, generally called *dew-butter* by the country people. It always fell in the night, and chiefly in the moorish low grounds; and was found hanging on the tops of the grass, and on the thatch of the houses of the poor people. It was seldom observed to fall twice in the same place; and usually, wherever it fell, it lay a fortnight upon the ground before it changed colour; but after that it gradually dried up, and became black. The cattle fed in the fields where it lay as well as in others, and received no harm by it. It fell in pieces of the bigness of one's finger-end; but they were dispersed scatteringly about, and it had an offensive smell like a churchyard. There were in the same places very stinking fogs during the winter, and some people supposed this no other than a sediment from the fog. It would not keep very long, but never bred worms. See Dew, Supplement.

May-Dew whitens linen and wax; the dew of autumn is converted into a white frost. Out of dew putrified by the sun, arise divers insects, which change apace from one species into another; what remains is converted into a fine white salt, with angles like those of saltpetre, after a number of evaporations, calcinations, and fixations.

There is a spirit drawn from May-dew, which has wonderful virtues attributed to it. The method of collecting and preparing it, is described by Hanneman, physician at Kiel. It is to be gathered in clean linen cloths; exposed to the sun in close vials; then distilled, and the spirit thrown upon the caput mortuum; this is to be repeated till the earth unite with the spirit, and become liquid; which happens about the seventh or eighth cohobation or distillation. By such means you gain a very red, odoriferous spirit. Stolterfoht, a physician of Lubec, thinks May-dew may be gathered in glass-plates, especially in still weather, and before sunrise; and Etmuller is of the same sentiment. It might likewise be collected with a glass funnel, exposed to the air, having a crooked neck to bring the dew into a vial in a chamber. See Phil. Trans. N° 3. Hoffman, and others. It is apparently from the preparation of this dew, that the brothers of the Rosy-Cross took their denomination. See Rosicrucians.

Dew-Born, in country affairs, a distemper in cattle, being swelled in the body, as much as the skin can hold, so that some beasts are in danger of bursting. This distemper proceeds from the greediness of a beast to feed, when put into a rank pasture, but commonly when the grass is full of water. In this case the beast should be stirred up and down, and made to purge well; but the proper cure is bleeding in the tail; then take a grated nutmeg, with an egg, and breaking the top of the shell, put out so much of the white as you may have room to slip the nutmeg into the shell; mix them together, and then let shell and all be put down the beast's throat; that done, walk him up and down, and he will soon mend.

Dew-Worm. See Lumbricus, Helminthology *Index*.

DEWAN, in the Mogul government, is the receiver-general and civil governor of the province. In private affairs the same word signifies a steward.

DEWANNY, the revenue department of a province.

DE WIT, John, the famous pensionary, was born in 1625, at Dort; where he prosecuted his studies so diligently, that, at the age of 23, he published *Elementa Curvarum Linearum*, one of the profoundest books in mathematics at that time. After taking his degrees, and travelling, he, in 1650, became pensionary of Dort, and distinguished himself very early in the management of public affairs. He opposed with all his power the war between the English and the Dutch; and when the event justified his predictions, he was unanimously chosen pensionary of Holland. In this capacity he laboured to procure a peace with Cromwell; in which peace a secret article was introduced by one side or other, for the exclusion of the house of Orange. In the war with England after the king's restoration, when it was thought expedient, on Opdam's defeat and death, that some of their own deputies should command the fleet, he was one of the three put in commission; and wrote an accurate relation of all that happened during the expedition he was engaged in, for which, at his return, he received the solemn thanks of the States General. In 1667, he established the perpetual edict for abolishing the office of Stadtholder, to fix the liberty of the republic, as it was hoped, on a firm basis; which produced seditions and tumults, that restored the office, on pretence that the De Wits were enemies to the house of Orange, and plundered the state. The pensionary begged dismission from his post; which was granted, with thanks for his faithful services. But the invasion of the French, and the internal divisions among the Hollanders themselves, spread everywhere terror and confusion; which the Orange party heightened to ruin the De Wits. Cornelius, the pensionary's brother, was imprisoned and condemned to exile; and a report being raised that he would be rescued, the mob armed, and surrounded the prison where the two brothers then were together, dragged them out, barbarously murdered them, hung the bodies on the gallows, and cut them to pieces, which many of them even broiled and ate with savage fury. Such was the end of one of the greatest geniuses of his age; of whom Sir William Temple, who was well acquainted with him, writes with the greatest esteem and admiration. He observes, that when he was at the head of the government, he differed nothing in his manner of living from an ordinary citizen. His office, for the first ten years, brought him in little more than 300l. and in the latter part of his life, not above 700l. per annum. He refused a gift of 10,000l. from the states-general, because he thought it a bad precedent in the government. With great reason, therefore, Sir William Temple, speaking of his death, observes, "He was a person that deserved another fate, and a better return from his country, after 18 years spent in their ministry, without any care of his entertainments or ease, and little of his fortune. A man of unwearied industry, inflexible constancy, sound, clear, and deep understanding, and untainted integrity; so that whenever he was blinded, it was by the passion he had for that which he esteemed the good and interest of the state. This testimony is justly due to him from all that were well acquainted with him; and is the more willingly paid, since there can be as little interest to flatter, as honour to reproach, the dead."

Besides the works already mentioned, he wrote a book containing those maxims of government upon which he acted; which will be a never-fading monument to his immortal memory. A translation of it from the original Dutch, entitled, *The true interest and political maxims of the republic of Holland*, has been printed in London; to the last edition of which, in 1746, are prefixed historical memoirs of the illustrious brothers Cornelius and John de Wit, by John Campbell, Esq.

DEXTANS, in Roman antiquity, ten ounces, or $\frac{10}{12}$ of their libra. See LIBRA.

DEXTER, in *Heraldry*, an appellation given to whatever belongs to the right side of a shield or coat of arms: thus we say, *bend-dexter*, *dexter-point*, &c.

DEXTROCHERE, or DESTROCHERE, in *Heraldry*, is applied to the right arm painted in a shield, sometimes naked, sometimes clothed, or adorned with a bracelet; and sometimes armed, or holding some moveable member used in the arms.

DEY, the title of the sovereign of Algiers, under the protection of the grand signior. A prince under this title was appointed by the sultan, at the request of the Turkish soldiers, in the year 1710. The term *dey* in the Turkish language, signifies *an uncle* by the mother's side; and the reason of the denomination is this: that the Turkish military consider the grand signior as their father; the republic as their mother, by which they are nourished and maintained; and the dey as the brother of the republic, and consequently the uncle of all who are under his dominion. Besides the age, experience, and valour, which are necessary qualifications of a person to be elected, he must also be a native Turk, and have made the voyage to Mecca. He has no guards or considerable retinue. He presides at the divan, and is most distinguished by the respect and submission which are paid him.

DIABETES, in *Physic*, a preternatural discharge of urine, which has changed its properties, and exceeds the quantity of liquids drank. See MEDICINE *Index*.

DIABOLUS. See DEVIL.

DIABOLUS Marinus. See RAIA, ICHTHYOLOGY *Index*.

DIABOLUS Metallorum, a title given by chemists to jupiter or tin: because, when incorporated with other metals, it renders them incapable of reduction, or at least very difficult to undergo that operation.

DIACAUSTIC CURVE, a species of the caustic curves formed by refraction.

DIACHYLON, in *Pharmacy*, an emollient digestive plaster, composed of mucilages or viscid juices drawn from certain plants. See PHARMACY.

DIACODIUM, in *Pharmacy*, a syrup prepared from poppy heads. It is also called the *syrupus de meconio*. See PHARMACY.

DIACOUSTICS, called also DIAPHONICS, the consideration of the properties of refracted sound, as it passes through different mediums. The word is formed from the Greek δια, *per*, "through," which intimates a passage, and ακουω, "I hear;" *q. d.* the consideration of the passage of the sounds we hear. See ACOUSTICS.

DIACRII, in antiquity, was the name of a party or faction at Athens.—That city, we read, was divided into two parties; the one favourers of an oligarchy, who would only have a few persons employed in the government; the other consisted of such as were for a democratical or popular government, wherein the whole people should have a share. The first were called *diacrii*, and the latter *pediaci;* the latter inhabiting the lower, and the former the ακρον, or upper quarter or part of the city.—The laws of Solon imported, that Pisistratus should be chief of the diacrii; though the scholiast on Aristophanes's comedy The Wasps, affirms, that Pandion distributed the quarter of the diacrii among his sons, and put Lycus at their head.

DIADELPHIA (δις, "twice," and αδελφος, "a brother"), the 17th class in the sexual system, comprehending those plants which bear hermaphrodite flowers with two sets of united stamina; but this circumstance must not be absolutely depended on. They are the *papilionacei* of Tournefort, the *irregulares tetrapetali* of Rivinus, and the *leguminosæ* of Ray. See BOTANY *Index*.

DIADEM, in antiquity, a head-band or fillet, worn by kings as a badge of their royalty. It was made of silk, thread, or wool, and tied round the temples and forehead, the ends being tied behind, and let fall on the neck. It was usually white and quite plain; though sometimes embroidered with gold, and set with pearls and precious stones. In latter times, it came to be twisted round crowns, laurels, &c. and even appears to have been worn on divers parts of the body. See CROWN. The word comes from the Latin *diadema;* of the Greek διαδημα, "a little band encompassing the head," of the verb, διαδεω, *cingo*, "I gird."

DIADEM, in *Heraldry*, is applied to certain circles or rims serving to inclose the crowns of sovereign princes, and to bear the globe and cross, or the fleur de lis, for their crest. The crowns of sovereigns are bound, some with a greater and some with a less number of diadems.—The bandage about the heads of Moors on shields is also called *diadem* in blazoning.

DIÆRESIS, in *Surgery*, an operation serving to divide and separate the part when the continuity is a hinderance of the cure.

DIÆRESIS, in *Medicine*, is the consuming of the vessels of an animal body, when, from some corroding cause, certain passages are made which naturally ought not to have been; or certain natural passages are dilated beyond their ordinary dimensions, so that the humours which ought to have been contained in the vessels extravasate or run out.

Diæresis, in *Grammar*, the division of one syllable into two, which is usually noted by two points over a letter, as *aulaï*, instead of *aulæ*, *dissolüenda* for *dissolvenda*.

DIÆTETÆ, in Grecian antiquity, a kind of judges, of which there were two sorts, the cleroti and diallacterii. The former were public arbitrators, chosen by lot to determine all causes exceeding ten drachms, within their own tribe, and from their sentence an appeal lay to the superior courts.

The diallacterii, on the contrary, were private arbitrators, from whose sentence there lay no appeal, and accordingly they always took an oath to administer justice without partiality.

DIAGLYPHICE, the art of cutting or engraving figures on metals, such as seals, intaglios, matrices of letters, &c. or coins for medals. See Engraving.

DIAGNOSIS, (from διαγνωσκω, *to discern* or *distinguish*), the diagnostics or the signs of a disease. They are of two kinds, viz. the adjunct and the pathognomonic: the first are common to several diseases, and serve only to point out the difference between diseases of the same species; the latter are those which always attend the disease, and distinguish it from all others.

DIAGNOSTIC, in *Medicine*, a term given to those signs which indicate the present state of a disease, its nature and cause.

DIAGONAL, in *Geometry*, a right line drawn across a quadrilateral figure, from one angle to another; by some called the *diameter*, and by others the *diametral*, of the figure. See Geometry.

DIAGORAS, surnamed the *Atheist*, lived in the 91st Olympiad. He was not a native of Athens, but he philosophised there. He delighted in making verses, and had composed a poem which a certain poet stole from him. He sued the thief, who swore it was his own, and got glory by it. This tempted Diagoras to deny a Providence. The Athenians summoned him to give an account of his doctrine. He fled, and they set a price upon his head, promising a reward to any who should kill him; but he took shipping, and was cast away.

DIAGRAM, in *Geometry*, a scheme for explaining and demonstrating the properties of any figure, whether triangle, square, circle, &c. See Geometry.

Diagram, among ancient musicians, the same with the scale of the modern. See Scale.

DIAH, Diat, a name given by the Arabs to the punishment of retaliation. By the Mahometan law, a brother, or the next relation of a murdered person, ought to take part against the murderer, and demand his blood in reparation for that which he has shed. Before the time of Mahomet, the Arabs had a custom of putting a freeman of their prisoners to death in lieu of every slave they lost in battle, and a man for every woman that was killed. But Mahomet regulated the laws of reprisal; directing in the Alcoran, by the diat, that a freeman should be required for a freeman, and a slave for a slave. The Turks, probably in consequence of this law, formerly massacred almost all their prisoners of war, but they now content themselves with enslaving and selling them.

DIAHEXAPLA, or Diahexapte, among farriers, a compound medicine, so called from its containing six ingredients, viz. birthwort and gentian roots, juniper-berries, bay-berries, myrrh, and ivory shavings. It is commended for colds, consumptions, pursiness, and many other disorders in horses.

DIAL, an instrument, serving to measure time; which, if effected by the aid of the sun, is called a *sun-dial.* The word is from the Latin *dies*, "day," because indicating the hour of the day. The ancients also called it *sciatherium*, from its effect by the shadow. See the article Dialling.

DIALECT, an appellation given to the language of a province in so far as it differs from that of the whole kingdom. The term, however, is more particularly used in speaking of the ancient Greek, whereof there were four dialects, the Attic, Ionic, Æolic, and Doric; each of which was a perfect language in its kind, that took place in certain countries, and had peculiar beauties.

In Great Britain, besides, the grand diversity of English and Scotch, almost every county has a dialect of its own, all differing considerably in pronunciation, accent, and tone, although one and the same language.

DIALECTICS, in the literary history of the ancients, that branch of logic, which taught the rules and modes of reasoning. See Logic, Part III.

Zeno Eleates was the first who discovered the natural series of principles and conclusions observed in reasoning, and formed an art thereof in form of a dialogue; which, for this reasoning, was called *dialectica.*

The dialectica of the ancients is usually divided into several kinds; the first was the *eleatica*, that of Zeno Eleates, which was threefold; viz, *consecutionum*, *colloquutionum*, and *contentionum.* The first consisting of rules for deducing or drawing conclusions. The second the art of dialogue; which became of such universal use in philosophy, that all reasoning was called *interrogation*: then syllogism being laid aside, the philosophers did all by dialogue; it lying on the respondent to conclude and argue from the several concessions made. The last part of Zeno's dialectics, Εριστικη, was contentious, or the art of disputing and contradicting; though some, particularly Laertius, ascribe this part to Protagoras, a disciple of Zeno.

The second is the *dialectica megarica*, whose author is Euclid, not the mathematician, but another of Megara. He gave much into the method of Zeno and Protagoras: though there are two things appropriated to him: the first, that he impugned the demonstrations of others, not by assumptions, but conclusions; continually making illations, and proceeding from consequence to consequence: the second, that he set aside all arguments drawn from comparisons of similitude as invalid.

He was succeeded by Eubulides, from whom the sophistic way of reasoning is said to be derived. In his time the art is described as manifold: mentiens, fallens, electra, obvelata, arcevalis, cornuta and calva. See Sophism.

The third is the dialectics of Plato, which he proposes as a kind of analysis to direct the human mind, by by dividing, defining, and bringing things to the first truth; where being arrived, and stopped there a little, it applies itself to explain sensible things, but with a view to return to the first truth, where alone it can rest. Such is the idea of Plato's analysis.

The fourth is Aristotle's dialectics; containing the doctrine of simple words, delivered in his book of Prædicaments; the doctrine of propositions, in his book *De Interpretatione;* and that of the several kinds of syllogism, in his books of Analytics, Topics, and Elenchuses.

The fifth is the dialectics of the Stoics; which they call a part of philosophy, and divide into rhetoric and dialectic; to which some add the definitive, whereby things are justly defined; comprehending likewise the canons or criterions of truth.

The Stoics, before they come to treat of syllogisms, have two principal places; the one about the signification of words, the other about the things signified. On occasion of the first, they consider abundance of things belonging to the grammarian's province: what, and how many letters; what is a word, diction, speech, &c. On occasion of the latter, they consider things themselves, not as without the mind, but as in it, received in it by means of the senses. Accordingly, they first teach, that *nil sit in intellectu, quod non prius fuerit in sensu;* "whatever is in the mind came thither by the senses;" and that *aut incursione sui*, as Plato, who meets the sight; *aut similitudine*, as Cæsar by his effigy; *aut proportione*, either by enlarging as a giant, or by diminishing as a pigmy; *aut translatione*, as a Cyclops; *aut compositione*, as a Centaur; *aut contrario*, as death; *aut privatione*, as a blind man.

The sixth is Epicurus's dialectics; for though he seems to have despised dialectic, he cultivated it with vigour. He was only averse to that of the Stoics; who he thought attributed too much to it, as pronouncing him alone wise who was well versed in dialectics.

For this reason, Epicurus, seeming to set aside the common dialectics, had recourse to another way, viz. to certain canons which he substituted in their stead, the collection whereof he called *canonica;* and as all questions in philosophy are either *de re* or *de voce*, he gave separate rules for each. See EPICUREANS.

DIALIA, in antiquity, sacrifices performed by the flamen dialis. See FLAMEN.

DIALING, or DIALLING. See DIALLING.

DIALIS, in antiquity, a Latin term signifying something that belongs to Jupiter.—The word is formed from Διος, the genitive of Ζευς, *Jupiter.*

Flamen DIALIS. See FLAMEN.

DIALITHA, in the writings of the ancients, a word used to express the elegant ornaments of the Greeks and Romans, composed of gold and gems. They also called these *lithocolla*, "cemented stones or gems;" the gold being in this case as a cement to hold the stones together. They wore bracelets and other ornamental things about their habits thus made; and their cups and table-furniture, for magnificent treats, were of this kind. The green stones were found to succeed best of all in these things; and the emerald and greenish topaz, or, as we call it, chrysolite, were most in esteem for this purpose. This use of the stones explains what Pliny very often says of them in his description: *Nihil jucundius aurum decet*, "Nothing becomes gold better;" this he says of the green topaz or chrysolite; and this and many other like passages have greatly perplexed the critics, who did not hit upon this explication.

DIALLING.

THE art of drawing dials on the surface of any given body or plane. The Greeks and the Latins call this art *gnomonica* and *sciatherica*, by reason it distinguishes the hours by the shadow of the gnomon. Some call it *photo-sciatherica*, because the hours are sometimes shown by the light of the sun. Lastly, others call it *horologiography.*

1 Utility of the art. Dialling is a most necessary art: for notwithstanding we are provided with moving machines, such as clocks and watches, to show time; yet these are apt to be out of order, go wrong, and stop; consequently they stand frequently in need of regulation by some invariable instrument, as a dial; which being rightly constructed and duly placed, will always, by means of the sun, inform us of the true solar time; which time being corrected by the equation table published annually in the ephemerides, almanacks, and other books, will be the mean time to which clocks and watches are to be set.

2 History. The antiquity of dials is beyond doubt. Some attribute their invention to Anaximenes Milesius; and others to Thales. Vitruvius mentions one made by the ancient Chaldee historian Berosus, on a reclining plane, almost parallel to the equinoctial. Aristarchus Samius invented the hemispherical dial. And there were some spherical ones, with a needle for a gnomon. The discus of Aristarchus was a horizontal dial, with its limb raised up all around, to prevent the shadow stretching too far.

It was late ere the Romans became acquainted with dials. The first sun-dial at Rome was set up by Papirius Cursor, about the year of the city 460; before which time, says Pliny, there is no mention of any account of time but by the sun's rising and setting: it was set up at or near the temple of Quirinus, but went ill. About 30 years after, M. Valerius Messala being consul, brought out of Sicily another dial, which he set up on a pillar near the rostrum; but for want of its being made for that latitude, it could not go true. They made use of it 99 years; till Martius Philippus set up another more exact.

But there seem to have been dials among the Jews much earlier than any of these. Witness the dial of Ahaz: who began to reign 400 years before Alexander, and within 12 years of the building of Rome: mentioned by Isaiah, chap. xxxviii. ver. 8.

The first professed writer on dialling is Clavius; who demonstrates all, both the theory and the operations, after the rigid manner of the ancient mathematicians; but

but so intricately, that few, we dare say, ever read them all. Dechales and Ozanam gave much easier demonstrations in their *Courses*, and Wolfius in his *Elements*. M. Picard has given a new method of making large dials, by calculating the hour-lines; and M. de la Hire, in his *Dialling*, printed in 1683, a geometrical method of drawing hour-lines from certain points determined by observation. Eberhardus Welperus, in 1625, published his *Dialling*, wherein he lays down a method of drawing the primary dials on a very easy foundation. The same foundation is described at length by Sebastian Munster, in his *Rudimenta Mathematica*, published in 1551. Sturmius, in 1672, published a new edition of Welperus's *Dialling*, with the addition of a whole second part, about inclining and declining dials, &c. In 1709, the same work, with Sturmius's additions, was republished, with the addition of a fourth part, containing Picard's and de la Hire's methods of drawing large dials. Paterson, Michael, and Muller, have each wrote on dialling in the German tongue; Coetsius in his *Horologiographia Plana*, printed in 1689; Gaupennius, in his *Gnomonica Mechanica*; Bion, in his *Use of Mathematical Instruments*; the late ingenious Mr Ferguson, in his *Select Lectures*; Mr Emmerson, in his *Dialling*; and Mr W. Jones, in his *Instrumental Dialling*.

3 Definitions. A *Dial*, accurately defined, is a plane, upon which lines are described in such a manner, that the shadow of a wire, or of the upper edge of another plane, erected perpendicularly on the former, may show the true time of the day.

The edge of the plane by which the time of the day is found, is called the *stile of the dial*, which must be parallel to the earth's axis; and the line on which the said plane is erected, is called the *substile*.

The angle included between the substile and stile, is called the *elevation* or *height of the stile*.

Those dials whose planes are parallel to the plane of the horizon, are called *horizontal dials*; and those dials whose planes are perpendicular to the plane of the horizon, are called *vertical* or *erect dials*.

Those erect dials, whose planes directly front the north or south, are called *direct north* or *south dials*; and all other erect dials are called *decliners*; because their planes are turned away from the north or south.

Those dials whose planes are neither parallel nor perpendicular to the plane of the horizon, are called *inclining* or *reclining dials*, according as their planes make acute or obtuse angles with the horizon; and if their planes are also turned aside from facing the south or north, they are called *declining-inclining* or *declining-reclining dials*.

The intersection of the plane of the dial, with that of the meridian, passing through the stile, is called the *meridian of the dial*, or the *hour-line of XII*.

Those meridians, whose planes pass through the stile, and make angles of 15, 30, 45, 60, 75, and 90 degrees with the meridian of the place (which marks the hour-line of *XII*) are called *hour-circles*; and their intersections with the plane of the dial are called *hour-lines*.

In all declining dials, the substile makes an angle with the hour-line of *XII*, and this angle is called the *distance of the substile from the meridian*.

The declining plane's difference of longitude, is the angle formed at the intersection of the stile and plane of the dial, by two meridians; one of which passes through the hour-line of *XII*, and the other through the substile.

Thus much being premised concerning dials in general, we shall now proceed to explain the different methods of their construction.

Plate CLXXI. fig. 1. 4 The universal principle on which dialling depends. If the whole earth *a* P *e p* were transparent, and hollow, like a sphere of glass, and had its equator divided into 24 equal parts by so many meridian semicircles, *a*, *b*, *c*, *d*, *e*, *f*, *g*, &c. one of which is the geographical meridian of any given place, as London (which is supposed to be at the point *a*); and if the hour of *XII* were marked at the equator, both upon that meridian and the opposite one, and all the rest of the hours in order on the rest of the meridians, those meridians would be the hour-circles of London: then, if the sphere had an opaque axis, as PE*p*, terminating in the poles P and *p*, the shadow of the axis would fall upon every particular meridian and hour, when the sun came to the plane of the opposite meridian, and would consequently show the time at London, and at all other places on the meridian of London.

5 Horizontal dial. If this sphere was cut through the middle by a solid plane ABCD, in the rational horizon of London, one half of the axis EP would be above the plane, and the other half below it; and if straight lines were drawn from the centre of the plane to those points where its circumference is cut by the hour-circles of the sphere, those lines would be the hour-lines of a horizontal dial for London: for the shadow of the axis would fall upon each particular hour-line of the dial, when it fell upon the like hour-circle of the sphere.

Fig. 2. 6 Vertical dial. If the plane which cuts the sphere be upright, as AFCG, touching the given place (London) at F, and directly facing the meridian of London, it will then become the plane of an erect direct south dial: and if right lines be drawn from its centre E to those points of its circumference where the hour-circles of the sphere cut it, these will be the hour-lines of a vertical or direct south-dial for London, to which the hours are to be set as in the figure (contrary to those on a horizontal dial), and the lower half E *p* of the axis will cast a shadow on the hour of the day in this dial, at the same time that it would fall upon the like hour-circle of the sphere, if the dial plane was not in the way.

7 Inclining, reclining, and declining dials. If the plane (still facing the meridian) be made to incline or recline any given number of degrees, the hour-circles of the sphere will still cut the edge of the plane in those points to which the hour-lines must be drawn straight from the centre; and the axis of the sphere will cast a shadow on these lines at the respective hours. The like will still hold, if the plane be made to decline by any given number of degrees from the meridian towards the east or west: provided the declination be less than 90 degrees, or the reclination be less than the co-latitude of the place: and the axis of the sphere will be a gnomon or stile for the dial. But it cannot be a gnomon, when the declination is quite 90 degrees, nor when the reclination is equal to the colatitude; because in these two cases, the axis has no elevation above the plane of the dial.

And thus it appears, that the plane of every dial represents the plane of some great circle upon the earth; and the gnomon of the earth's axis, whether it be a small

small wire as in the above figures, or the edge of a thin plate, as in the common horizontal dials.

The whole earth, as to its bulk, is but a point, if compared to its distance from the sun; and therefore, if a small sphere of glass be placed upon any part of the earth's surface, so that its axis be parallel to the axis of the earth, and the sphere have such lines upon it, and such planes within it, as above described; it will show the hours of the day as truly as if it were placed at the earth's centre, and the shell of the earth were as transparent as glass.

But because it is impossible to have a hollow sphere of glass perfectly true, blown round a solid plane; or if it was, we could not get at the plane within the glass to set it in any given position; we make use of a wire-sphere to explain the principles of dialling, by joining 24 semicircles together at the poles, and putting a thin flat plate of brass within it. l. I, 2.

8
lling by
t com-
n terre-
s l globe.

A common globe of 12 inches diameter has generally 24 meridian semicircles drawn upon it. If such a globe be elevated to the latitude of any given place, and turned about until one of these meridians cut the horizon in the north point, where the hour of *XII* is supposed to be marked, the rest of the meridians will cut the horizon at the respective distances of all the other hours from *XII*. Then if these points of distance be marked on the horizon, and the globe be taken out of the horizon, and a flat board or plate be put into its place, even with the surface of the horizon; and if straight lines be drawn from the centre of the board to those points of distance on the horizon which were cut by the 24 meridian semicircles; these lines will be the hour-lines of a horizontal dial for that latitude, the edge of whose gnomon must be in the very same situation that the axis of the globe was, before it was taken out of the horizon; that is, the gnomon must make an angle with the plane of the dial equal to the latitude of the place for which the dial is made.

If the pole of the globe be elevated to the co-latitude of the given place, and any meridian be brought to the north point of the horizon, the rest of the meridians will cut the horizon in the respective distances of all the hours from *XII*, for a direct south dial, whose gnomon must be an angle with the plane of the dial, equal to the co-latitude of the place; and the hours must be set the contrary way on this dial to what they are on the horizontal.

But if your globe have more than 24 meridian semicircles upon it, you must take the following method for making *horizontal* and *south dials*.

9
To con-
st t a ho-
riz tal
di

Elevate the pole to the latitude of your place, and turn the globe until any particular meridian (suppose the first) comes to the north point of the horizon, and the opposite meridian will cut the horizon in the south. Then set the hour-index to the uppermost *XII* on its circle; which done, turn the globe westward until 15 degrees of the equator pass under the brazen meridian, and then the hour index will be at *I* (for the sun moves 15 degrees every hour), and the first meridian will cut the horizon in the number of degrees from the north point that *I* is distant from *XII*. Turn on until other 15 degrees of the equator pass under the brazen meridian, and the hour index will then be at *II*, and the first meridian will cut the horizon in the number of degrees that *II* is distant from *XII*: and so by making 15 degrees of the equator pass under the brazen meridian for every hour, the first meridian of the globe will cut the horizon in the distances of all the hours from *XII* to *VI*, which is just 90 degrees; and then you need go no farther, for the distances of *XI*, *X*, *IX*, *VIII*, *VII*, and *VI*, in the forenoon, are the same from *XII* as the distances of *I*, *II*, *III*, *IV*, *V*, and *VI*, in the afternoon: and these hour lines, continued through the centre, will give the opposite hour-lines on the other half of the dial.

Thus, to make a horizontal dial for the latitude of London, which is $51\frac{1}{2}$ degress north, elevate the north pole of the globe $51\frac{1}{2}$ degrees above the north point of the horizon; and then turn the globe until the first meridian (which is that of London on the English terrestrial globe) cuts the north point of the horizon, and set the hour-index to *XII* at noon.

Then turning the globe westward until the index points successively to *I*, *II*, *III*, *IV*, *V*, and *VI*, in the afternoon, or until 15, 30, 45, 60, 75, and 90 degrees of the equator pass under the brazen meridian, you will find that the first meridian of the globe cuts the horizon in the following number of degrees from the north towards the east, viz. $11\frac{2}{3}$, $24\frac{1}{4}$, $38\frac{1}{12}$, $53\frac{3}{2}$, $71\frac{1}{15}$, and 90; which are the respective distances of the above hours from *XII* upon the plane of the horizon.

To transfer these, and the rest of the hours, to a horizontal plane, draw the parallel right lines *a c* and *d b*, upon the plane, as far from each other as is equal to the intended thickness of the gnomon or stile of the dial, and the space included between them will be the meridian or twelve-o'clock line on the dial. Cross this meridian at right angles with the six-o'clock line *g h*, and setting one foot of your compasses in the intersection *a*, as a centre, describe the quadrant *g e* with any convenient radius or opening of the compasses; then, setting one foot in the intersection *b*, as a centre, with the same radius describe the quadrant *f h*, and divide each quadrant into 90 equal parts or degrees, as in the figure. Fig. 3.

Because the hour-lines are less distant from each other about noon, than in any other part of the dial, it is best to have the centres of these quadrants at a little distance from the centre of the dial plane, on the side opposite to *XII*, in order to enlarge the hour-distances thereabouts, under the same angles on the plane. Thus the centre of the plane is at C, but the centres of the quadrants are at *a* and *b*.

Lay a ruler over the point *b* (and keeping it there for the centre of all the afternoon hours in the quadrant *f h*) draw the hour-line of *I* through $11\frac{2}{3}$ degrees in the quadrant; the hour-line of *II*, through $24\frac{1}{4}$ degrees; of *III*, through $38\frac{1}{12}$ degrees; *IIII*, through $53\frac{1}{2}$; and *V*, through $71\frac{1}{15}$: and because the sun rises about four in the morning, on the longest day, at London, continue the hour-lines of *IIII* and *V* in the afternoon through the centre *b* to the opposite side of the dial.— This done, lay the ruler to the centre *a* of the quadrant *c g*; and through the like divisions or degrees of that quadrant, viz. $11\frac{2}{3}$, $24\frac{1}{4}$, $38\frac{1}{11}$, $53\frac{1}{2}$, and $71\frac{1}{15}$, draw the forenoon hour-lines of *XI*, *X*, *IX*, *VIII*, and *VII*, and because the sun sets not before eight in the evening on the longest day, continue the hour-lines of *VII* and *VIII* in the forenoon, through the centre *a*, to Fig. 3.

VII:

VII and *VIII* in the afternoon; and all the hour-lines will be finished on this dial; to which the hours may be set, as in the figure.

Lastly, through 51½ degrees of either quadrant, and from its centre, draw the right line *a g* for the hypothenuse or axis of the gnomon *a g i;* and from *g*, let fall the perpendicular *g i*, upon the meridian line *a i*, and there will be a triangle made, whose sides are *a g*, *g i*, and *i a*. If a plate similar to this triangle be made as thick as the distance between the lines *a c* and *b d*, and set upright between them, touching at *a* and *b*, its hypothenuse *a g* will be parallel to the axis of the world, when the dial is truly set; and will cast a shadow on the hour of the day.

N. B. The trouble of dividing the two quadrants may be saved if you have a scale with a line of chords upon it (as represented in the plate); for if you extend the compasses from 0 to 60 degrees of the line of chords, and with that extent, as a radius, describe the two quadrants upon their respective centres, the above distances may be taken with the compasses upon the lines, and set off upon the quadrants.

Fig. 4.
10
An erect south dial.

To make an erect direct south dial. Elevate the pole to the co-latitude of your place, and proceed in all respects as above taught for the horizontal dial from *VI* in the morning to *VI* in the afternoon; only the hours must be reversed as in the figure; and the hypothenuse *a g* of the gnomon *a g f*, must make an angle with the dial-plane equal to the co-latitude of the place. As the sun can shine no longer on this dial than from six in the morning until six in the evening, there is no occasion for having any more than 12 hours upon it.

¶ 11
Erect declining dial.

To make an erect dial, declining from the south towards the east or west. Elevate the pole to the latitude of your place, and screw the quadrant of altitude to the zenith. Then, if your dial declines towards the east (which we shall suppose it to do at present), count in the horizon the degrees of declination, from the east point towards the north, and bring the lower end of the quadrant to that degree of declination at which the reckoning ends. This done, bring any particular meridian of your globe (as suppose the first meridian) directly under the graduated edge of the upper part of the brazen meridian, and set the hour to *XII* at noon. Then, keeping the quadrant of altitude at the degree of declination in the horizon, turn the globe eastward on its axis, and observe the degrees cut by the first meridian in the quadrant of altitude (counted from the zenith) as the hour-index comes to *XI, X, IX*, &c. in the forenoon, or as 15, 30, 45, &c. degrees of the equator pass under the brazen meridian at these hours respectively; and the degrees then cut in the quadrant by the first meridian, are the respective distances of the forenoon hours from *XII* on the plane of the dial.—Then, for the afternoon hours, turn the quadrant of altitude round the zenith, until it comes to the degree in the horizon opposite to that where it was placed before; namely, as far from the west point of the horizon towards the south, as it was set at first from the east point towards the north; and turn the globe westward on its axis, until the first meridian comes to the brazen meridian again, and the hour index to *XII:* then, continue to turn the globe westward; and as the index points to the afternoon hours *I, II, III*, &c. or as 15, 30, 45, &c. degrees of the equator pass under the brazen meridian, the first meridian will cut the quadrant of altitude in the respective number of degrees from the zenith that each of these hours is from *XII* on the dial.—And note, that when the first meridian goes off the quadrant at the horizon in the forenoon, the hour-index shows the time when the sun will come upon this dial; and when it goes off the quadrant in the afternoon, the index will point to the time when the sun goes off the dial.

Having thus found all the hour-distances from *XII*, lay them down upon your dial-plane, either by dividing a semicircle into two quadrants of 90 degrees each (beginning at the hour-line of *XII*), or by the line of chords, as above directed.

In all declining dials, the line on which the stile or gnomon stands (commonly called the *substile-line*) makes an angle with the twelve o'clock line, and falls among the forenoon hour-lines, if the dial declines towards the east; and among the afternoon hour-lines, when the dial declines towards the west; that is, to the left hand from the twelve o'clock line in the former case, and to the right hand from it in the latter.

To find the distance of the substile from the twelve o'clock line; if your dial declines from the south toward the east, count the degrees of that declination in the horizon from the east point towards the north, and bring the lower end of the quadrant of altitude to that degree of declination where the reckoning ends: then turn the globe until the first meridian cuts the horizon in the like number of degrees, counted from the south points towards the east; and the quadrant and first meridian will then cross one another at right angles; and the number of degrees of the quadrant, which are intercepted between the first meridian and the zenith, is equal to the distance of the substile line from the twelve o'clock line; and the number of degrees of the first meridian, which are intercepted between the quadrant and the north pole, is equal to the elevation of the stile above the plane of the dial.

If the dial declines westward from the south, count that declination from the east point of the horizon towards the south, and bring the quadrant of altitude to the degree in the horizon at which the reckoning ends; both for finding the forenoon hours and distance of the substile from the meridian: and for the afternoon hours, bring the quadrant to the opposite degree in the horizon, namely, as far from the west towards the north, and then proceed in all respects as above.

Thus we have finished our declining dial; and in so doing we made four dials, viz.

1. A north dial, declining eastward by the same number of degrees. 2. A north dial, declining the same number west. 3. A south dial, declining east. And, 4. A south dial, declining west. Only, placing the proper number of hours, and the stile or gnomon respectively, upon each plane. For (as above-mentioned) in the south-west plane, the substilar line falls among the afternoon hours; and in the south-east, of the same declination, among the forenoon hours, at equal distances from *XII*. And so all the morning hours on the west decliner will be like the afternoon hours on the east decliner: the south-east decliner will produce the north-west decliner; and the south-west decliner the north-east decliner, by only extending the hour-lines

hour-lines, stile and substile, quite through the centre: the axis of the stile (or edge that casts the shadow on the hour of the day) being in all dials whatever parallel to the axis of the world, and consequently pointing towards the north pole of the heaven in north latitudes, and towards the south pole in south latitudes.

12 easy hod for struct- of dials.

But because every one who would like to make a dial, may perhaps not be provided with a globe to assist him, and may probably not understand the method of doing it by logarithmic calculation; we shall show how to perform it by the plain dialling lines, or scale of latitudes and hours (as represented on the Plate), and which may be had on scales commonly sold by the mathematical-instrument-makers.

This is the easist of all mechanical methods, and by much the best, when the lines are truly divided: and not only the half-hours and quarters may be laid down by all of them, but every fifth minute by most, and every single minute by those where the line of hours is a foot in length.

5.

Having drawn your double meridian line *a b*, *c d*, fig. 5. on the plane intended for a horizontal dial, and crossed it at right angles by the six o'clock line *f e* (as in fig. 3.), take the latitude of the place with your compasses, in the scale of latitudes, and set that extent from *c* to *e*, and from *a* to *f*, on the six o'clock line: then, taking the whole six hours between the points of the compasses in the scale of hours, with that extent set one foot in the point *c*, and let the other foot fall where it will upon the meridian line *c d*, as at *d*. Do the same from *f* to *b*, and draw the right lines *e d* and *f b*, each of which will be equal in length to the whole scale of hours. This done, setting one foot of the compasses in the beginning of the scale at *XII*, and extending the other to each hour of the scale, lay off these extents from *d* to *e* for the afternoon hours, and from *b* to *f* for those of the forenoon: this will divide the lines *d e* and *b f* in the same manner as the hour-scale is divided at 1, 2, 3, 4, and 6; on which the quarters may also be laid down, if required. Then, laying a ruler on the point *c*, draw the first five hours in the afternoon, from that point, through the dots at the numeral figures, 1, 2, 3, 4, 5, on the line *d e*; and continue the lines of *IIII* and *V* through the centre *c* to the other side of the dial, for the like hours of the morning: which done, lay the ruler on the point *a*, and draw the last five hours in the forenoon through the dots, 5, 4, 3, 2, 1, on the line *f b*; continuing the hour-lines of *VII* and *VIII* through the centre *a* to the other side of the dial, for the like hours of the evening; and set the hours to their respective lines, as in the figure. Lastly, make the gnomon the same way as taught above for the horizontal dial, and the whole will be finished.

To make an erect south dial; take the co-latitude of your place from the scale of latitudes, and then proceed in all respects for the hour-line as in the horizontal dial; only reversing the hours, as in fig. 4. and making the angle of the stile's height equal to the co-latitude.

But, lest the young diallist should have neither globe nor wooden scale, we shall now show him how he may make a dial without any of these helps. Only, if he has not a line of chords, he must divide a quadrant into 90 equal parts or degrees for taking the proper angle of the stile's elevation; which is easily done.

Fig. 6.

13 Horizontal dial.

With any opening of the compasses, as ZL, fig. 6. describe the two semicircles LF*k* and LQ*k*, upon the centres Z and *z*, where the six o'clock line crosses the double meridian line, and divide each semicircle into 12 equal parts, beginning at L (though, strictly speaking, only the quadrants from L to the six o'clock line need be divided); then connect the divisions which are equidistant from L, by the parallel lines KM, IN, HO, GP, and FQ. Draw VZ for the hypothenuse of the stile, making the angle VZE equal to the latitude of your place; and continue the line VZ to R. Draw the line R*r* parallel to the six o'clock line; and set off the distance *a*K from Z to Y, the distance *b*I from Z to X, *c*H from Z to W, *d*G from Z to T, and *e*F from Z to S. Then draw the lines S*s*, T*t*, W*w*, X*x*, and Y*y*, each parallel to R*r*. Set off the distance *y*Y from *a* to 11, and from *f* to 1; the distance *x*X from *b* to 10, and from *g* to 2; *w*W from *c* to 9, and from *h* to 3; *t*T from *d* to 8, and from *i* to 4; *s*S from *e* to 7, and from *n* to 5. Then laying a ruler to the centre Z, draw the forenoon hour lines through the points 11, 10, 9, 8, 7; and laying it to the centre *z*, draw the afternoon lines through the points 1, 2, 3, 4, 5; continuing the forenoon lines of *VII* and *VIII* through the centre Z, to the opposite side of the dial, for the like afternoon hours; and the afternoon lines *IIII* and *V* through the centre *z*, to the opposite side, for the like morning hours. Set the hours to these lines as in the figure, and then erect the stile or gnomon, and the horizontal dial will be finished.

To construct a south dial draw the line VZ, making an angle with the meridian ZL equal to the co-latitude of your place; and proceed in all respects as in the above horizontal dial for the same latitude, reversing the hours as in fig. 4. and making the elevation of the gnomon equal to the co-latitude.

Perhaps it may not be unacceptable to explain the method of constructing the dialling lines, and some others; which is as follows:

14 Dialling lines, how constructed. Fig. 7.

With any opening of the compasses, as EA, fig. 7. according to the intended length of the scale, describe the circle ADCB, and cross it at right angles by the diameters CEA and DEB. Divide the quadrant AB first into 9 equal parts, and then each part into 10: so shall the quadrant be divided into 90 equal parts or degrees. Draw the right line AFB for the chord of this quadrant; and setting one foot of the compasses in the point A, extend the other to the several divisions of the quadrant, and transfer these divisions to the line AFB by the arcs 10, 10, 20, 20, &c. and this will be a line of chords, divided into 90 unequal parts; which, if transferred from the line back again to the quadrant, will divide it equally. It is plain by the figure that the distance from A to 60 in the line of chords, is just equal to AE, the radius of the circle from which that line is made; for if the arc 60, 60, be continued, of which A is the centre, it goes exactly through the centre D of the arc AB.

And therefore, in laying down any number of degrees on a circle, by the line of chords, you must first open the compasses so as to take in just 60 degrees upon

upon that line as from A to 60: and then, with that extent, as a radius, describe a circle, which will be exactly of the same size with that from which the line was divided: which done, set one foot of the compasses in the beginning of the chord line, as at A, and extend the other to the number of degrees you want upon the line; which extent, applied to the circle, will include the like number of degrees upon it.

Divide the quadrant CD into 90 equal parts, and from each point of division draw right lines, as *i k l*, &c. to the line CE, all perpendicular to that line, and parallel to DE, which will divide EC into a line of sines: and although these are seldom put among the dialling lines on a scale, yet they assist in drawing the line of latitudes. For if a ruler be laid upon the point D, and over each division in the line of sines, it will divide the quadrant CB into 90 unequal parts, as B *a*, B *b*, &c. shown by the right lines 10 *a*, 20 *b*, 30 *c*, &c. drawn along the edge of the ruler. If the right line BC be drawn, subtending this quadrant, and the nearest distances B *a*, B *b*, B *c*, &c. be taken in the compasses from B, and set upon this line in the same manner as directed for the line of chords, it will make a line of latitudes BC, equal in length to the line of chords AB, and of an equal number of divisions, but very unequal as to their lengths.

Draw the right line DGA, subtending the quadrant DA; and parallel to it, draw the right line *r s*, touching the quadrant DA at the numeral figure 3. Divide this quadrant into six equal parts, as 1, 2, 3, &c. and through these points of division draw right lines from the centre E to the line *r s*, which will divide it at the points where the six hours are to be placed, as in the figure. If every sixth part of the quadrant be subdivided into four equal parts, right lines drawn from the centre through these points of division, and continued to the line *r s*, will divide each hour upon it into quarters.

Fig. 8.

15
A dial on a card.

In fig. 8. we have the representation of a portable dial, which may be easily drawn on a card, and carried in a pocket-book. The lines *a d*, *a b*, and *b c* of the gnomon, must be cut quite through the card; and as the end *a b* of the gnomon is raised occasionally above the plane of the dial, it turns upon the uncut line *c d* as on a hinge. The dotted line AB must be slit quite through the card, and the thread C must be put through the slit, and have a knot tied behind, to keep it from being easily drawn out. On the other end of this thread is a small plummet D, and on the middle of it a small bead for showing the hour of the day.

To rectify this dial, set the thread in the slit right against the day of the month, and stretch the thread from the day of the month over the angular point where the curve lines meet at *XII*; then shift the bead to that point on the thread, and the dial will be rectified.

To find the hour of the day, raise the gnomon (no matter how much or how little) and hold the edge of the dial next the gnomon towards the sun, so as the uppermost edge of the shadow of the gnomon may just cover the *shadow line*; and the bead then playing freely on the face of the dial, by the weight of the plummet, will show the time of the day among the hour lines, as it is forenoon or afternoon.

To find the time of sun-rising and setting, move the thread among the hour-lines, until it either covers some one of them, or lies parallel betwixt any two; and then it will cut the time of sun-rising among the forenoon hours, and of sun-setting among the afternoon hours, for that day of the year to which the thread is set in the scale of months.

To find the sun's declination, stretch the thread from the day of the month over the angular point at XII, and it will cut the sun's declination, as it is north or south, for that day, in the proper scale.

To find on what days the sun enters the signs, when the bead, as above rectified, moves along any of the curve-lines which have the signs of the zodiac marked upon them, the sun enters those signs on the days pointed out by the thread in the scale of months.

The construction of this dial is very easy, especially if the reader compares it all along with fig. 9. Plate CLXXII. as he reads the following explanation of that figure.

Plate CLXXII. fig. 9.

Draw the occult line AB (fig. 9.) parallel to the top of the card, and cross it at right angles with the six o'clock line ECD; then upon C, as a centre, with the radius CA, describe the semicircle AEL, and divide it into 12 equal parts (beginning at A), as A *r*, A *s*, &c. and from these points of division draw the hour-lines *r*, *s*, *t*, *u*, *v*, E, *w*, *x*, all parallel to the six o'clock line EC. If each part of the semicircle be subdivided into four equal parts, they will give the half-hour lines and quarters, as in fig. 2. Draw the right line ASD*o*, making the angle SAB equal to the latitude of your place. Upon the centre A describe the arch RST, and set off upon it the arcs SR and ST, each equal to 23½ degrees, for the sun's greatest declination; and divide them into 23½ equal parts, as in fig. 2. Through the intersection D of the lines ECD and AD*o*, draw the right line FDG at right angles to AD*o*. Lay a ruler to the points A and R, and draw the line ARF through 23½ degrees of south declination in the arc SR; and then laying the ruler to the points A and T, draw the line ATG through 23½ degrees of north declination in the arc ST: so shall the lines ARF and ATG cut the line FDG in the proper lengths for the scale of months. Upon the centre D, with the radius DF, describe the semicircle F*o*G; which divide into six equal parts, F*m*, *m n*, *n o*, &c. and from these points of division draw the right lines *m h*, *n i*, *p k*, and *q l*, each parallel to *o*D. Then setting one foot of the compasses in the point F, extend the other to A, and describe the arc AZH for the tropic of ♑; with the same extent, setting one foot in G, describe the arc AEO for the tropic of ♋. Next setting one foot in the point *h*, and extending the other to A, describe the arc ACI for the beginnings of the signs ♒ and ♐; and with the same extent, setting one foot in the point *l*, describe the arc AN for the beginnings of the signs ♊ and ♌. Set one foot in the point *i*, and having extended the other to A, describe the arc AK for the beginnings of the signs ♓ and ♏; and with the same extent, set one foot in *k*, and describe the arc AM for the beginnings of the signs ♉ and ♍. Then setting one foot in the point D, and extending the other to A, describe the curve AL for the beginnings of ♈ and ♎; and the signs will be finished. This done, lay a ruler from the point A over the sun's declination in the arch RST; and where the ruler cuts the line EDG, make marks:

Fig 9 compared with fig. 8.

marks: and place the days of the months right against these marks, in the manner shown by fig. 2. Lastly, draw the shadow line PQ parallel to the occult line AB; make the gnomon, and set the hours to their respective lines, as in fig. 2. and the dial will be finished.

16 niversal ials. There are several kinds of dials called *universal*, because they serve for all latitudes. One, of Mr Pardie's construction, was formerly considered as the best. It consists of three principal parts; the first whereof is called the horizontal plane, A fig. 10. because in practice it must be parallel to the horizon. In this plane is fixed an upright pin, which enters into the edge of the second part BD, called the meridional plane; which is made of two pieces, the lowest whereof B is called the *quadrant*, because it contains a quarter of a circle, divided into 90 degrees; and it is only into this part, near B, that the pin enters. The other piece is a semicircle D adjusted to the quadrant, and turning in it by a groove, for raising or depressing the diameter EF of the semicircle, which diameter is called the *axis of the instrument*. The third piece is a circle G, divided on both sides into 24 equal parts, which are the hours. This circle is put upon the meridional plane so that the axis EF may be perpendicular to the circle, and the point C be the common centre of the circle, semicircle, and quadrant. The straight edge of the semicircle is chamfered on both sides to a sharp edge, which passes through the centre of the circle. On one side of the chamfered part, the first six months of the year are laid down, according to the sun's declination for their respective days, and on the other side the last six months. And against the days on which the sun enters the signs, there are straight lines drawn upon the semicircle, with the characters of the signs marked upon them. There is a black line drawn along the middle of the upright edge of the quadrant, over which hangs a thread H, with its plummet I, for levelling the instrument. *N. B.* From the 23d of September to the 20th of March, the upper surface of the circle must touch both the centre C of the semicircle, and the line of ♈ and ♎; and from the 20th of March to the 23d of September, the lower surface of the circle must touch that centre and line.

Plate CLXXII. fig. 10.

To find the time of the day by this dial. Having set it on a level place in sunshine, and adjusted it by the levelling screws *k* and *l*, until the plumb-line hangs over the back line upon the edge of the quadrant, and parallel to the said edge; move the semicircle in the quadrant, until the line of ♈ and ♎ (where the circle touches) comes to the latitude of your place in the quadrant: then turn the whole meridional place BD, with its circle G, upon the horizontal plane A, until the edge of the shadow of the circle fall precisely on the day of the month in the semicircle; and then the meridional plane will be due north and south, the axis EF will be parallel to the axis of the world, and will cast a shadow upon the true time of the day among the hours on the circle.

N. B. As, when the instrument is thus rectified, the quadrant and semicircle are in the plane of the meridian, so the circle is then in the plane of the equinoctial. Therefore, as the sun is above the equinoctial in summer (in northern latitudes), and below it in winter; the axis of the semicircle will cast a shadow on the hour of the day, on the upper surface of the circle, from the 20th of March till the 23d of September; and from the 23d of September to the 20th of March, the hour of the day will be determined by the shadow of the semicircle upon the lower surface of the circle. In the former case, the shadow of the circle falls upon the day of the month, on the lower part of the diameter of the semicircle; and in the latter case, on the upper part.

The method of laying down the months and signs upon the semicircle is as follows: Draw the right line ACB, fig. 11. equal to the diameter of the semicircle ADB, and cross it in the middle at right angles with the line ECD, equal in length to ADB; then EC will be the radius of the circle FCG, which is the same as that of the semicircle. Upon E, as a centre, describe the circle FCG, on which set off the arcs C *h* and C *i*, each equal to 23½ degrees, and divide them accordingly into that number for the sun's declination. Then laying the edge of a ruler over the centre E, and also over the sun's declination for every fifth day of each month (as in the card-dial), mark the points on the diameter AB of the semicircle from *a* to *g*, which are cut by the ruler; and *there* place the days of the months accordingly, answering to the sun's declination. This done, setting one foot of the compasses in C, and extending the other to *a* or *g*, describe the semicircle *a b c d e f g*; which divide into six equal parts, and through the points of division draw right lines parallel to CD, for the beginning of the sines (of which one half are on one side of the semicircle, and the other half on the other), and set the characters of the sines to their proper lines, as in the figure,

An universal dial, of a very ingenious construction, has lately been invented by Mr G. Wright of London. The hour-circle or arch E, (fig. 19.), and latitude arch C, are the portions of two meridian circles; one fixed, and the other moveable. The hour or dial-plate SEN at top is fixed to the arch C, and has an index that moves with the hour-circle E; therefore the construction of this dial is perfectly similar to the construction of the meridians and hour-circle upon a common globe. The peculiar problems to be performed by this instrument are, 1. *To find the latitude of any place.* 2. *The latitude of the place being known, to find the time by the sun and stars.* 3. *To find the sun or star's azimuth and altitude.* 17 A new one by Mr G. Wright. Plate CLXXIII. fig. 19.

Previous to use, this instrument should be in a well-adjusted state: to perform which, you try the levels of the horizontal plates A *a*, by first turning the screws BBBB till the bubbles of air in the glass tubes of the spirit-levels (which levels are at right angles to each other) are central or in the middle, and remain so when you turn the upper plate A half round its centre; but if they should not keep so, there are small screws at the end of each level, which admit of being turned one way or the other as may be requisite, till they are so. The plates A *a* being thus made horizontal, set the latitude arch or meridian C steadily between the two grooved sides that hold it (one of which is seen at D) by the screw behind. On this side D is divided the nonius or vernier, corresponding with the divisions on the latitude arch C, and which may be subdivided into 5 minutes of a degree, and even less if required. The latitude arch C is to be so placed in D, that the pole

pole M may be in a vertical position; which is done by making 90° on the arch at bottom coincide with the 0 of the nonius. The arch is then fixed by the tightening screw at the back of D. Hang a silken plumb-line on the hook at G; which line is to coincide with a mark at the bottom of the latitude arch at H, all the while you move the upper plate A round its centre. If it does not so, there are four screws to regulate this adjustment, two of which pass through the base I into the plate A; the other two screws fasten the nonius piece D together; which when unscrewed a thread or two, the nonius piece may be easily moved to the right or left of 90° as may be found requisite.

Prob. 1. *To find the latitude of the place.* Fasten the latitude and hour circles together, by placing the pin K into the holes; slide the nonius piece E on the hour-circle to the sun's declination for the given day: the sun's declination you may know in the ephemeris by White, or other almanacks, for every day in the year. The nonius piece E must be set on that portion of the hour-circle marked ND or SD, according as the sun has north or south declination. About 20 minutes or a quarter of an hour before noon, observe the sun's shadow or spot that passes through the hole at the axis O, and gently move the latitude arch C down in its groove at D, till you observe the spot exactly fall on the cross line on the centre of the nonius piece at L; and by the falling of this spot, so long as you observe the sun to increase in altitude, you depress the arch C: but at the instant of its stationary appearance the spot will appear to go no lower; then fix the arch by the screw at the back of D, and the degrees thereby cut by the nonius on the arch will be the latitude of the place required: if great exactness is wanted, allowance should be made for the refraction of the atmosphere, taken from some nautical or astronomical treatise.

Prob. 2. *The latitude of the place being given, to find the time by the sun or stars.* From an ephemeris, as before, you find the sun's declination for the day north or south, and set the nonius piece E on the arch accordingly. Set the latitude arch C, by the nonius at D, to the latitude of the place; and place the magnifying glass at M, by which you will very correctly set the index carrying a nonius to the upper *XII* at S. Take out the pin K, slacken the horizontal screw N, and gently move, either to the right or left as you see necessary, the hour-circle E, at the same time with the other hand moving the horizontal plate A round its axis to the right and left, till the latitude arch C fall into the meridian; which you will know by the sun's spot falling exactly in the centre of the nonius piece, or where the lines intersect each other. The time may be now read off exactly to a minute by the nonius on the dial-plate at top, and which will be the time required. The horizontal line drawn on the nonius piece L, not seen in the figure, being the parallel of declination, or path that the sun-dial makes, therefore can fall on the centre of that line at no other time but when the latitude arch C is in the meridian, or due north and south. Hence the hour-circle, on moving round with the pole, must give the true time on the dial-plate at top. There is a hole to the right, and cross hairs to the left; of the centre axis hole O, where the sun's rays pass through; whence the sun's shadow or spot will also appear on the right and left of the centre on the nonius piece L, the holes of which are occasionally used as sights to observe through. If the sun's rays are too weak for a shadow, a dark glass to screen the eye is occasionally placed over the hole. The most proper time to find a true meridian is three or four hours before or after noon; and take the difference of the sun's declination from noon at the time you observe. If it be the morning, the difference is that and the preceding day; if afternoon, that and the following day; and the meridian being once found exact, the hour-circle E is to be brought into this meridian, a fixed place made for the dial, and an object to observe by it also fixed for it at a great distance. The sights LO must at all times be directed against this fixed object, to place the dial truly in the meridian, proper for observing the planets, moon, or bright stars, by night.

Prob. 3. *To find the sun's azimuth and altitude.* The latitude arch C being in the meridian, bring the pole M into the zenith, by setting the latitude arch to 90°. Fasten the hour-circle E in the meridian by putting in the pin K; fix the horizontal plates by the screw N; and set the index of the dial-plate to *XII*, which is the south point: Now take out the pin K, and gently move the hour-circle E; leaving the latitude arch fixed, till the sun's rays or spot passing through the centre hole in the axis O fall on the centre line of the hour-circle E, made for that purpose. The *azimuth* in time may be then read off on the dial-plate at top by the magnifying glass. This time may be converted into degrees, by allowing at the rate of 15 for every hour. By sliding the nonius piece E, so that the spot shall fall on the cross line thereon, the altitude may be taken at the same time if it does not exceed 45 degrees. Or the altitude may be taken more universally, by fixing the nonius piece E to the 0 on the divisions, and sliding down the latitude arch in such a manner in the groove at D, till the spot falls exactly on the centre of the nonius E. The degrees and minutes then shown by the nonius at D, taken from 90, will be the altitude required. By looking through the sight-holes LO, the altitude of the moon, planets, and stars, may be easily taken. Upon this principle it is somewhat adapted for levelling also; by lowering the nonius piece E, equal altitudes of the sun may be had; and by raising it higher, equal depressions.

More completely to answer the purposes of a good theodolite, of levelling, and the performance of problems in practical astronomy, trigonometry, &c. the horizontal plate D is divided into 360°, and an opposite nonius on the upper plate A, subdividing the degrees into 5 or more minutes. A telescope and spirit-level applies on the latitude arch at HG by two screws, making the latitude arch a vertical arch; and the whole is adapted to triangular staffs with parallel plates, similar to those used with the best theodolites.

18
An equinoctial dia
more universal.

Plate
CLXXIII
fig. 20.

A dial more universal for the performance of problems than the above, though in some particulars not so convenient and accurate, has been invented by some instrument-makers. It consists of the common equatorial circles reduced to a portable size, and instead of a telescope carries a plain sight. Its principal parts consist of the sight-piece OP, fig. 20. moveable over the declination's semicircle D. It has a nonius Q to the

semicircle.

semicircle. A dark glass to skreen the eye applies occasionally over either of the holes at O; these holes on the inner side of the piece are intersected by cross lines, as seen in the figure below; and to the sight P two pieces are screwed, the lower having a small hole for the sun's rays or shadow, and the upper two cross hairs or wires.

The declination circle or arch D is divided into two, 90° each; and is fixed perpendicularly on a circle with a chamfered edge, containing a nonius division that subdivides into single minutes the under equatorial circle MN, which in all cases represents the equator, and is divided into twice 12 hours, and each hour into five minutes. At right angles below this equatorial circle is fixed the semicircle of altitude AB, divided into two quadrants of 90° each. This arch serves principally to measure angles of altitude and depression; and it moves centrally on an upright pillar fixed in the horizontal circle EF. This circle EF is divided into four quadrants of 90° each, and against it there is fixed a small nonius plate at N. The horizontal circle may be turned round its centre or axis; and two spirit levels LL are fixed on it at right angles to one another.

We have not room to detail the great variety of astronomical and trigonometrical problems, that may be solved by this general instrument, which is described in Jones's "Instrumental Dialling." One example connected with our present purpose may here suffice, viz. *To find the time when the latitude is given.* Supposing the instrument to be well adjusted by the directions hereafter given: The meridian of the place should be first obtained to place the instrument in, which is settled by a distant mark, or particular cavities to receive the screws at IGH, made in the base it stands on. The meridian is best found by equal altitudes of the sun. In order to take these, you set the middle mark of the nonius on the declination arch D at 0, and fix it by the screw behind; then set the horary or hour-circle to *XII.* The circle EF being next made horizontal, you direct the sights to the sun, by moving the horizontal circle EF and altitude semicircle AB: the degrees and minutes marked by the nonius on the latter will be the altitude required. To take *equal* altitudes, you observe the sun's altitude in the morning two or three hours before noon by the semicircle AB: leave the instrument in the same situation perfectly unaltered till the afternoon, when, by moving the horizontal circle EF, only find the direction of the sight or the sun's spot to be just the same, which will be an equal altitude with the morning. The place of the horizontal circle EF against the nonius at each time of observation is to be carefully noted; and the middle degree or part between each will be the place where the semicircle AB, and sight OP, will stand or coincide with, when directed to the south or north, (according to the sun's situation north or south at noon at the place of observation. Set the index, or sight-piece OP, very accurately to this middle point, by directing the sight to some distant object; or against it, let one be placed up; this object will be the meridian mark, and will always serve at any future time. To find the time, the meridian being thus previously known by equal altitudes of the sun (or star), and determined by the meridian mark made at a distance, or by the cavities in the base to set the screw in: Place the equatorial accordingly, and level the horizontal circle EF by the spirit-levels thereon. Set the semicircle AB to the latitude of the place, and the index of the sights OP to the declination of the sun, found by the ephemeris, as before directed. Turn the semicircle D till the sight holes are accurately directed to the sun, when the nonius on the hour-circle MN will show the time. It may easily be known when the sun's rays are direct through, by the spot falling on the lower intersectors of the marks across the hole at O. See the figure S adjoining.

The adjustments of this equatorial dial are to be made from the following trials. 1st, To adjust the levels LL on EF: Place the 0 of any of the divisions on EF to the middle mark or stroke on the nonius at N: bring the air-bubbles in the levels in the centres of each case, by turning the several screws at IGH: this being exactly done, turn the circle EF to 90° or half round: if the bubble of the air then remains in the centre, they are right, and properly adjusted for use; but if they are not, you make them so by turning the necessary screws placed for that purpose at the ends of the level-cases by means of a turn-screw, until you bring them to that fixed position, that they will return when the plate EF is turned half round. 2dly, To adjust the line of sight OP: Set the nonius to 0 on the declination arch D, the nonius on the hour-circle to *VI*, and the nonius on the semicircle AB to 90°. Direct to some part of the horizon where there may be a variety of fixed objects. Level the horizontal circle EF by the levels LL, and observe any object that may appear on the centre of the cross wires. Reverse the semicircle AB, viz. so that the opposite 90° of it be applied to the nonius, observing particularly that the other nonii preserve their situation. If then the remote object formerly viewed still continues in the centre of the cross wires, the line of sight OP is truly adjusted; but if not, unscrew the two screws of the frame carrying the cross wires, and move the frame till the intersection appears against another or new object, which is half way between the first and that which the wires were against on the reversion. Return the semicircle AB to its former position; when, if the intersection of the wires be found to be against the half-way object, or that to which they were last divided, the line of sight is adjusted; if not, the operation of observing the interval of the two objects, and applying half way, must be repeated.

It is necessary to observe, that one of the wires should be in the plane of the declination circle, and the other wire at right angles; the frame containing the wires is made to shift for that purpose.

The hole at P which forms the sun's spot is also to be adjusted by directing the sight to the sun, that the centre of the shadow of the cross hairs may fall exactly on the upper hole; the lower frame with the hole is then to be moved till the spot falls exactly on the lower sight-hole.

Lastly, it is generally necessary to find the correction always, to be applied to the observations by the semicircle of altitude AB. Set the nonius to 0 on the declination arch D, and the nonius to *XII* on the equator or hour-circle: Turn the sight to any fixed and distinct object, by moving the arch AB and circle EF only: Note the degree and minute of the angle of altitude or depression: Reverse the declination semicircle

circle by placing the nonins on the hour-circle to the opposite *XII:* Direct the sight to the same object again as before. If the altitude or depression now given be the same as was observed in the former position, no correction is wanted; but if not the same, half the difference of the two angles is the correction to be added to all observations or rectifications made with that quadrant by which the least angle was taken, or to be subtracted from all observations made with the other quadrant. These several adjustments are absolutely necessary previous to the use of the instrument; and when once well done, will keep so, with care, a considerable time.

19 Universal ring-dial. Fig. 21, 22, 23. Plate CLXXIII.

The *Universal* or *Astronomical Equinoctial Ring-Dial*, is an instrument of an old construction, that also serves to find the hour of the day in any latitude of the earth (see fig. 21.). It consists of two flat rings or circles, usually from 4 to 12 inches diameter, and of a moderate thickness; the outward ring AE representing the meridian of the place it is used at, contains two divisions of 90° each opposite to one another, serving to let the sliding piece H, and ring G (by which the dial is usually suspended), be placed on one side from the equator to the north pole, and on the other side to the south, according to the latitude of the place. The inner ring B represents the equator, and turns diametrically within the outer by means of two pivots inserted in each end of the ring at the hour *XII.*

Across the two circles is screwed to the meridian a thin pierced plate or bridge, with a cursor C, that slides along the middle of the bridge: this cursor has a small hole for the sun to shine through. The middle of this bridge is conceived as the axis of the world, and its extremities as the poles: on the one side are delineated the 12 signs of the zodiac, and sometimes opposite the degrees of the sun's declination; and on the other side the days of the month throughout the year. On the other side of the outer ring A are the divisions of 90°, or a quadrant of altitude: It serves, by the placing of a common pin P in the hole *h* (see fig. 22.), to take the sun's altitude or height, and from which the latitude of the place may easily be found.

20 Its use.

Use of the Dial. Place the line *a* in the middle of the sliding piece H over the degree of latitude of the place. Suppose, for example, 51½ for London; put the line which crosses the hole of the cursor C to the day of the month or the degree of the sign. Open the instrument till the two rings be at right angles to each other, and suspend it by the ring G; that the axis of the dial represented by the middle of the bridge be parallel to the axis of the earth, viz. the north pole to the north, and *vice versa*. Then turn the flat side of the bridge towards the sun, so that his rays passing through the small hole in the cursor may fall exactly in a line drawn through the middle of the concave surface of the inner ring or hour-circle, the bright spot by which shows the hour of the day in the said concave surface of the dial. *Note*, The hour *XII* cannot be shown by this dial, because the outer ring being then in the plane of the meridian, excludes the sun's rays from the inner; nor can this dial show the hour when the sun is in the equinoctial, because his rays then falling parallel to the plane of the inner circle or equinoctial, are excluded by it.

To take the altitude of the sun by this dial, and with the declination thereby to find the *latitude of the place.* Place a common pin P in the hole *h*, projecting in the side of the meridian where the quadrant of altitude is; then bring the centre mark of the sliding piece H to the o or middle of the two divisions of latitude on the other side, and turn the pin towards the sun till it cuts a shadow over the degree of the quadrant of altitude; then what degree the shadow cuts is the altitude. Thus, in fig. 22. the shadow *hg* appears to cut 35°, the altitude of the sun.

The sun's *declination* is found by moving the cursor in the sliding piece till the mark across the hole stands just against the day of the month; then, by turning to the other side of the bridge, the mark will stand against the sun's declination.

In order to find the *altitude* of the place, observe that the latitude and the declination be the same, viz. both north or south; subtract the declination from the meridian or greatest daily altitude of the sun, and the remainder is the complement of the latitude; which subtracted from 90°, leaves the latitude.

Example.

	Deg.	Min.
The meridian altitude may be	57	48
The sun's declination for the day	19	18
Complement of latitude	38	30
	90	0
The latitude	51	30

But if the latitude and declination be contrary, add them together, and the sum is the complement of the latitude. This dial is sometimes mounted on a stand, with a compass, two spirit levels, and adjusting screws, &c. &c. (see fig. 23.), by which it is rendered more useful and convenient for finding the sun's azimuth, altitudes, variation of the needle, declinations of planes, &c. &c.

21 Universal cross-dial. Fig. 24, 2 26.

An *Universal Dial on a plain cross*, is described by Mr Ferguson. It is moveable on a joint C, for elevating it to any given latitude on the quadrant C *o* 90, as it stands upon the horizontal board A. The arms of the cross stand at right angles to the middle part; and the top of it from *a* to *n*, is of equal length with either of the arms *n e* or *m k*. See fig. 24.

This dial is rectified by setting the middle line *tu* to the latitude of the place on the quadrant, the board A level, and the point N northward by the needle; thus, the plane of the cross will be parallel to the plane of the equator. Then, from *III* o'clock in the morning till *VI*, the upper edge *k l* of the arm *io* will cast a shadow on the time of the day on the side of the arm *c m*; from *VI* till *IX*, the lower edge *i* of the arm *i o* will cast a shadow on the hours on the side *o q*; from *IX* in the morning to *XII* at noon, the edge *a b* of the top part *a n* will cast a shadow on the hours on the arm *n e f*; from *XII* to *III* in the afternoon, the edge *c d* of the top part will cast a shadow on the hours on the arm *k l m*; from *III* to *VI* in the evening the edge *g h* will cast a shadow on the hours on the part *p q*; and from *VI* till *IX*, the shadow of the

the edge *e f* will show the time on the top part *a n*. The breadth of each part, *a b*, *e f*, &c. must be so great, as never to let the shadow fall quite without the part or arm on which the hours are marked, when the sun is at his greatest declination from the equator.

g. 25.

To determine the breadth of the sides of the arms which contain the hours, so as to be in just proportion to their length; make an angle ABC (fig. 25.) of $23\frac{1}{2}$ degrees, which is equal to the sun's greatest declination; and suppose the length of each arm, from the side of the long middle part, and also the length of the top part above the arms, to be equal to B *d*. Then, as the edges of the shadow, from each of the arms, will be parallel to B *e*, making an angle of $23\frac{1}{2}$ degrees with the side B *d* of the arm, when the sun's declination is $23\frac{1}{2}°$, it is plain, that if the length of the arm be B *d*, the least breadth that it can have, to keep the edge B *e* of the shadow B *e g d* from going off the side of the arm *d e* before it comes to the end of it *e d*, must be equal to *e d* or *d* B. But in order to keep the shadow within the quarter divisions of the hours, when it comes near the end of the arm, the breadth of it should be still greater, so as to be almost doubled, on account of the distance between the tips of the arms.

The hours may be placed on the arms, by laying down the cross *a b c d* (fig. 26.) on a sheet of paper; and with a black lead pencil held close to it, drawing its shape and size on the paper. Then take the length *a e* in the compasses, and with one foot in the corner *a*, describe with the other the quadrant *e f*. Divide this arc into six equal parts, and through the points of division draw right lines *a g*, *a h*, &c. continuing three of them to the arm *c e*, which are all that can fall upon it; and they will meet the arm in those points through which the lines that divide the hours from each other, as in fig. 24. are to be drawn right across it. Divide each arm, for the three hours contained in it, in the same manner; and set the hours to their proper places, on the sides of the arms, as they are marked in fig. 33. Each of the hour spaces should be divided into four equal parts, for the half hours and quarters, in the quadrant *e f*; and right lines should be drawn through these division-marks in the quadrant, to the arms of the cross, in order to determine the places thereon where the subdivisions of the hours must be marked.

This is a very simple kind of universal dial; it is easily made, and has a pretty uncommon appearance in a garden.

22
E y me-
th of
dr ving a
di by the
u ersal
m anical
di
Fi 27.

Fig. 27. is called an *Universal Mechanical Dial*, as by its equinoctial circle an easy method is had of describing a dial on any kind of plane. For example: Suppose a dial is required on an horizontal plane. If the plane be immoveable, as ABCD (fig. 27.), find a meridian line as GF; or if moveable, assume the meridian at pleasure: then by means of the triangle EKF, whose base is applied on the meridian line, raise the equinoctial dial H till the index GI becomes parallel to the axis of the earth, (which is so, if the angle KEF be equal to the elevation of the pole), and the 12 o'clock line on the dial hand over the meridian line of the plane or the base of the triangle. If then, in the night time or a darkened place, a lighted candle be successively applied to the axis GI, so as the shadow of the index or stile GI falls upon one hour-line after another, the same shadow will mark out the several hour-lines on the plane ABCD. Noting the points therefore on the shadow, draw lines through them to G; then an index being fixed on G, according to the angle IGF, its shadow will point out the several hours by the light of the sun. If a dial were required on a vertical plane, having raised the equinoctial circle as directed, push forward the index GI till the tip thereof I touch the plane. If the plane be inclined to the horizon, the elevation of the pole should be found on the same; and the angle of the triangle KEF should be made equal thereto.

23
Dials on
threeplanes
by one gno-
mon.
Fig. 28.

Mr Ferguson describes a method of making *three dials on three different planes, so that they may all show the time of the day by one gnomon.* On the flat board ABC (fig. 28.), describe an horizontal dial, with its gnomon FGH, the edge of the shadow of which shows the time of the day. To this horizontal board join the upright board EDC, touching the edge GH of the gnomon; then making the top of the gnomon at G the centre of the vertical south dial, describe it on the board EDC. Besides, on a circular plate IK describe an equinoctial dial, and by a slit *c d* in the *XII* o'clock line from the edge to the centre, put it on the gnomon EG as far as the slit will admit. The same gnomon will show the same hour on each of these dials.

Plate
CLXXII.
fig. 16.

An Universal Dial, showing the hours of the day by a terrestrial globe, and by the shadows of several gnomons, at the same time: together with all the places of the earth which are then enlightened by the sun; and those to which the sun is then rising, or on the merdian, or setting. This dial is made of a thick square piece of wood, or hollow metal. The sides are cut into semicircular hollows, in which the hours are placed; the stile of each hollow coming out from the bottom thereof, as far as the ends of the hollows project. The corners are cut out into angles; in the insides of which the hours are also marked; and the edge of the end of each side of the angle serves as a stile for casting a shadow on the hours marked on the other side.

In the middle of the uppermost side, or plane, there is an equinoctial dial; in the centre whereof an upright wire is fixed, for casting a shadow on the hours of that dial, and supporting a small terrestrial globe on its top.

The whole dial stands on a pillar in the middle of a round horizontal board, in which there is a compass and magnetic needle, for placing the meridian stile toward the south. The pillar has a joint with a quadrant upon it, divided into 90 degrees (supposed to be hid from sight under the dial in the figure) for setting it to the latitude of any given place.

The equator of the globe is divided into 24 equal parts, and the hours are laid down upon it at these parts. The time of the day may be known by these hours, when the sun shines upon the globe.

To rectify and use this dial, set it on a level table, or sole of a window, where the sun shines, placing the meridian stile due south, by means of the needle; which will be, when the needle points as far from the north fleur-de-lis towards the west, as it declines westward, at your place. Then bend the pillar in the joint, till the black

black line on the pillar comes to the latitude of your place in the quadrant.

The machine being thus rectified, the plane of its dial part will be parallel to the equator, the wire or axis that supports the globe will be parallel to the earth's axis, and the north pole of the globe will point toward the north pole of the heavens.

The same hour will then be shown in several of the hollows, by the ends of the shadows of their respective stiles; the axis of the globe will cast a shadow on the same hour of the day, in the equinoctial dial, in the centre of which it is placed, from the 20th of March to the 23d of September: and if the meridian of your place on the globe be set even with the meridian stile, all the parts of the globe that the sun shines upon will answer to those places of the real earth which are then enlightened by the sun. The places where the shade is just coming upon the globe answer to all those places of the earth to which the sun is then setting; as the places where it is going off, and the light coming on, answer to all the places of the earth where the sun is then rising. And lastly, if the hour of *VI* be marked on the equator in the meridian of your place (as it is marked on the meridian of London in the figure), the division of the light and shadow on the globe will show the time of the day.

The northern stile of the dial (opposite to the southern or meridian one) is hid from the sight in the figure, by the axis of the globe. The hours in the hollow to which that stile belongs are also supposed to be hid by the oblique view of the figure; but they are the same as the hours in the front hollow. Those also in the right and left hand semicircular hollows are mostly hid from sight; and so also are all those on the sides next the eye of the four acute angles.

The construction of this dial is as follows:

Plate CLXXII. fig. 17.

On a thick square piece of wood, or metal, draw the lines *a c* and *b d*, fig. 17. as far from each other as you intend for the thickness of the stile *a b c d*; and in the same manner draw the like thickness of the other three stiles *e f g h*, *i k l m*, and *n o p q*, all standing outright as from the centre.

With any convenient opening of the compasses, as *a* A, (so as to have proper strength of stuff when KI is equal to *a* A), set one foot on *a* as a centre, and with the other foot describe the quadrantal arc A *c*. Then, without altering the compasses, set one foot on *b* as a centre, and with the other foot describe the quadrant *d* B. All the other quadrants in the figure must be described in the same manner, and with the same opening of the compasses, on their centres *e f i k*, and *n o*; and each quadrant divided into six equal parts, for as many hours, as in the figure; each of which parts must be subdivided into 4, for the half hours and quarters.

At equal distances from each corner, draw the right lines I *p* and K *p*, I *q* and M *q*, N *r* and O *r*, P *s* and Q *s*; to form the four angular hollows I *p* K, L *q* M, N *r* O, and P *s* Q; making the distances between the tips of these hollows, as I K, L M, N O, and P Q, each equal to the radius of the quadrants; and leaving sufficient room within the angular points *p q r* and *s*, for the equinoctial in the middle.

To divide the inside of these angles properly for the hour spaces thereon, take the following method. Set one foot of the compasses in the point I as a centre, and open the other to K; and with that opening describe the arc K *t*; then, without altering the compasses, set one foot in K, and with the other foot describe the arc I *t*. Divide each of these arcs, from I and K to their intersection at *t*, into four equal parts; and from their centres I and K, through the points of division, draw the right lines I 3, I 4, I 5, I 6, I 7 and K 2, K 1, K 12, K 11; and they will meet the sides K *p* and I *p* of the angle I *p* K where the hours thereon must be placed. And these hour spaces in the arc must be sbudivided into four equal parts, for the half hours and quarters. Do the like for the other three angles, and draw the dotted lines, and set the hours in the insides where those lines meet them, as in the figure; and the like hour-lines will be parallel to each other in all the quadrants and in all the angles.

Mark points for all these hours on the upper side; and cut out all the angular hollows and the quadrantal ones quite through the places where their four gnomons must stand; and lay down the hours on their insides (as in fig. 18.), and set in their gnomons, which must be as broad as the dial is thick; and this breadth and thickness must be large enough to keep the shadows of the gnomons from ever falling quite out at the sides of the hollows, even when the sun's declination is at the greatest.

Lastly, Draw the equinoctial dial at the middle, all the hours of which are equidistant from each other; and the dial will be finished.

As the sun goes round, the broad end of the shadow of the stile *a b c d* will show the hours in the quadrant A *c* from sunrise till *VI* in the morning: the shadow from the end M will show the hours on the side L *q* from *V* to *IX* in the morning; the shadow of the stile *e f g h* in the quadrant D *g* (in the long days) will show the hours from sunrise till *VI* in the morning; and the shadow of the end N will show the morning hours on the side O *r* from *III* to *VII*.

Just as the shadow of the northern stile *a b c d* goes off the quadrant A *c*, the shadow of the southern stile *i k l m* begins to fall within the quadrant F *l*, at *VI* in the morning; and shows the time, in that quadrant, from *VI* till *XII* at noon; and from noon till *VI* in the evening in the quadrant *m* E. And the shadow of the end O shows the time from *XI* in the forenoon till *III* in the afternoon, on the side *r* N; as the shadow on the end P shows the time from *IX* in the morning till *I* o'clock in the afternoon, on the side Q *s*.

At noon, when the shadow of the eastern stile *e f g h* goes off the quadrant *h* C (in which it showed the time from *VI* in the morning till noon, as it did in the quadrant *g* D from sunrise till *VI* in the morning), the shadow of the western stile *n o p q* begins to enter the quadrant H *p*, and shows the hours thereon from *XII* at noon till *VI* in the evening; and after *that* till sunset, in the quadrant *q* G, and the end Q casts a shadow on the side P*s* from *V* in the evening till *IX* at night, if the sun be not set before that time.

The shadow of the end I shows the time on the side K *p* from *III* till *VII* in the afternoon; and the shadow of the stile *a b c d* shows the time from *VI* in the evening till the sun sets.

The shadow of the upright central wire, that supports

ports the globe at top, shows the time of the day, in the middle or equinoctial line, all the summer half-year, when the sun is on the north side of the equator.

Having shown how to make sun-dials by the assistance of a good globe, or of a dialling scale, we shall now proceed to the method of constructing dials arithmetically; which will be more agreeable to those who have learned the elements of trigonometry, becauses globes and scales can never be so accurate as the logarithms in finding the angular distance of the hours. Yet as a globe may be found exact enough for some other requisites in dialling, we shall take it occasionally.

The construction of sun-dials on all planes whatever may be included in one general rule; intelligible, if that of a horizontal dial for any given latitude be well understood. For there is no plane, however obliquely situated with respect to any given place, but what is parallel to the horizon of some other place; and therefore, if we can find that other place by a problem on the terrestrial globe, or by a trigonometrical calculation, and construct a horizontal dial for it, that dial applied to the plane where it is to serve will be a true dial for that place. Thus, an erect direct south dial in 51½ degrees north latitude, would be a horizontal dial on the same meridian, 90 degrees southward of 51½ degrees of north latitude. But if the upright plane declines from facing the south at the given place, it would still be a horizontal plane 90 degrees from that place, but for a different longitude, which would alter the reckoning of the hours accordingly.

Case I. 1. Let us suppose that an upright plane at London declines 36 degrees westward from facing the south, and that it is required to find a place on the globe to whose horizon the said plane is parallel; and also the difference of longitude between London and that place.

Rectify the globe to the latitude of London, and bring London to the zenith under the brass meridian; then that point of the globe which lies in the horizon at the given degree of declination (counted westward from the south point of the horizon) is the place at which the above-mentioned plane would be horizontal. —Now, to find the latitude and longitude of that place keep your eye upon the place, and turn the globe eastward until it comes under the graduated edge of the brass meridian; then the degree of the brass meridian that stands directly over the place in its latitude, and the number of degrees in the equator, which are intercepted between the meridian of London and the brass meridian, is the place's difference of longitude.

Thus, as the latitude of London is 51½ degrees north, and the declination of the place is 36 degrees west; elevate the north pole 51½ degrees above the horizon, and turn the globe until London comes to the zenith, or under the graduated edge of the meridian; then count 36 degrees on the horizon westward from the south point, and make a mark on that place of the globe over which the reckoning ends, and bringing the mark under the graduated edge of the brass meridian, it will be found to be under 30¼ degrees in south latitude; keeping it there, count in the equator the number of degrees between the meridian of London and the brazen meridian (which now becomes the meridian of the required place), and you will find it to be 42¾. Therefore an upright plane at London, declining 36 degrees westward from the south, would be a horizontal plane at that place, whose latitude is 30¼ degrees south of the equator, and longitude 42¾ degrees west of the meridian of London.

Which difference of longitude being converted into time, is 2 hours 51 minutes.

The vertical dial declining westward 36 degrees at London, is therefore to be drawn in all respects as a horizontal dial for south latitude 30¼ degrees; save only that the reckoning on the hours is to anticipate the reckoning on the horizontal dial by 2 hours 51 minutes; for so much sooner will the sun come to the meridian of London, than to the meridian of any place whose longitude is 42¾ degrees west from London.

2. But to be more exact than the globe will show us, we shall use a little trigonometry.

Plate CLXXII. fig. 12.

Let NESW (fig. 12.) be the horizon of London, whose zenith is Z, and P the north pole of the sphere; and let Z*h* be the position of a vertical plane at Z, declining westward from S (the south) by an angle of 36 degrees; on which plane an erect dial for London at Z is to be described. Make the semidiameter ZD perpendicular to Z*h*; and it will cut the horizon in D, 36 degrees west of the south S. Then a plane, on the tangent HD, touching the sphere in D, will be parallel to the plane Z*h*; and the axis of the sphere will be equally inclined to both these planes.

Let WQE be the equinoctial, whose elevation above the horizon of Z (London) is 38½ degrees; and PRD be the meridian of the place D, cutting the equinoctial in R. Then it is evident, that the arc RD is the latitude of the place D (where the plane K*h* would be horizontal) and the arc RQ is the difference of longitude of the plane Z*h* and DH.

In the spherical triangle WDR, the arc WD is given, for it is the complement of the plane's declination from S to south; which complement is 54° (viz. 90°—36°); the angle at R, in which the meridian of the place D cuts the equator, is a right angle; and the angle RWD measures the elevation of the equinoctial above the horizon of Z, namely 38½ degrees. Say therefore, as radius is to the co-sine of the plane's declination from the south, so is the co-sine of the latitude of Z to the sine of RD the latitude of D; which is of a different denomination from the latitude of Z, because Z and D are on different sides of the equator.

As radius - -	10.00000
To co-sine 36° 0′=RQ	9.90796
So co-sine 51° 30′=QZ	9.79415

To sine 30° 14′=DR (9.70211) = the latitude of D, whose horizon is parallel to the vertical plane Z *h* at Z.

N. B. When radius is made the first term, it may be omitted; and then by subtracting it mentally from the sum of the other two, the operation will be shortened. Thus, in the present case,

To

To the logarithmic sine of WR=[*] 54° 0′ 9.90796
Add the logarithmic sine of RD=[†] 38° 30′ 9.79415

Their sum—radius - - - 9.70211

gives the same solution as above. And we shall keep to this method in the following part of this article.

To find the difference of longitude of the places D and Z, say, As radius is to the co-sine of 38½ degrees, the height of the equinoctial at Z, so is the co-tangent of 36 degrees, the plane's declination, to the co-tangent of the difference of longitudes. Thus,

To the logarithmic sine of [‡] 51° 30′ 9.89354
Add the logarithmic tang. of [§] 54° 0′ 10.13874

Their sum—radius - - - 10.03228

is the nearest tangent of 47° 8′=WR: which is the co-tangent of 42° 52′=RQ, the difference of longitude sought. Which difference, being reduced to time, is 2 hours 51½ minutes.

3. And thus having found the exact latitude and longitude of the place D, to whose horizon the vertical plane at Z is parallel, we shall proceed to the construction of a horizontal dial for the place D, whose latitude is 38° 14′ south; but anticipating the time at D by 2 hours 51 minutes (neglecting the ½ minute in practice), because D is so far westward in longitude from the meridian of London; and this will be a true vertical dial at London, declining westward 36 degrees.

Fig. 13. Assume any right line CSL (fig. 13.) for the substile of the dial, and make the angle KCP equal to the latitude of the place (viz. 30° 14′), to whose horizon the plane of the dial is parallel; then CRP will be the axis of the stile, or edge that casts the shadow on the hours of the day, in the dial. This done, draw the contingent line EQ, cutting the substilar line at right angles in K; and from K make KR perpendicular to the axis CRP. Then KG (=KR) being made radius, that is, equal to the chord of 60° or tangent of 45° on a good sector, take 42° 52′ (the difference of longitude of the places Z and D) from the tangents, and having set it from K to M, draw CM for the hour-line of *XII*. Take KN, equal to the tangent of an angle less by 15 degrees than KM; that is, the tangent of 27° 52′: and through the point N draw CN for the hour-line of *I*. The tangent of 12° 52′ (which is 15° less than 27° 42′), set off the same way, will give a point between K and N, through which the hour-line of *II* is to be drawn. The tangent of 2° 8′, (the difference between 45° and 52° 52′) placed on the other side of CL, will determine the point through which the hour-line of *III* is to be drawn: to which 2° 8′, if the tangent of 15° be added, it will make 17° 8′; and this set off from K towards Q on the line EQ, will give the point for the hour-line of *IV*; and so of the rest.—The forenoon hour-lines are drawn the same way, by the continual addition of the tangents 15°, 30°, 45°, &c. to 42° 52′ (= the tangents of KM) for the hours of *XI*, *X*, *IX*, &c. as far as necessary; that is, until there be five hours on each side of the substile. The sixth hour, counted from that hour or part of the hour on which the substile falls, will be always in a line perpendicular to the substile, and drawn through the centre C.

4. In all erect dials, CM, the hour-line of *XII*, is perpendicular to the horizon of the place for which the dial is to serve; for that line is the intersection of a vertical plane with the plane of the meridian of the place, both which are perpendicular to the plane of the horizon: and any line HO or *ho*, perpendicular to CM, will be a horizontal line on the plane of the dial, along which line the hours may be numbered; and CM being set perpendicular to the horizon, the dial will have its true position.

5. If the plane of the dial had declined by an equal angle towards the east, its description would have differed only in this, that the hour-line of *XII* would have fallen on the other side of the substile CL, and the line HO would have a subcontrary position to what it has in this figure.

6. And these two dials, with the upper points of their stiles turned toward the north pole, will serve for other two planes parallel to them; the one declining from the north toward the east, and the other from the north toward the west, by the same quantity of angle. The like holds true of all dials in general, whatever be their declination and obliquity of their planes to the horizon.

Case II. 7. If the plane of the dial not only declines, but also reclines, or inclines. Suppose its declination from fronting the south S (fig. 14.) be equal Fig. 14. to the arc SD on the horizon; and its reclination be equal to the arc D*d* of the vertical circle DZ: then it is plain, that if the quadrant of altitude Z*d*D on the globe cuts the point D in the horizon, and the reclination is counted upon the quadrant from D to *d*: the intersection of the hour-circle PR*d*, with the equinoctial WQE, will determine R*d*, the latitude of the place *d*, whose horizon is parallel to the given plane Z*h* at Z; and RQ will be the difference in longitude of the places at *d* and Z.

Trigonometrically thus: Let a great circle pass through the three points, W, *d*, E; and in the triangle WD*d*, right-angled at D, the sides WD and D*d* are given; and thence the angle DW*d* is found, and so is the hypothenuse W*d*. Again, the difference, or the sum, of DW*d* and DWR, the elevation of the equinoctial above the horizon of Z, gives the angle *d*WR; and the hypothenuse of the triangle WR*d* was just now found; whence the sides R*d* and WR are found, the former being the latitude of the place *d*, and the latter the complement of RQ, the difference of longitude sought.

Thus, if the latitude of the place Z be 52° 10′ north; the declination SD of the plane Z*h* (which would be horizontal at *d*) be 36°, and the reclination be 15°, or equal to the arc D*d*; the south latitude of the place *d*, that is, the arc R*d*, will be 15° 9′; and RQ the difference

---

[*] The co-sine of 36.0, or of RQ. [†] The co-sine of 51.30, or of QZ. [‡] The co-sine of 38.30, or of WDR. [§] The co-tangent of 36.0, or of DW.

difference of the longitude, 36° 2′. From these data, therefore, let the dial (fig. 15.) be described, as in the former example.

8. There are several other things requisite in the practice of dialling; the chief of which shall be given in the form of arithmetical rules, simple and easy to those who have learned the elements of trigonometry. For in practical arts of this kind, arithmetic should be used as far as it can go; and scales never trusted to, except in the final construction, where they are absolutely necessary in laying down the calculated hour-distances on the plane of the dial.

Rule I. *To find the angles which the hour-lines on any dial make with the substile.* To the logarithmic sine of the given latitude, or of the stile's elevation above the plane of the dial, add the logarithmic tangent of the hour (*) distance from the meridian, or from the (†) substile; and the sum minus radius will be the logarithmic tangent of the angle sought.

For KC (fig. 13.) is to KM in the ratio compounded of the ratio of KC to KG (=KR) and of KG to KN; which making CK the radius 10,000000, or 10,0000, or 10, or 1, are the ratio of 10,000000, or of 10,0000, or of 10, or of 1, to KG×KM.

Thus, in a horizontal dial, for latitude 51° 30′, to find the angular distance of *XI* in the forenoon, or *I* in the afternoon, from *XII*.

To the logarithmic sine of 51° 30′	9.89354 ‡
Add the logarithmic tang. of 51° 0′	9.42805
The sum —radius is - -	9.32159=the

logarithmic tangent of 11° 50′, or of the angle which the hour-line of *XI* or *I* makes with the hour of *XII*.

And by computing in this manner, with the sine of the latitude, and the tangents of 30, 45, 60, and 75°, for the hours of *II, III, IIII,* and *V* in the afternoon; or of *X, IX, VIII,* and *VII* in the forenoon; you will find their angular distances from *XII* to be 24° 18′, 38° 3′, 53° 35′, and 71° 6′; which are all that there is occasion to compute for.—And these distances may be set off from *XII* by a line of chords; or rather, by taking 1000 from a scale of equal parts, and setting that extent as a radius from C to *XII;* and then, taking 209 of the same parts (which are the natural tangent of 11° 50′), and setting them from *XII* to *XI* and *I*, on the line *h o*, which is perpendicular to C *XII;* and so for the rest of the hour lines, which, in the table of natural tangents, against the above distances, are 451, 782, 1355, and 2920, of such equal parts from *XII*, as the radius C *XII* contains 1000. And lastly, set off 1257 (the natural tangent of 51° 30′) for the angle of the stile's height, which is equal to the latitude of the place.

Rule II. *The latitude of the place, the sun's declination, and his hour distance from the meridian, being given, to find* (1.) *his altitude,* (2.) *his azimuth.* (1.) Let d (fig. 14.) be the sun's place, dR his declination; and in the triangle PZd, Pd, the sum, or the difference, of dR, and the quadrant PR, being given by the supposition, as also the complement of the latitude PZ, and the angle dPZ, which measures the horary distance of d from the meridian; we shall (by Case 4. of Keill's Oblique Spheric Trigonometry) find the base Zd, which is the sun's distance from the zenith, or the complement of his altitude.

And (2.) as sine Zd : sine Pd :: sine dPZ : dZP, or of its supplement DZS, the azimuthal distance from the south.

Or the practical rule may be as follows:

Write A for the sine of the sun's altitude, L and l for the sine and co-sine of the latitude, D and d for the sine and co-sine of the sun's declination, and H for the sine of the horary distance from *VI*.

Then the relation of H to A will have three varieties.

1. When the declination is toward the elevated pole, and the hour of the day is between *XII* and *VI;* it is

$$A=LD+Hld, \text{ and } H=\frac{A-LD}{ld}.$$

2. When the hour is after *VI*, it is $A=LD-Hld$, and $H=\frac{LD+A}{ld}$.

3. When the declination is toward the depressed pole, we have $A=Hld-LD$, and $H=\frac{A+LD}{ld}$.

Which theorems will be found useful, and expeditious enough for solving those problems in geography and dialling which depend on the relations of the sun's altitude to the hour of the day.

Example I. Suppose the latitude of the place to be 51½ degrees north: the time 5 hours distant from *XII*, that is, an hour after *VI* in the morning, or before *VI* in the evening; and the sun's declination 20° north. *Required the sun's altitude?*

Then to log. L=log. sin. 51° 30′	1.89354**
add log. D=log. sin. 20° 0′	1.53405
Their sum	1.42759 gives

LD=logarith. of 0.267664, in the natural sines.

And,

(*) That is, of 15, 30, 45, 60, 75°, for the hours of *I, II, III, IIII,* and *V*, in the afternoon; and *XI, X, IX, VIII, VII,* in the forenoon.

(†) In all horizontal dials and erect north or south dials, the substile and meridian are the same; but in all declining dials the substile line makes an angle with the meridian.

(‡) In which case the radius CK is supposed to be divided into 10,0000 equal parts.

** Here we consider the radius as unity, and not 10,0000: but which, instead of the index 9, we have —1 as above; which is of no farther use than making the work a little easier.

And, to log. H= log. sin. †† 15° 0′ 1.41300

add { log. l= log. sin. ‡‡ 38° 0′ 1.79414
 log. d= log. sin. §§ 70° 0′ 1.97300

Their sum 1.18014 gives

$H\,l\,d$=logarithm of 0.151408, in the natural sines.

And these two numbers (0.267664 and 0.151408) make 0.419072=A; which, in the table, is the nearest natural sine of 24° 47′, the sun's altitude sought.

The same hour distance being assumed on the other side of *VI*, then LD—$H\,l\,d$ is 0.116256, the sine of 6° 40½′; which is the sun's altitude at *V* in the morning, or *VII* in the evening, when his north declination is 20°.

But when the declination is 20° south (or towards the depressed pole) the difference $H\,l\,d$—LD becomes negative; and thereby shows, that an hour before *VI* in the morning, or past *VI* in the evening, the sun's centre is 6° 40½′ below the horizon.

Examp. 2. From the same *data*, to find the sun's *azimuth*. If H, L, and D, are given, then (by par. 2. of Rule II.) from H having found the altitude and its complement Zd; and the arc Pd (the distance from the pole) being given; say, As the co-sine of the altitude is to the sine of the distance from the pole, so is the sine of the hour-distance from the meridian to the sine of the azimuth distance from the meridian.

Let the latitude be 51° 30′ north, the declination 15° 9′ south, and the time *II* h. 24 m. in the afternoon, when the sun begins to illuminate a vertical wall, and it is required to find the position of the wall.

Then, by the foregoing theorems, the complement of the altitude will be 81° 32½′, and Pd the distance from the pole being 109° 5′, and the horary distance from the meridian, or the angle dPZ, 36°,

To log. sin. 74° 51′ - - 1.98464
Add log. sin. 36° 0′ - - 1.76922

And from the sum - 1.75386
Take the log. sin. 81° 32½′ 1.99525

Remains 1.75861=log. sin. 35°, the azimuth distance sought.

When the altitude is given, find from thence the hour, and proceed as above.

This praxis is of singular use on many occasions:—in finding the declination of vertical planes more exactly than in the common way, especially if the transits of the sun's centre are observed by applying a ruler with sights, either plain or telescopical, to the wall or plane whose declination is required:—in drawing a meridian line, and finding the magnetic variation:—in finding the bearings of places in terrestrial surveys; the transits of the sun over any place, or his horizontal distance from it, being observed, together with the altitude and hour; and thence determining small differences of longitude:—in observing the variations at sea, &c.

24 Improved declinator.

The *declination*, *inclination*, and *reclination* of planes, are frequently taken with a sufficient degree of accuracy by an instrument called a *declinator* or *declinatory*.

Plate CLXXIV. fig. 34.

The construction of this instrument is as follows: On a mahogany board ABIK, (fig. 34.) is inserted a semicircular arch AGEB of ivory or box-wood, divided into two quadrants of 90° each, beginning from the middle G. On the centre C turns a vertical quadrant DFE divided into 90°, beginning from the base E; on which is a moveable index CF, with a small hole at F for the sun's rays to pass through, and form a spot on a mark at C. The lower extremity of the quadrant at E is pointed, to mark the linear direction of the quadrant when applied to any other plane; as this quadrant takes off occasionally, and a plumb-line P hangs at the centre on C, for taking the inclinations and reclinations of planes. At H, on the plane of the board, is inserted a compass of points and degrees, with a magnetical needle turning on a pivot over it. The addition of the moveable quadrant and index considerably extend the utility of the declinator, by rendering it convenient for taking *equal altitudes* of the sun, the sun's altitude and bearing, at the same time, &c.

25 To take by it the declination, &c. and to find a meridian line

To apply this instrument in taking the declination of a wall or plane: Place the side ACB in a horizontal direction to the plane proposed, and observe what degree or point of the compass the N part of the needle stands over from the north or the south, and it will be the *declination* of the plane from the north or south accordingly. In this case allowance must be made for the variation of the needle (if any) at the place; and which, if not previously known, will render this operation very inaccurate. At London it is now 20° 30′ to the west.

Another way more exact may be used, when the sun shines out half an hour before noon. The side ACB being placed against the plane, the quadrant must be so moved on the semicircle AGB, and the index CF on DE, till the sun's rays passing through the hole at F fall exactly on the mark at G, and continued so till the sun requires the index to be raised no higher: you will then have the meridian or greatest altitude of the sun; and the angle contained between G and E will be the declination required. The position of CE is the meridian or 12 o'clock line. But the most exact way for taking the declination of a plane, or finding a meridian line, by this instrument, is, in the forenoon, about two or three hours before 12 o'clock, to observe two or three heights or altitudes EF of the sun; and at the same time the respective angular polar distance GE from G: write them down; and in the afternoon watch for the same, or one of the same altitudes, and mark the angular distances or distance on the quadrant AG. Now, the division or degree exactly *between* the two noted angular distances will be the true meridian, and the distance at which it may fall from the C of the divisions at G will be the declination of the plane. The reason for observing two

---

†† The distance of one hour from VI.

‡‡ The co-latitude of the place.

§§ The co-declination of the sun.

two or three altitudes and angles in the morning is, that in case there should be clouds in the afternoon, you may have the chance of one corresponding altitude.

The quadrant occasionally takes off at C, in order to place it on the surface of a pedestal or plane intended for an horizontal dial; and thereby from equal altitudes of the sun, as above, draw a meridian or 12 o'clock line to set the dial by.

The base ABIK serves to take the inclination and reclination of planes. In this case, the quadrant is taken off, and the plummet P is fitted on a pin at the centre C: then the side IGK being applied to the

g. 35. plane proposed, as QL (fig. 35.) if the plumb-line cuts the semicircle in the point G, the plane is horizontal; or if it cut the quadrant in any point at S, then will GCS be the angle of inclination. Lastly, if applying the side ACB to the plane, the plummet cuts G, the plane is vertical; or if it cuts either of the quadrants, it is accordingly the angle of reclination. Hence, if the quantity of the angle of inclination be compared with the elevation of the pole and equator, it is easily known whether the plane be inclined or reclined.

Of the double Horizontal Dial, and the Babylonian *and* Italian *Dials.*

To the *gnomonic* projection, there is sometimes added a *stereographic* projection of the hour-circles, and the parallels of the sun's declination, on the same horizontal plane; the upright side of the gnomon being sloped into an edge, standing perpendicularly over the centre of the projection; so that the dial, being in its due position, the shadow of *that* perpendicular edge is a vertical circle passing through the sun, in the stereographic projection.

The months being duly marked on this dial, the sun's declination, and the length of the day at any time, are had by inspection (as also his latitude, by means of a scale of tangents). But its chief property is, that it may be placed true, whenever the sun shines, without the help of any other instrument.

Plate XXII. g. 14. Let *d* (fig. 14.) be the sun's place in the stereographic projection, *x d y z* the parallel of the sun's declination, Z *d* a vertical circle through the sun's centre, P *d* the hour-circle; and it is evident, that the diameter NS of this projection being placed duly north and south, these three circles will pass through the point *d*. And therefore, to give the dial its due position, we have only to turn its gnomon toward the sun, on a horizontal plane, until the hour on the common gnomonic projection coincides with that marked by the hour-circle P *d*, which passes through the intersection of the shadow Z *d* with the circle of the sun's present declination.

The Babylonian and Italian dials reckon the hours, not from the meridian as with us, but from the sun's rising and setting. Thus, in Italy, an hour before sunset is reckoned the 23d hour; two hours before sunset the 22d hour; and so of the rest. And the shadow that marks them on the hour-lines, is *that* of the point of a stile. This occasions a perpetual variation between their dials and clocks, which they must correct from time to time, before it arises to any sensible quantity, by setting their clocks so much faster or slower. And in Italy, they begin their day, and regulate their clocks, not from sunset, but from about mid-twilight, when the *Ave-Maria* is said; which corrects the difference that would otherwise be between the clock and the dial.

The improvements which have been made in all sorts of instruments and machines for measuring time, have rendered such dials of little account. Yet, as the theory of them is ingenious, and they are really, in some respects, the best contrived of any for vulgar use, a general idea of their description may not be unacceptable.

Let fig. 16. represent an erect direct south wall, on which a Babylonian dial is to be drawn, showing the hours from sun-rising; the latitude of the place, whose horizon is parallel to the wall, being equal to the angle KCR. Make, as for a common dial, KG=KR (which is perpendicular to CR) the radius of the equinoctial ÆQ, and draw RS perpendicular to CK for the stile of the dial; the shadow of whose point R is to mark the hours, when SR is set upright on the plane of the dial.

Then it is evident, that in the contingent line ÆQ, the spaces K 1, K 2, K 3, &c. being taken equal to the tangents of the hour-distances from the meridian, to the radius KG, one, two, three, &c. hours after sun-rising, on the equinoctial day; the shadow of the point R will be found, at these times, respectively in the points 1, 2, 3, &c.

Draw, for the like hours after sun-rising, when the sun is in the tropic of Capricorn ♑ V, the like common lines CD, CE, CF, &c. and at these hours the shadow of the point R will be found in those lines respectively. Find the sun's altitudes above the plane of the dial at these hours; and with their co-tangents S *d*, S *e*, S *f*, &c. to radius SR, describe arcs intersecting the hour-lines in the points *d*, *e*, *f*, &c. so shall the right lines 1 *d*, 2 *e*, 3 *f*, &c. be the lines of *I*, *II*, *III*, &c. hours after sun-rising.

The construction is the same in every other case; due regard being had to the difference of longitude of the place at which the dial would be horizontal, and the place for which it is to serve; and likewise, taking care to draw no lines but what are necessary; which may be done partly by the rules already given for determining the time that the sun shines on any plane; and partly from this, that on the tropical days, the hyperbola described by the shadow of the point R limits the extent of all the hour-lines.

Of the right placing of Dials, and having a true Meridian Line for the regulating of Clocks and Watches.

The plane on which the dial is to rest being duly prepared, and every thing necessary for fixing it, you may find the hour tolerably exact by a large equinoctial ring-dial, and set your watch to it. And then the dial may be fixed by the watch at your leisure.

If you would be more exact, take the sun's altitude by a good quadrant, noting the precise time of observation by a clock or watch. Then compute the time for the altitude observed; and set the watch to agree with that time, according to the sun. A Hadley's quadrant is very convenient for this purpose: for by it you may take the angle between the sun and his image reflected from a bason of water; the half of which angle, subtracting the refraction, is the altitude required. This is best done in summer; and the nearer the sun is to the prime vertical (the east or west azimuth) when the observation is made, so much the better.

Or, in summer, take two equal altitudes of the sun in the same day; one any time between 7 and 10 in the morning, the other between 2 and 5 in the afternoon; noting the moments of these two observations by a clock or watch: and if the watch shows the observations to be at equal distances from noon, it agrees exactly with the sun; if not, the watch must be corrected by half the difference of the forenoon and afternoon intervals; and then the dial may be set true by the watch.

Thus, for example, suppose you had taken the sun's altitude when it was 20 minutes past *VIII* in the morning by the watch; and found, by observing in the afternoon, that the sun had the same altitude 10 minutes before *IIII;* then it is plain that the watch was 5 minutes too fast for the sun: for 5 minutes after *XII* is the middle time between *VIII*h. 20 m. in the morning, and *III*h. 50 m. in the afternoon; and therefore, to make the watch agree with the sun, it must be set back five minutes.

A good *meridian line*, for regulating clocks or watches, may be had by the following method.

Make a round hole, almost a quarter of an inch diameter, in a thin plate of metal; and fix the plate in the top of a south window, in such a manner that it may recline from the zenith at an angle equal to the colatitude of your place, as nearly as you can guess: for then the plate will face the sun directly at noon on the equinoctial days. Let the sun shine freely through the hole into the room; and hang a plumb-line to the ceiling of the room, at least five or six feet from the window, in such a place as that the sun's rays, transmitted through the hole, may fall upon the line when it is noon by the clock; and having marked the said place on the ceiling, take away the line.

Having adjusted a sliding bar to a dove-tail groove, in a piece of wood about 18 inches long, and fixed a hook into the middle of the bar, nail the wood to the above-mentioned place on the ceiling parallel to the side of the room in which the window is; the groove and the bar being towards the floor: Then hang the plumb-line upon the hook in the bar, the weight or plummet reaching almost to the floor; and the whole will be prepared for further and proper adjustment.

This done, find the true solar time by either of the two last methods, and thereby regulate your clock. Then, at the moment of the next noon by the clock, when the sun shines, move the sliding-bar in the groove, until the shadow of the plumb-line bisects the image of the sun (made by his rays transmitted through the hole) on the floor, wall, or on a white screen placed on the north side of the line; the plummet or weight at the end of the line hanging freely in a pail of water placed below it on the floor.—But because this may not be quite correct for the first time, on account that the plummet will not settle immediately, even in water; it may be farther corrected on the following days, by the above method, with the sun and clock; and so brought to a very great exactness.

N. B. The rays transmitted through the hole will cast but a faint image of the sun, even on a white screen, unless the room be so darkened that no sunshine may be allowed to enter but what comes through the small hole in the plate. And always, for some time before the observation is made, the plummet ought to be immersed in a jar of water, where it may hang freely; by which means the line will soon become steady, which otherwise would be apt to continue swinging.

Description of two New Instruments for facilitating the practice of Dialling.

I. *The* DIALLING *Sector*, contrived by the late Mr Benjamin Martin, is an instrument by which dials are drawn in a more easy, expeditious, and accurate manner. The principal lines on it are the *line of latitudes* and the *line of hours* (fig. 32.) They are found on Fig. 32. most of the common plane scales and sectors; but in a manner that greatly confines and diminishes their use; for the first, they are of a *fixed length;* and secondly, *too small* for any degree of accuracy. But in this new *sector*, the *line of latitudes* is laid down, as it is called, *sector-wise*, viz. one line of latitudes upon each leg of the sector, beginning in the centre of the joint, and diverging to the end (as upon other sectors), where the extremes of the two lines at 90° and 90° are nearly one inch apart, and their length 11½ inches: which length admits of great exactness; for at the 70th degree of latitude, the divisions are to quarters of a degree or 15 minutes. This accuracy of the division admits of a peculiar advantage, namely, that it may be equally communicated to any length from 1 to 23 inches, by taking the *parallel* distances (see fig. 33.), viz. from 10 to 10, 20 to 20, 30 to 30, and so on, as is done in like cases on the lines of sines, tangents, &c. Hence its universal use for drawing dials of any proposed size. The line of hours for this end is adapted and placed contiguous to it on the sector, and of a size large enough for the very minutes to be distinct on the part where they are smallest, which is on each side of the hour of *III*.

From the construction of the line of hours before shown, the divisions on each side of the hour *III* are the same to each end, so that the hour-line properly is only a *double line of three hours*. Hence a line of 3 hours answers all the purposes of a line of 6, by taking the double extent of 3, which is the reason why upon the sector the line of hours extends only to 4½.

To make use of the *line of latitude* and *line of hours* on the sector: As single scales only, they will be found more accurate than those placed on the common scales and sectors, in which the hours are usually subdivided but into 5 minutes, and the line of latitudes into whole degrees. But it is shown above how much more accurately these lines are divided on the *dialling sector*. As an example of the great exactness with which horizontal and other dials may be drawn by it, on account of this new *sectoral* disposition of these scales, and how all the advantages of their great length are preserved in any lesser length of the *VI* o'clock line *c e* and *a f*, (fig. 30): Apply either of the distances of *c e* or *a f* to Fig. 30. the line of latitude at the given latitude of London, suppose 51° 32′ on one line to 51° 32′ on the other, in the manner shown in fig. 5. and then taking all the hours, quarters,

quarters, &c. from the hour scale by similar parallel extents, you apply them upon the lines *e d* and *f b* as before described.

As the hour-lines on the sector extend to but 4½, the *double distance* of the hour 3, when used either *singly* or *sectorally*, must be taken, to be first applied from 51° 32′ on the latitudes, to its contact on the *XII* o'clock line, before the several hours are laid off. The method of drawing a vertical north or south dial is perfectly the same as for the above horizontal one; only reversing the hours as in fig. 1. and making the angle of the stile's height equal to the complement of the latitude 38° 28′.

The method of drawing a *vertical declining dial* by the sector, is almost evident from what has been already said in dialling. But more fully to comprehend the matter, it must be considered there will be a variation of particulars as follows: 1. Of the *subtile* or *line* over which the stile is to be placed; 2. The height of the stile above the plane; 3. The difference between the meridian of the place and that of the plane, or their difference of longitude. From the given *latitude of the place*, and *declination of the plane*, you calculate the three requisites just mentioned, as in the following example. Let it be required to make an *erect south dial*, declining from the meridian *westward* 28° 43′, in the latitude of London 51° 32′. The first thing to be found is the distance of the substilar line GB (fig. 31.) from the meridian of the plane G *XII*. The analogy from this is: *As radius is to the sine of the declination, so is the co-tangent of the latitude to the tangent of the distance sought*, viz. As radius : 28° 43′ :: tang. 38° 28′ : tangent 20° 55′. This and the following analogy may be as accurately worked on the Gunter's line of sines, tangents, &c. properly placed on the sector, as by the common way from logarithms. Next, to find the plane's difference of longitude. *As the sine of the latitude is to radius, so is the tangent of the declination to the tangent of the difference of longitude*, viz. As s 51° 32′ : radius :: tang. 28° 43′ : tang. 35° 0′. Lastly, to find the height of the stile: *As radius is to the co-sine of the latitude, so is the co-sine of the declination to the sine of the stile's height*, viz. Radius : s 38° 28′ :: s 65° 17′ : s 35° 5′.

The three requisites thus obtained, the dial is drawn in the following manner: Upon the meridian line G *XII*, with any radius GC describe the arch of a circle, upon which set off 28° 55′ from C to B, and draw GB, which will be the substilar line, over which the stile of the dial must be placed.

At right angles to this line GB, draw AQ indefinitely through the point G: then from the scale of latitude take the height of the stile 33° 5′, and set it each way from G to A and Q. Lastly, take the double length of 3 on the hour-line in your compasses, and setting one foot in A or Q, with the other foot mark the line GB in D, and join ADQD, and then the triangle ADQ is completed upon the substile GB.

To lay off the hours, the plane's difference of longitude being 35°, equal to 2 h. 20 min. in time, allowing 15° to an hour, so that there will be 2 h. 20′ between the point D, and the meridian G *XII*, in the line AD. Therefore, take the first 20′ of the hour-scale in your compasses, and set off from D to 2; then take 1 h. 20′, and set off from D to 1; 2 h. 20′, and set off from D to 12; 3 h. 20′, from D to 11; 4 h. 20′ from D to 10; and 5 h. 20′ from D to 9, which will be 40′ from A.

Then, on the other side of the substilar line GB, you take 40′ from the beginning of the scale, and set off from D to 3; then take 1 h. 40′, and set off from D to 4; also 2 h. 40′, and set off from D to 5; and so on to 8, which will be 20′ from Q. Then from G the centre, through the several points 2, 1, 12, 11, 10, 9, on one side, and 3, 4, 5, 6, 7, 8, on the other, you draw the hour-lines, as in the figure they appear. The hour of *VIII* need only be drawn for the morning; for the sun goes off from this *west decliner* 20′ before *VIII* in the evening.—The quarters, &c. are all set off in the same manner from the hour-scale as the above hours were.

The next thing is fixing the stile or gnomon, which is always placed in the substilar line GB, and which is already drawn. The stile above the plane has been found to be 33° 5′; therefore with any radius GB describe an obscure arch, upon which set off 33° 5′ from B to S, and draw GS, and the angle SGB will be the true height of the gnomon above the substile GB.

II. *The* DIALLING *Trigon* is another new instrument of great utility in the practice of dialling; and was also contrived by the late Mr Martin. It is composed of two graduated scales and a plane one. On the scale AB (fig. 36.) is graduated the line of latitudes; and on the scale AC, the line of hours: these properly conjoined with the plane scale BD, as shown in the figure, truly represent the gnomonical triangle, and is properly called a *dialling trigon*. The hour-scale AC is here of its full length; so that the hours, halves, quarters, &c. and every single minute (if required) may be immediately set off by a steel point; and from what has before been observed in regard to the sector, it must appear that this method by the trigon is the most expeditious way of drawing dials that any mechanism of this sort can afford. As an example of the application of the trigon in the construction of an horizontal dial for the latitude of London 51° 32′, you must proceed as follows: Apply the trigon to the 6 o'clock line *a f* (fig. 29.) on the morning side, so that the line of latitudes may coincide with the 6 o'clock line, and the beginning of the divisions coincide with the centre *a*; and at 51° 32′ of the line of latitudes place the 6 o'clock edge of the line of hours, and the other end or beginning of the scale close against the plane scale *c d*, as by the figure at *d*, and fastening these bars down by the several pins placed in them to the paper and board, then the hours, quarters, &c. are all marked off with a steel point instantly, and the hour lines drawn through them as before, and as shown in the figure. When this is done for the side *a f* or morning hours, you move the scale of latitudes and hours to the other side, *c c*, or afternoon side, and place the hour-scale to 51° 32′ as before, and push down the hours, quarters, &c. and draw the lines through them for the afternoon hours, which is clearly represented in the figure.

Fig. 36.

Fig. 29.

In like manner is an *erect north* or *south* dial drawn (see fig. 30.), the operation being just the same, only reversing the hours as in the figure, and marking the angles

angles of the stile's height equal to the complement of the latitude.

Fig. 31. The trigon may be likewise used for drawing *vertical declining dials* (fig. 31.) as it is with the same facility applied to the lines AQ, GB, and the hours and quarters marked off as before directed.

On the scale BD of the trigon is graduated a line of chords, which is found useful for laying off the necessary angles of the stile's height. The scales of this trigon, when not in use, lie very close together, and pack up into a portable case for the pocket.

Dialling Lines ‖ Dialogue.

DIALLING *Lines*, or *Scales*, are graduated lines, placed on rules, or the edges of quadrants, and other instruments, to expedite the construction of dials. See Plate CLXXI.

DIALLING-*Sector*. See DIALLING, p. 212. and Plate CLXXIV.

DIALLING-*Sphere*, is an instrument made of brass, with several semicircles sliding over one another, on a moving horizon, to demonstrate the nature of the doctrine of spherical triangles, and to give a true idea of the drawing of dials on all manner of planes.

DIALLING-*Trigon*. See DIALLING, p. 213, and Plate CLXXIV.

DIALLING, in a mine, called also *Plumming*, is the using of a compass (which they call *dial*), and a long line, to know which way the load or vein of ore inclines, or where to shift an air-shaft, or bring an adit to a desired place.

DIALOGISM, in *Rhetoric*, is used for the soliloquy of persons deliberating with themselves. See SOLILOQUY.

DIALOGUE, in matters of literature, a conversation between two or more persons either by writing or by word of mouth.

Composition and Style of written DIALOGUE. As the end of speech is conversation, no kind of writing can be more natural than dialogue, which represents this. And accordingly we find it was introduced very early, for there are several instances of it in the Mosaic history. The ancient Greek writers also fell very much into it, especially the philosophers, as the most convenient and agreeable method of communicating their sentiments and instructions to mankind. And indeed it seems to be attended with very considerable advantages, if well and judiciously managed. For it is capable to make the driest subjects entertaining and pleasant, by its variety, and the different characters of the speakers. Besides, things may be canvassed more minutely, and many lesser matters, which serve to clear up a subject, may be introduced with a better grace, by questions and answers, objections and replies, than can be conveniently done in a continued discourse. There is likewise a further advantage in this way of writing, that the author is at liberty to choose his speakers: and therefore, as Cicero has well observed, when we imagine that we have persons of an established reputation for wisdom and knowledge talking together, it necessarily adds a weight and authority to the discourse, and more closely engages the attention. The subject matter of it is very extensive; for whatever is a proper argument of discourse, public or private, serious or jocose; whatever is fit for wise and ingenious men to talk upon, either for improvement or diversion, is suitable for a dialogue.

Dialogue.

From this general account of the nature of dialogue, it is easy to perceive what kind of style best suits it. Its affinity with EPISTLES, shows there ought to be no great difference between them in this respect. Indeed, some have been of opinion, that it ought rather to sink below that of an epistle, because dialogues should in all respects represent the freedom of conversation; whereas epistles ought sometimes to be composed with care and accuracy, especially when written to superiors. But there seems to be little weight in this argument, since the design of an epistle is to say the same things, and in the same manner, as the writer judges would be most fit and proper for him to speak, if present. And the very same thing is designed in a dialogue, with respect to the several persons concerned in it. Upon the whole, therefore, the like plain, easy, and simple style, suited to the nature of the subject, and the particular characters of the persons concerned, seems to agree to both.

But as greater skill is required in writing dialogues than letters, we shall give a more particular account of the principal things necessary to be regarded in their composition, and illustrate them chiefly from Cicero's excellent dialogues concerning an orator.—A dialogue, then consists of two parts; an *introduction*, and *the body of the discourse*.

1. The *introduction* acquaints us with the place, time, persons, and occasion of the conversation. Thus Cicero places the scene of his dialogues at Crassus's country seat; a very proper recess, both for such a debate and the parties engaged in it. And as they were persons of the first rank, and employed in the greatest affairs of state, and the discourse held them for two days; he represents it to have happened at the time of a festival, when there was no business done at Rome, which gave them an opportunity to be absent.

And because the greatest regard is to be had in the choice of the persons, who ought to be such as are well acquainted with the subject upon which they discourse; in these dialogues of Cicero, the two principal disputants are Crassus and Antony, the greatest orators of that age, and therefore the most proper persons to dispute upon the qualifications necessary for their art. One would think it scarce necessary to observe, that the conference should be held by persons who lived at the same time, and so were capable to converse together. But yet some good writers have run into the impropriety of feigning dialogues between persons who lived at distant times. Plato took this method, in which he has been followed by Macrobius. But others,

who

DIALLING. PLATE CLXXI.

Fig. 1.

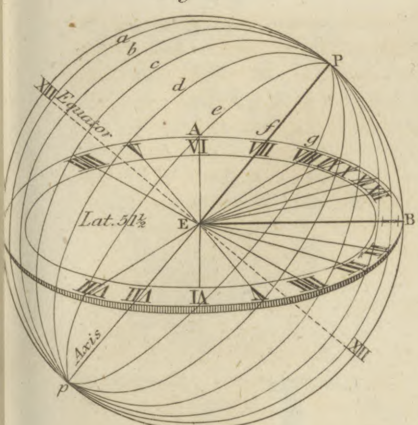


Fig. 2.

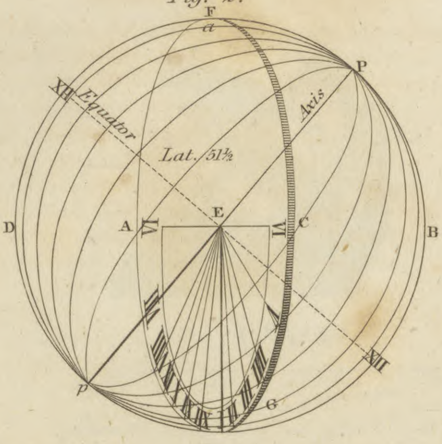


Fig. 3.

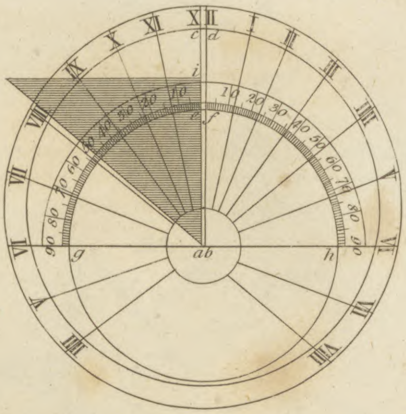


Fig. 5.

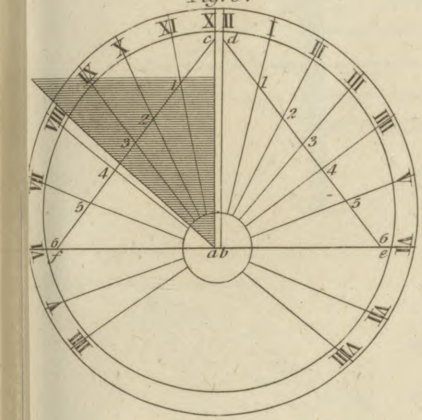


Fig. 4.

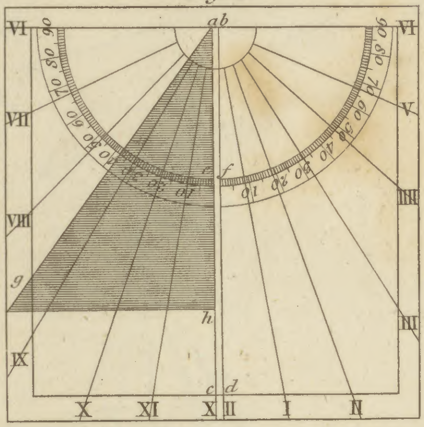
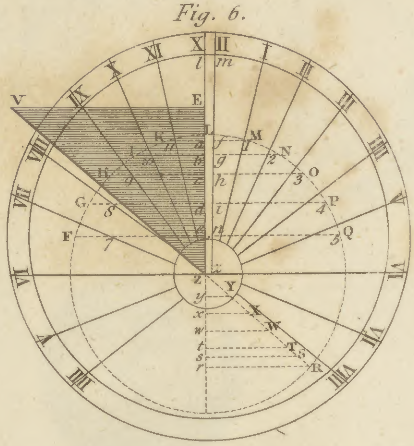


Fig. 6.



Line of Chords

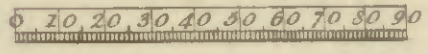
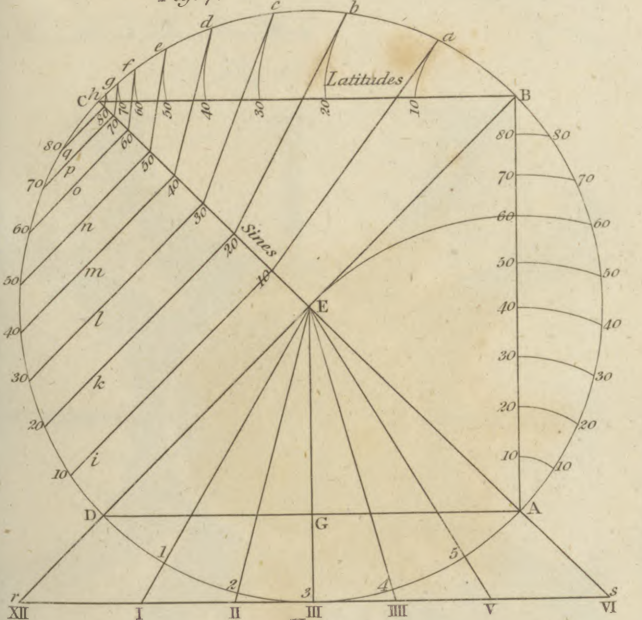
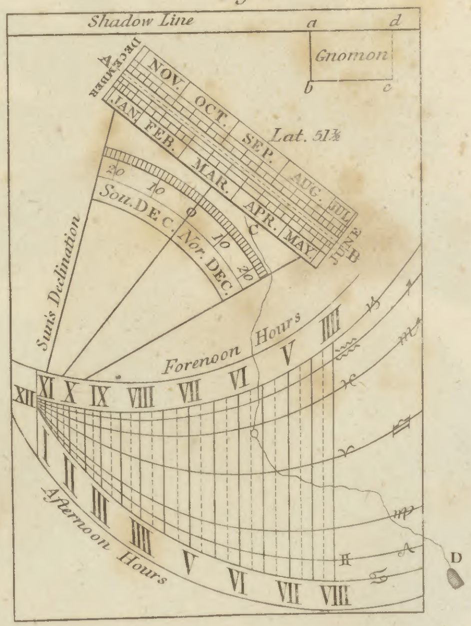


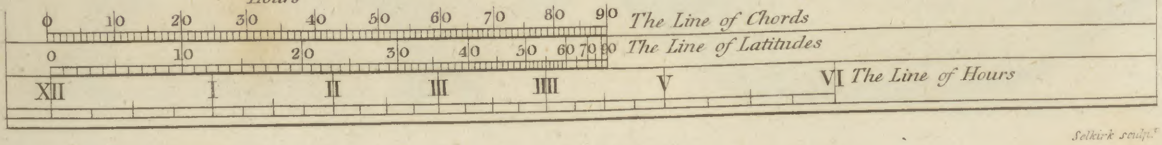
Fig. 8.

Fig. 7.



Hours





Selkirk sculp.t

Fig. 9.

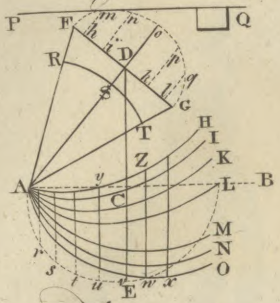


Fig. 10.

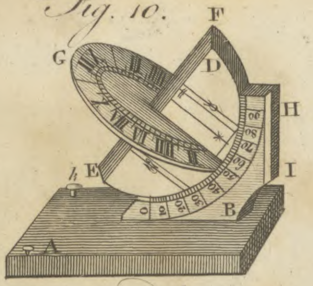


Fig. 12.

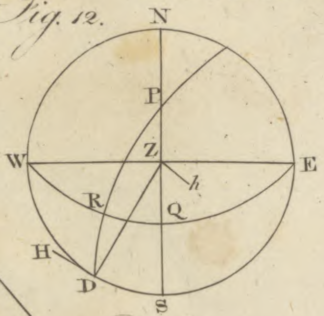


Fig. 11.

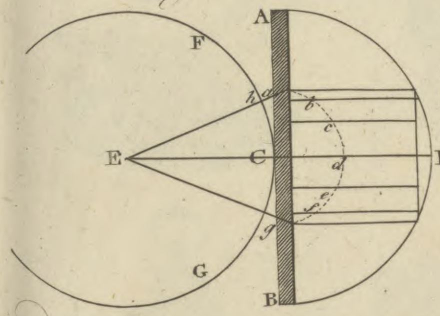


Fig. 16.

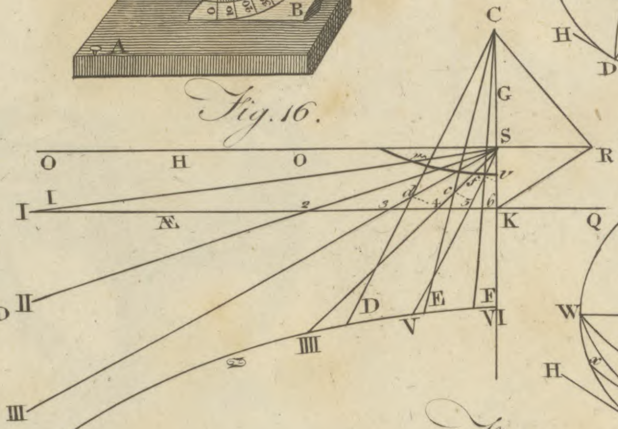


Fig. 14.

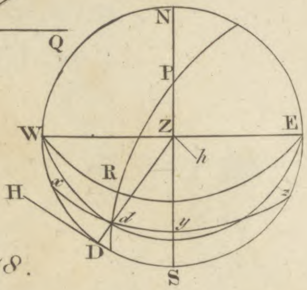


Fig. 13.

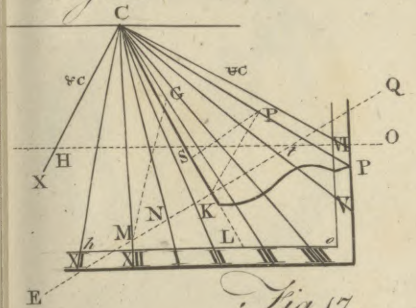


Fig. 15.

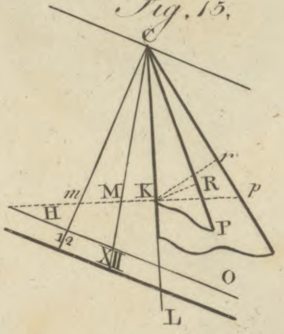


Fig. 17.

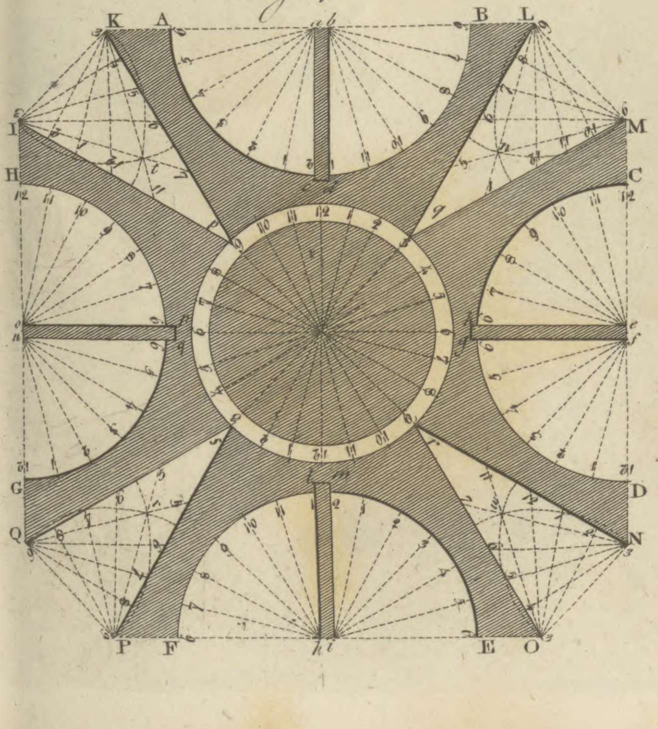
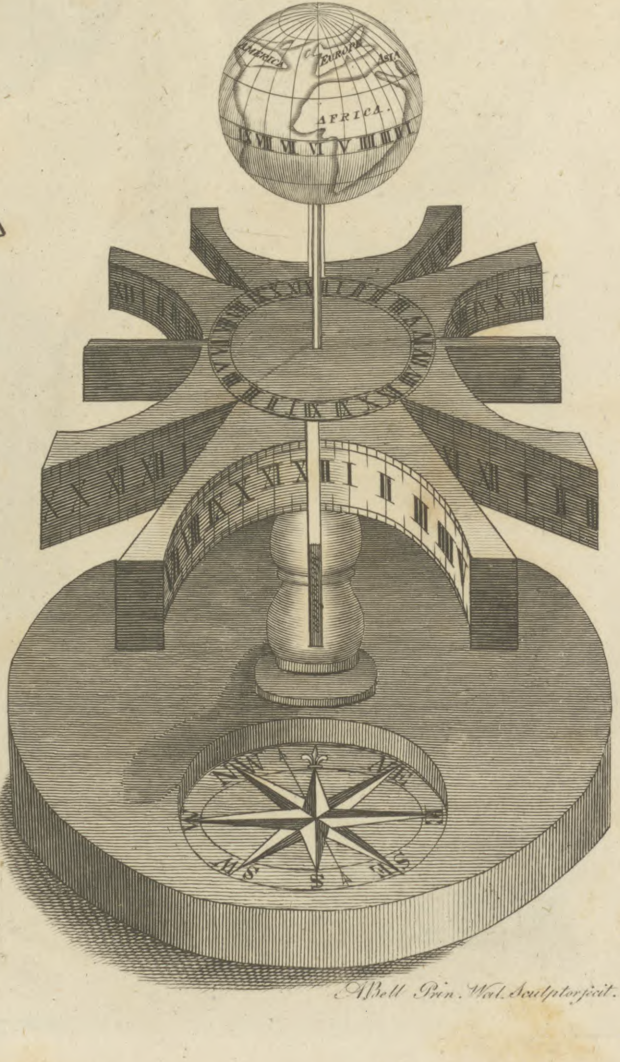


Fig. 18.



A.Bell Prin. Wal. Sculptor fecit.

DIALLING. *PLATE CLXXIII.*

Fig. 19.

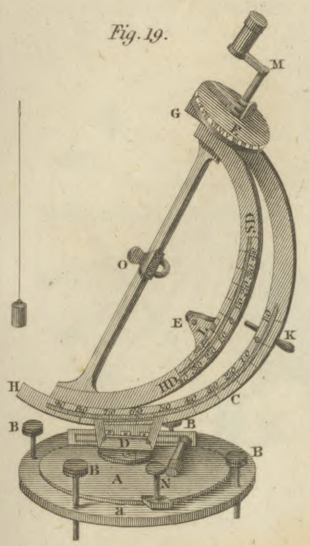


Fig. 20.

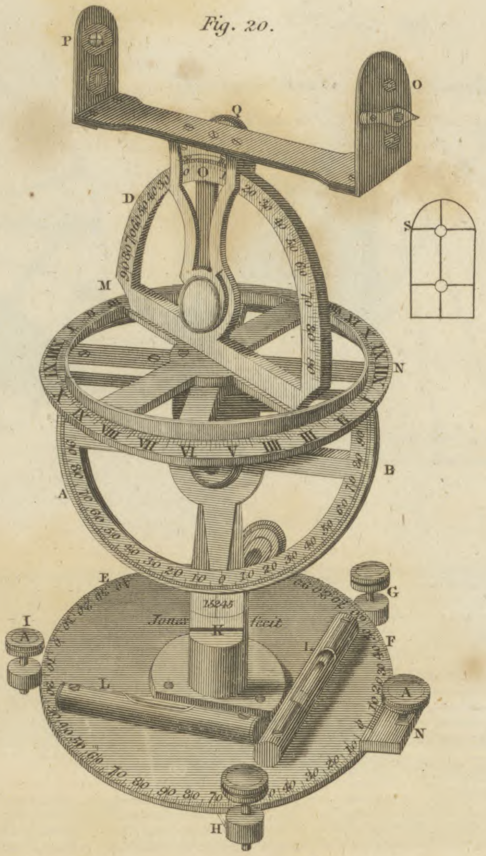


Fig. 21.

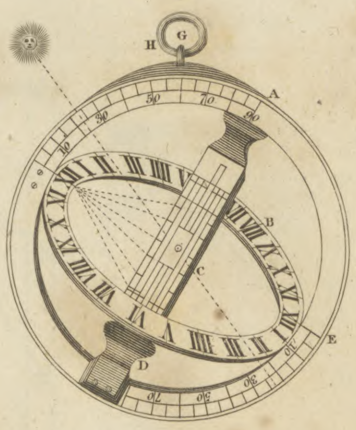


Fig. 23.

Fig. 22.

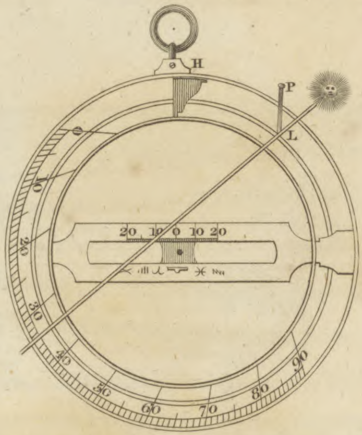


Fig. 28.

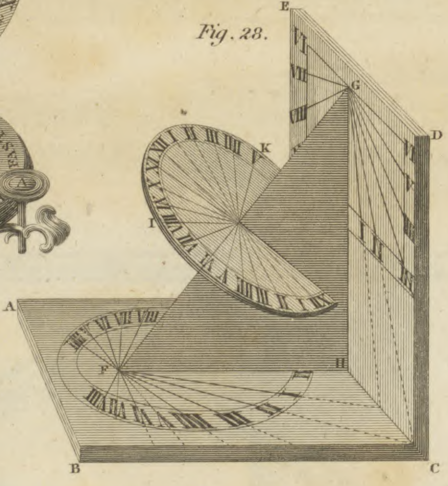


Fig. 27.

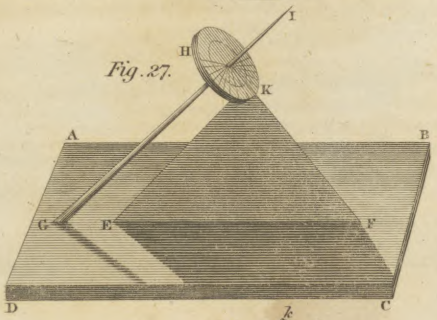


Fig. 26.

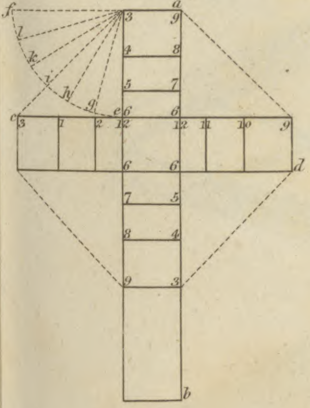


Fig. 24.

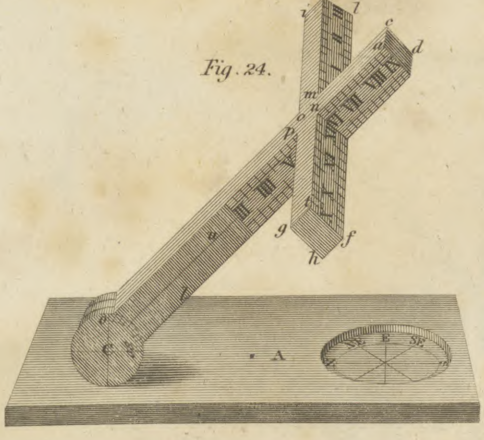
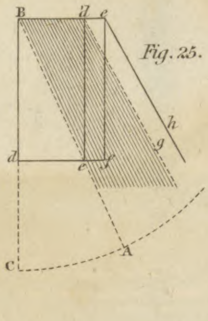


Fig. 25.



Engraved by W. Archibald Edin.^r

Fig. 29.

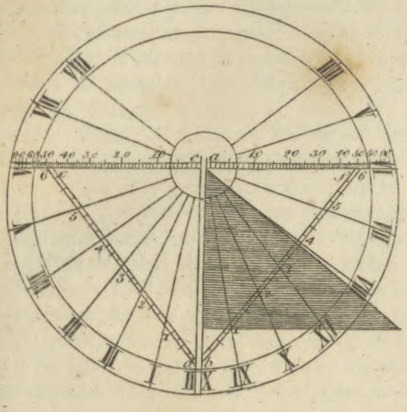


Fig. 30.

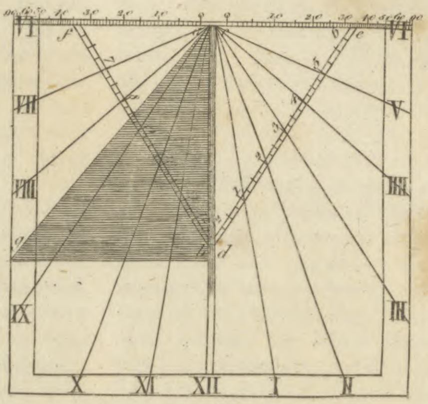


Fig. 31.

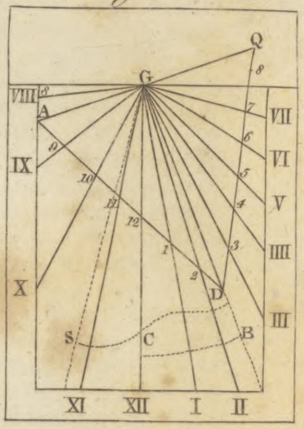


Fig. 32.

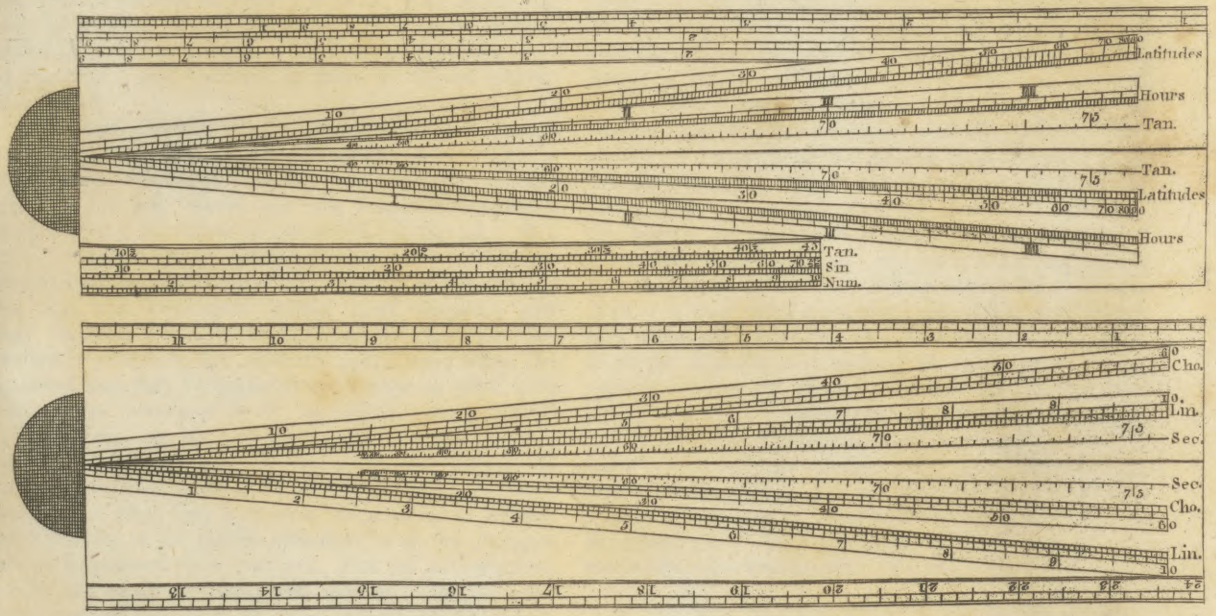



Fig. 33.

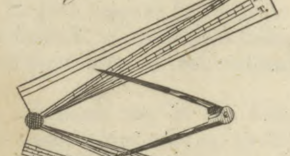


Fig. 34.

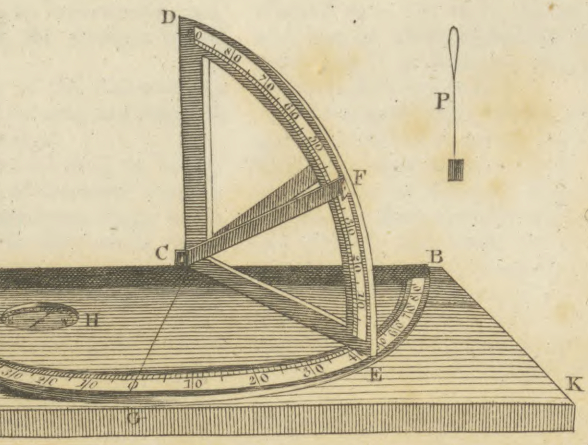


Fig. 36.

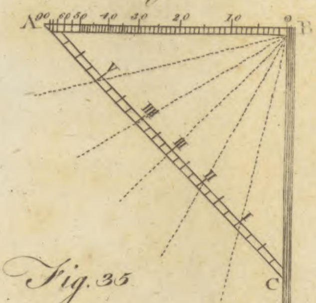
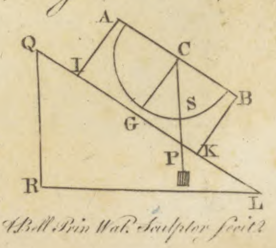


Fig. 35



A. Bell Prin. Wal. Sculptor fecit.

who have been willing to bring persons to discourse together, who lived in different ages, without such inconsistency, have wrote dialogues of the dead. Lucian has made himself most remarkable in this way. As to the number of persons in a dialogue, they may be more or less; so many as can conveniently carry on a conversation without disorder or confusion may be admitted. Some of Cicero's dialogues have only two, others three or more, and those concerning an orator seven. And it is convenient they should all, in some respects, be persons of different characters and abilities; which contributes both to the variety and beauty of the discourse, like the different attitudes of figures in a picture. Thus, in Cicero's dialogues last-mentioned, Crassus excelled in art, Antony principally for the force of his genius, Catullus for the purity of his stile, Scevola for his skill in the law, Cæsar for wit and humour; and through Sulpitius and Cotta, who were young men, were both excellent orators, yet they differed in their manner. But there should be always one chief person, who is to have the main part of the conversation; like the hero in an epic poem or a tragedy, who excels the rest in action; or the principal figure in a picture, which is most conspicuous. In Plato's dialogues, this is Socrates; and Crassus in those of Cicero abovementioned.

It is usual likewise, in the introductions, to acquaint us with the occasion of the discourse. Indeed this is not always mentioned; as in Cicero's dialogue of the parts of oratory, where the son begins immediately with desiring his father to instruct him in the art. But it is generally taken notice of, and most commonly represented as accidental. The reason of which may be, that such discourses appear most natural; and may likewise afford some kind of apology for the writer in managing his different characters, since the greatest men may be supposed not always to speak with the utmost exactness in an accidental conversation. Thus Cicero, in his dialogues concerning an orator, makes Crassus occasionally fall upon the subject of oratory, to divert the company from the melancholy thoughts of what they had been discoursing of before, with relation to the public disorders, and the dangers which threatened their country. But the introduction ought not to be too long and tedious. Mr Addison complains of this fault in some authors of this kind. "For though (as he says) some of the finest treatises of the most polite Latin and Greek writers are in dialogue, as many very valuable pieces of French, Italian, and English, appear in the same dress; yet in some of them there is so much time taken up in ceremony, that, before they enter on their subject, the dialogue is half over."

2. We come now to the *body* of the discourse, in which some things relating to the persons, and others to the subject, are proper to be remarked.

And as to the *persons*, the principal thing to be attended to is to keep up a justness of character through the whole. And the distinct characters ought to be so perfectly observed, that from the very words themselves, it may be always known who is the speaker. This makes dialogue more difficult than single description, by reason of the number and variety of characters which are to be drawn at the same time, and each of them managed with the greatest propriety. The principal speaker should appear to be a person of great sense and wisdom, and best acquainted with the subject. No question ought to be asked him, or objection started to what he says, but what he should fairly answer. And what is said by the rest should principally tend to promote his discourse, and carry it through in the most artful and agreeable manner. When the argument is attended with difficulties, one other person or more may be introduced, of equal reputation or near it, but of different sentiments, to oppose him, and maintain the contrary side of the question. This gives opportunity for a thorough examination of the point on both sides and answering all objections. But if the combatants are not pretty equally matched, and masters of the subject, they will treat it but superficially. And through the whole debate there ought not to be the least wrangling, peevishness, or obstinacy; nothing but the appearance of good humour and good breeding, the gentleman and the friend, with a readiness to submit to conviction and the force of truth, as the evidence shall appear on one side or the other. In Cicero, these two characters are Crassus and Antony. And from them Mr Addison seems to have taken his Philander and Cynthio in his *Dialogues upon the usefulness of ancient medals*, which are formed pretty much on Cicero's plan. When younger persons are present, or such who are not equally acquainted with the subject, they should be rather upon the inquiry than dispute: And the questions they ask should be neither too long nor too frequent, that they may not too much interrupt the debate, or appear over talkative before wiser and more experienced persons. Sulpitius and Cotta sustain this character in Cicero, and Eugenius in Mr Addison. And it is very convenient there should be one person of a witty and jocose humour, to enliven the discourse at proper seasons, and make it the more entertaining, especially when the dialogue is drawn out to any considerable length. Cæsar has this part in Cicero. And in Mr Addison, Cynthio is a person of this turn, and opposes Philander in a merry way. Mr Addison's subject admitted of this: but the seriousness and gravity of Cicero's argument required a different speaker for the jocose part. Many persons ought not to speak immediately after one another. Horace's rule for plays is:

To crowd the stage is odious and absurd.
Let no fourth actor strive to speak a word.

Though Scaliger and others think a fourth person may sometimes be permitted to speak in the same scene without confusion. However, if this is not commonly to be allowed upon the stage, where the actors are present, and may be distinguished by their voice and habit; much less in a dialogue, where you have only their names to distinguish them.

With regard to the *subject*, all the arguments should appear probable at least, and nothing be advanced which may seem weak or trivial. There ought also to be an union in dialogue, that the discourse may not ramble, but keep up to the main design. Indeed, short and pleasant digressions are sometimes allowable for the ease and entertainment of the reader. But every thing thould be so managed, that he may still be able to carry on the thread of the discourse in his mind, and keep the main argument in view, till the whole is finished. The writers of dialogue have not confined their

their discourses to any certain space of time; but either concluded them with the day, or broke off when their speakers have been tired, and reassumed them again the next day. Thus Cicero allows two days for his three dialogues concerning an orator; but Mr Addison extends his to three days, allowing a day for each. Nor has the same method always been observed in composing dialogues. For sometimes the writer, by way of narrative, relates a discourse which passed between other persons. Such are the dialogues of Cicero and Mr Addison last mentioned, and many others both of the ancients and moderns. But, at other times, the speakers are introduced in person, as talking to each other. This, as Cicero observes, prevents the frequent repetition of those words, *he said*, and *he replied;* and by placing the hearer, as it were, in the conversation, gives him a more lively representation of the discourse, which makes it the more affecting. And therefore Cicero, who wrote his *dialogue of old age* in this manner, in which Cato, who was then in years, largely recounts the satisfaction of life which may be enjoyed in old age, tells his friend Atticus, he was himself so affected with that discourse, that when he reviewed it sometimes, he fancied they were not his own words, but Cato's. There are some other dialogues of Cicero, written in the same way; as that *Of friendship* and *Of the parts of Oratory*. And both Plato and Lucian generally chose this method.

DIALOGUE, in dramatic composition. See POETRY, chap. ii. 22, 23.

DIALTHÆA, in *Pharmacy*, an unguent formerly much used as a resolvent; so called from ALTHÆA, or marshmallows, which is the principal ingredient in it.

DIALYSIS, in *Grammar*, a mark or character, consisting of two points, ¨, placed over two vowels of a word, in order to separate them, because otherwise they would make them a diphthong, as *Mosaïc*, &c.

DIAMASTIGOSIS, a festival at Sparta in honour of Diana Orthia, which received that name απο του μαστιγουν, from *whipping*, because boys were whipped before the altar of the goddess. These boys, called Bomonicæ, were originally free-born Spartans, but in the more delicate ages they were of mean birth, and generally of a slavish origin. This operation was performed by an officer in a severe and unfeeling manner; and that no compassion should be raised, the priest stood near the altar with a small light statue of the goddess, which suddenly became heavy and insupportable if the lash of the whip was more lenient or less rigorous. The parents of the children attended the solemnity, and exhorted them not to commit any thing either by fear or groans, that might be unworthy of Laconian education. These flagellations were so severe, that the blood gushed in profuse torrents, and many expired under the lash of the whip, without uttering a groan, or betraying any marks of fear. Such a death was reckoned very honourable; and the corpse was buried with much solemnity with a garland of flowers on its head. The origin of this festival is unknown. Some suppose that Lycurgus first instituted it to inure the youth of Lacedæmon to bear labour and fatigue, and render them insensible to pain and wounds. Others maintain, that it is a mitigation of an oracle, which ordered that human blood should be shed on Diana's altar; and according to their opinion, Orestes first introduced that barbarous custom, after he had brought the statue of Diana Taurica into Greece. There is another tradition which mentions, that Pausanias, as he was offering up prayers and sacrifices to the gods, before he engaged with Mardonius, was suddenly attacked by a number of Lydians, who disturbed the sacrifice, and were at last repelled with staves and stones, the only weapons with which the Lacedæmonians were provided at that moment. In commemoration of this, therefore, that whipping of boys was instituted at Sparta, and after that the Lydian procession.

DIAMETER, in *Geometry*, a right line passing through the centre of a circle, and terminated at each side by the circumference thereof. See GEOMETRY.

DIAMOND, the most highly valued of precious stones. The finest diamonds are perfectly transparent and colourless, of a regular form, and entirely free from flaws and veins. They have been distinguished by lapidaries into *oriental* and *occidental*. But these terms are not expressive of the country from which they are brought, but merely of their qualities and value, the oriental being reckoned the finest and hardest, and the occidental of inferior value. See CHEMISTRY and MINERALOGY *Index*.

Cornish DIAMOND, a name given by many to the rock crystals found in the tin mines of Cornwall. These crystals are usually bright and clear, and are found most frequently in the form of an hexangular column terminated at each end by an hexangular pyramid.

Rose DIAMOND is one that is quite flat underneath, with its upper part cut in divers little faces, usually triangles, the uppermost of which terminate in a point.—In rose diamonds, the depth of the stone from the base to the point must be half the breadth of the diameter of the base of the stone. The diameter of the crown must be $\frac{2}{5}$ of the diameter of the base. The perpendicular, from the base to the crown, must be $\frac{3}{5}$ of the diameter of the stone. The lozenges which appear in all circular rose diamonds, will be equally divided by the ribs that form the crown; and the upper angles or facets will terminate in the extreme point of the stone, and the lower in the base or girdle.

Rough DIAMOND, is the stone as nature produces it in the mines.

A rough diamond must be chosen uniform, of a good shape, transparent, not quite white, and free of flaws and shivers. Black, rugged, dirty, flawey, veiny stones, and all such as are not fit for cutting, they use to pound in a steel mortar made for that purpose; and when pulverized, they serve to saw, cut, and polish the rest. Shivers are occasioned in diamonds by this, That the miners, to get them more easily out of the vein, which winds between two rocks, break the rocks with huge iron levers, which shakes, and fills the stone with cracks and shivers. The ancients had two mistaken notions with regard to the diamond: the first, That it became soft, by steeping it in hot goats blood; and the second, that it is malleable, and bears the hammer. Experience shows us the contrary; there being nothing capable of mollifying the hardness of this stone; though its hardness be not such, that it will endure being struck at pleasure with the hammer.

Factitious DIAMONDS. Attempts have been made to produce

produce artificial diamonds, but with no great success. —Those made in France called *temple diamonds*, on account of the Temple at Paris, where the best of them are made, fall vastly short of the genuine ones; accordingly they are but little valued, though the consumption be pretty considerable for the habits of the actors on the stage, &c. See PASTES.

DIAMOND, in the glass trade, an instrument used for squaring the large plates or pieces; and, among glaziers, for cutting their glass.

These sorts of diamonds are differently fitted up. That used for large pieces, as looking-glasses, &c. is set in an iron ferril, about two inches long, and a quarter of an inch in diameter; the cavity of the ferril being filled up with lead, to keep the diamond firm: there is also a handle of box or ebony fitted to the ferril, for holding it by.

DIAMOND, in *Heraldry*, a term used for expressing the black colour in the achievements of peerage.

Guillim does not approve of blazoning the coats of peers by precious stones instead of metals and colours; but the English practice allows it. Morgan says the diamond is an emblem of fortitude.

DIANA, the goddess of hunting According to Cicero, there were three of this name; a daughter of Jupiter and Proserpine, who became mother of Cupid; a daughter of Jupiter and Latona; and a daughter of Upis and Glauce. The second is the most celebrated, and to her all the ancients allude. She was born at the same birth as Apollo: and the pains which she saw her mother suffer during her labour gave her such an aversion to marriage, that she obtained of her father to live in perpetual celibacy, and to preside over the travails of women. To shun the society of men, she devoted herself to hunting; and was always accompanied by a number of chosen virgins, who, like herself, abjured the use of marriage. She is presented with a quiver and attended with dogs, and sometimes drawn in a chariot by two white stags. Sometimes she appears with wings, holding a lion in one hand, and a panther in the other, with a chariot drawn by two heifers, or two horses of different colours. She is represented as tall; her face has something manly; her legs are bare, well shaped, and strong; and her feet are covered with a buskin worn by huntresses among the ancients. She received many surnames, particularly from the places where her worship was established, and from the functions over which she presided. She was called *Lucina*, *Ilythia*, or *Juno Pronuba*, when invoked by women in childbed; and *Trivia* when worshipped in the cross-ways, where her statues were generally erected. She was supposed to be the same as the moon and Proserpine or Hecate, and from that circumstance she was called *Triformis*; and some of her statues represented her with three heads, that of a horse, a dog, and a boar. Her power and functions under these three characters have been beautifully expressed in these two verses:

Terret, lustrat, agit, Proserpina, Luna, Diana,
Ima, suprema, feras, sceptro, fulgore, sagitta.

She was also called *Agrotera*, *Orithia*, *Taurica*, *Delia*, *Cynthia*, *Aricia*, &c. She was supposed to be the same as the Isis of the Egyptians, whose worship was introduced into Greece with that of Osiris under the name of Apollo. When Typhon waged war against the gods, Diana metamorphosed herself into a cat to avoid his fury. She is generally known, in the figures that represent her, by the crescent on her head, by the dogs which attend her, and by her hunting habit. The most famous of her temples was that of Ephesus, which was one of the seven wonders of the world: (See EPHESUS). She was there represented with a great number of breasts, and other symbols, which signified the earth or Cybele. Though she was the patroness of chastity, yet she forgot her dignity to enjoy the company of Endymion, and the very familiar favours which she granted to Pan and Orion are well known: (See ENDYMION, PAN, ORION). The inhabitants of Taurica were particularly attached to the worship of this goddess, and they cruelly offered on her altar all the strangers that were shipwrecked on their coasts. Her temple in Africa was served by a priest who had always murdered his predecessor; and the Lacedæmonians yearly offered her human victims till the age of Lycurgus, who changed this barbarous custom for the sacrifice of flagellation. The Athenians generally offered her goats; and others a white kid, and sometimes a boar pig or an ox. Among plants, the poppy and the dittany were sacred to her. She, as well as her brother Apollo, had some oracles; among which those of Egypt, Cilicia, and Ephesus, are the most known.

DIANÆ ARBOR, or ARBOR LUNÆ, in *Chemistry*, the beautiful arborescent form of silver, dissolved in nitric acid, and precipitated by another metal; so called from its resembling the trunk, branches, leaves, &c. of a tree. See SILVER, CHEMISTRY *Index*.

DIANÆ Fanum, in *Ancient Geography*, a promontory of Bithynia: now *Scutari*, a citadel opposite to Constantinople, on the east side of the Bosphorus Thracius.

DIANÆ Portus, a port of Corsica, situated between Aleria and Mariana, on the east side.

DIANDRIA (from δις, *twice*, and ανηρ, *a man*), the name of the second class in Linnæus's sexual system, consisting of hermaphrodite plants: which, as the name imports, have flowers with two stamina or male organs.

The orders in this class are three, derived from the number of styles or female parts. Most plants with two stamina have one style; as jessamine, lilac, privet, veronica, and bastard alaternus: vernal grass has two styles; pepper, three.

DIANIUM, in *Ancient Geography*, a town of the Contestani, in the Hither Spain; famous for a temple of Diana, whence the name: now *Denia*, a small town of Valencia, on the Mediterranean. Also a promontory near Dianium: now *El Cabo Martin*, four leagues from Denia, running out into the Mediterranean.

DIANTHERA, a genus of plants belonging to the diandria class, and in the natural method ranking under the 40th order, *Personatæ*. See BOTANY *Index*.

DIANTHUS, CLOVE GILLIFLOWER, CARNATION, PINK, SWEET-WILLIAM, &c. a genus of plants belonging to the decandria class, and in the natural method ranking under the 22d order, *Caryophyllei*. See BOTANY *Index*.

There is a great number of species; but not more than four that have any considerable beauty as garden flowers,

flowers, each of which furnishes some beautiful varieties. 1. The caryophyllus, or clove gilliflower, including all the varieties of carnation. It rises with many short trailing shoots from the root, garnished with long, very narrow, evergreen leaves; and amidst them upright slender flower-stalks, from one to three feet high, emitting many side shoots; all of which, as well as the main stalk, are terminated by large solitary flowers, having short oval scales to the calyx, and crenated petals. The varieties of this are very numerous, and unlimited in the diversity of flowers. 2. The deltoides, or common pink, rises with numerous short leafy shoots, crowning the root, in a tufted head close to the ground, closely garnished with small narrow leaves; and from the ends of the shoots many erect flower-stalks, from about 6 to 15 inches high, terminated by solitary flowers of different colours, single and double, and sometimes finely variegated. This species is perennial, as all the varieties of it commonly cultivated also are. 3. The Chinensis, Chinese or Indian pink, is an annual plant with upright firm flower-stalks, branching erect on every side, a foot or 15 inches high, having all the branches terminated by solitary flowers of different colours and variegations, appearing from July to November. 4. The barbatus, or bearded dianthus, commonly called *sweet-william*. This rises with many thick leafy shoots, crowning the root in a cluster close to the ground; garnished with spear-shaped evergreen leaves, from half an inch to two inches broad. The stems are upright and firm, branching erect two or three feet high, having all the branches and main stem crowned by numerous flowers in aggregate clusters of different colours and variegations.

Culture. Though the carnations grow freely in almost any garden earth, and in it produce beautiful flowers, yet they are generally superior in that of a light loamy nature; and of this kind of soil the florists generally prepare a kind of compost in the following manner, especially for those fine varieties which they keep in pots. A quantity of loamy earth must be provided, of a light sandy temperature, from an upland or dry pasture field or common, taking the top spit turf and all, which must be laid in a heap for a year, and turned over frequently. It must then be mixed with about one-third of rotten dung of old hotbeds, or rotten neats dung, and a little sea-sand, forming the whole into a heap again, to lie three, four, or six months, at which time it will be excellent for use; and if one parcel or heap was mixed with one of these kinds of dungs, and another parcel with the other, it will make a change, and may be found very beneficial in promoting the size of the flowers. This compost, or any other made use of for the purpose, should not be sifted, but only well broken with the spade and hands.—When great quantities of carnations are required, either to furnish large grounds, or for market, or when it is intended to raise new varieties, it is easily effected by sowing some seed annually in spring, in common earth, from which the plants will rise abundantly. Several good varieties may also be expected from the plants of each sowing; and possibly not one exactly like those from which the seed was saved. The single flowers are always more numerous than the double ones; but it is from the latter only that we are to select our varieties. The season for sowing the seed is any time from the 20th of March to the 15th of April.—The plants generally come up in a month after sowing: they must be occasionally weeded and watered till July, when they will be fit for transplanting into the nursery beds. These beds must be made about three feet wide, in an open situation; and taking advantage of moist weather, prick the plants therein four inches asunder, and finish with a gentle watering, which repeat occasionally till the plants have taken good root. Here they must remain till September, when they will be so well advanced in growth as to require more room; and should then have their final transplantation into other three feet wide beds of good earth, in rows 9 inches asunder, where they are to be placed in the order of quincunx. Here they are to remain all winter, until they flower, and have obtained an increase of the approved varieties of doubles by layers: and until this period, all the culture they require is, that if the winter should prove very severe, an occasional shelter of mats will be of advantage. In spring, the ground must be loosened with a hoe; they must be kept clear from weeds: and when the flower-stalks advance they are to be tied up to sticks, especially all those that promise by their large flower-pods to be doubles.

The only certain method of propagating the double varieties is by layers. The proper parts for layers are those leafy shoots arising near the crown of the root, which, when about five, six, or eight inches long, are of a proper degree of growth for layers. The general season for this work is June, July, and the beginning of August, as then the shoots will be arrived at a proper growth for that operation; and the sooner it is done after the shoots are ready the better, that they may have sufficient time to acquire strength before winter; these laid in June and July will be fit to take off in August and September, so will form fine plants in the month of October. The method of performing the work is as follows. First provide a quantity of small hooked sticks for pegs. They must be three or four inches long; and their use is to peg the layers down to the ground. Get ready also in a barrow a quantity of light rich mould, to raise the earth, if necessary, round each plant, and provide also a sharp penknife. The work is begun by stripping off all the leaves from the body of the shoots, and shortening those at top an inch or two evenly. Then choose a strong joint on the middle of the shoot or thereabouts, and on the back or under side thereof, cut with the penknife the joint half way through, directing your knife upwards so as to slit the joint up the middle, almost to the next joint above, by which you form a kind of tongue on the back of the shoot; observing that the swelling skinny part of the joint remaining at the bottom of the tongue must be trimmed off, that nothing may obstruct the issue of the fibres; for the layers always form their roots at that part. This done, loosen the earth about the plant; and, if necessary, add some fresh mould, to raise it for the more ready reception of the layers; then with your finger make a hollow or drill in the earth to receive the layer; which bend horizontally into the opening, raising the top upright, so as to keep the gash or slit part of the layer open; and, with one of the hooked sticks, peg down the

the body of the layer, to secure it in its proper place and position, still preserving the top erect and the slit open, and draw the earth over it an inch or two, bringing it close about the erect part of the shoot; and when all the shoots of each plant are thus laid, give directly some water to settle the earth close, and the work is finished. In dry weather the waterings must be often repeated, and in five or six weeks the layers will have formed good roots. They must then be separated with a knife from the old plant, gently raised out of the earth with the point of a knife or trowel, in order to preserve the fibrous roots of the layers as entire as possible; and when thus taken up, cut off the naked sticky part at bottom close to the root, and trim the tops of the leaves a little. They are then ready for planting either into beds or pots. In November the fine varieties in pots should be removed to a sunny sheltered situation for the winter; and if placed in a frame, to have occasional protection from hard frost, it will be of much advantage. In the latter end of February, or some time in March, the layers in the small pots, or such as are in beds, should be transplanted with balls into the large pots, where they are to remain for flower. To have as large flowers as possible, curious florists clear off all side shoots from the flower stem, suffering only the main or top buds to remain for flowering. When the flowers begin to open, attendance should be given to assist the fine varieties, to promote their regular expansion, particularly the largest kinds called *bursters*, whose flowers are sometimes three or four inches diameter. Unless these are assisted by art, they are apt to burst open on one side, in which case the flower will become very irregular; therefore, attending every day at that period, observe, as soon as the calyx begins to break, to cut it a little open at two other places in the indenting at top with narrow-pointed scissars, and hereby the more regular expansion of the petals will be promoted: observing, if one side of any flower comes out faster than another, to turn the pot about, that the other side of the flower may be next the sun, which will also greatly promote its regular expansion. When any fine flower is to be blown as large and spreading as possible, florists place spreading paper collars round the bottom of the flowers, on which they may spread their petals to the utmost expansion. These collars are made of stiff white paper, cut circular about three or four inches over, having a hole in the middle to receive the bottom of the flower, and one side cut open to admit it. This is to be placed round the bottom of the petals in the inside of the calyx, the leaves of which are made to spread flat for its support. The petals must then be drawn out and spread upon the collar to their full width and extent; the longest ones undermost, and the next longest upon these, and so on; observing that the collar must nowhere appear wider than the flower; and thus a carnation may be rendered very large and handsome.

These directions will answer equally well for the propagation of the pinks and sweet-williams, though neither of these require such nicety in their culture as the carnations.

DIAPASON, in *Music*, a musical interval, by which most authors who have written on the theory of music use to express the OCTAVE of the Greeks.

DIAPASON, among the musical-instrument-makers, a kind of rule or scale whereby they adjust the pipes of organs, and cut the holes of hautboys, flutes, &c. in due proportion for performing the tones, semitones, and concords, with precision.

DIAPASON Diaex, in *Music*, a kind of compound concord, whereof there are two sorts; the greater, which is in the proportion of 10-3; and the lesser, in that of 16-5.

DIAPASON Diapente, in *Music*, a compound consonance in a triple ratio, as 3-9. This interval, says Martianus Capella, consists of 9 tones and a semitone; 19 semitones, and 38 dieses. It is a symphony made when the voice proceeds from the first to the twelfth sound.

DIAPASON Diatessaron, in *Music*, a compound concord founded on the proportion of 8 to 3. To this interval Martianus Capella allows 8 tones and a semitone; 17 semitones, and 34 dieses. This is when the voice proceeds from its first to its eleventh sound. The moderns would rather call it the *eleventh*.

DIAPASON Ditone, in *Music*, a compound concord, whose terms are as 10-4, or as 5-2.

DIAPASON Semiditone, in *Music*, a compound concord, whose terms are in the proportion of 12-5.

DIAPEDESIS, in *Medicine*, a transudation of the fluids through the sides of the vessels that contain them, occasioned by the blood's becoming too much attenuated, or the pores becoming too patent.

DIAPENSIA, a genus of plants belonging to the pentandria class. See BOTANY *Index*.

DIAPENTE, in ancient music, an interval marking the second of the concords, and with the diatessaron an octave; and in modern music is called a *fifth*.

DIAPER, a kind of cloth on which are formed various figures, and which is chiefly employed for table-linen.

DIAPHANOUS, an appellation given to all transparent bodies, or such as transmit the rays of light.

DIAPHORESIS, in *Medicine*, an elimination of the humours in any part of the body through the pores of the skin. See PERSPIRATION.

DIAPHORETICS, among physicians, all medicines which promote perspiration.

DIAPHRAGM, (*Diaphragma*,) in *Anatomy*, a part vulgarly called the *midriff*, and by anatomists *septum transversum*. It is a strong muscular substance, separating the breast or thorax from the abdomen or lower venter, and serving as a partition between the abdominal and the thoracic viscera. See ANATOMY *Index*. Plato, as Galen informs us, first called it *diaphragm*, from the verb διαφραττειν, *to separate* or *be between two*. Till his time it had been called φρενες, from a notion that an inflammation of this part produced phrenzy; which is not more warranted by experience than another tradition, that a transverse section of the diaphragm with a sword causes the patient to die laughing.

DIAPHORESIS, (Διαφορησις), in *Rhetoric*, is used to express the hesitation or uncertainty of the speaker. We have an example in Homer, where Ulysses, going to relate his sufferings to Alcinous, begins thus;

Τι πρωτον τι δ' επειτα, τι δ' υστατιον καταλεξω?
Quid primum, quid deinde, quid postremo alloquar?

This figure is most naturally placed in the exordium or introduction to a discourse. See DOUBTING.

Diarbeck.

DIARBECK, or **DIARBEKR**, an extensive province of Eastern Asiatic Turkey; comprehending, in its latest extent, *Diarbekr*, properly so called, *Ierack* or *Chaldea*, and *Curdistan*, which were the ancient countries of Mesopotamia, Chaldea, and Assyria, with Babylon. It is called *Diarbeck*, *Diarbeker*, or *Diarbekr*, as signifying the "duke's country," from the word *dhyar* "a duke," and *bekr*, "country." It extends along the banks of the Tigris and Euphrates from north-north-west to south-east, that is, from Mount Taurus, which divides it from Turcomania on the north, to the inmost recess of the Persian gulf on the south, about 600 miles; and from east to west, that is, from Persia on the east to Syria and Arabia Deserta on the west, in some places 200, and in others about 300 miles, but in the southern or lower parts not above 150. As extending also from the 30th to the 38th degree of latitude, it lies under part of the fifth and sixth climates, whose longest day is about 14 hours and a half, and so in proportion, and consequently enjoys a good temperature of air, as well as, in the greater part of it, a rich and fertile soil. There are indeed, as in all hot countries, some large deserts in it, which produce no sustenance for men or cattle, nor have any inhabitants. Being a considerable frontier towards the kingdom of Persia, it is very well guarded and fortified; but as for those many cities once so renowned for their greatness and opulence, they are at present almost dwindled into heaps of ruins. Bagdad, Moussul, Caramed, and a few more, indeed continue to be populous and wealthy; but the rest can scarce be called by any other name than that of sorry places. The rivers Euphrates and Tigris have almost their whole course through this country.

Diarbeck Proper is bounded on the north by Turcomania, on the west by Syria, on the south by part of Arabia Deserta and Irack Proper, and on the east by Curdistan. It was named by Moses *Padan-Aram*; the latter being the general name of Syria; and the former signifying *fruitful*, a proper epithet for this country, which is really so to a very high degree, especially on the northern side, where it yields corn, wine, oil, fruits, and all necessaries of life in great abundance. Formerly it was the residence of many famed patriarchs, yet was overrun with the grossest idolatry, not only in the time of Abraham's coming out of it, and Jacob's sojourning in it, but likewise during the time it continued under the dominion of the Assyrians, Babylonians, Medes, Persians, and Romans. It received indeed the light of the gospel soon after our Saviour's ascension, from St Thaddæus, who is said to have been sent thither by St Thomas, at the request of Abgarus king of Edessa. This account, together with that monarch's letter to Jesus Christ, we have from Eusebius, who took it from the archives of that city; and the whole had passed current and uncontradicted for many ages, till more enlightened moderns found reasons to condemn it; but whether right or wrong, it plainly appears that Christianity flourished here in a most eminent manner, till its purity was sullied about the beginning of the sixth century by the heresy of the Jacobites, whose patriarch still resides here, with a jurisdiction over all that sect in the Turkish dominions.

Diarbeck Proper is a beglerbegate, under which are reckoned twelve sangiacs; and the principal towns in it are, Diarbekir or Caramed, Rika, Moussul, Orsa or Edessa, Elbir, Nisibis, Gezir Merdin, Zibin, Ur of the Chaldees, Amad, and Carasara; but all now of little note excepting Diarbekir and Moussul.

Diarbeck

Diarbekir

DIARBEKIR, the capital of the above district, is situated on a delightful plain, on the banks and near the head of the Tigris, about 155 miles, or 15 caravan days journey north-east from Aleppo, in latitude 37° 35′, east longitude 40° 50′. The bridge of 10 arches over the said river is said to have been built by the order of Alexander the Great. It is one of the richest and most mercantile cities in all Asiatic Turkey; and is well fortified, being encompassed with a double wall, the outermost of which is flanked with 72 towers, said to have been raised in memory of our Saviour's 72 disciples. It has several stately piazzas or market-places, well stored with all kinds of rich merchandise, and 12 magnificent mosques, said to have been formerly Christian churches. Its chief manufacture is the dressing, tanning, and dying of goats skins, commonly called *Turkey leather*, of which the vent is almost incredible in many parts of Europe and Asia: besides this, there is another of dyed fine linen and cotton cloths, which are nearly in the same request. The waters of the Tigris are reckoned extraordinary for those two branches of trade, and give red leather a finer grain and colour than any other. There is a good number of large and convenient inns on both sides of the river, for the caravans that go to and from Persia; and on the road near the town is a chapel with a cupola, where Job is said to lie buried. This place is much frequented by pilgrims of all nations and religions, and a Turkish hermit has a cell close to it. The fair sex, who, in most other parts of the Turkish empire, are kept quite immured, and considered as mere slaves, enjoy here an extraordinary liberty, and are commonly seen on the public walks of the city in company with the Christian women, and live in great friendship and familiarity with them. The same is said of the men, who are polite, affable, and courteous, and very different from what they affect to be, especially the Turks, in other cities of this empire. The city is under the government of a basha, who has great power and very large dominions. He has commonly a body of 20,000 horse under him, for repelling the frequent incursions of the Curdes and Tartars, who always go on horseback to rob the caravans. The adjacent territory is very rich and beautiful; the bread, wine, and flesh are excellent, the fruits exquisite, and the pigeons better and larger than any in Europe.

Mr Ives, who passed through this city in 1758, informs us, that "about two years ago it was very populous, its inhabitants amounting to 400,000 souls; but in the last year 300,000 died either by cold or famine. The Christians residing in the city before this calamity were reckoned to amount to 26,000, of whom 20,000 died. This account he had from one of the French missionaries, a Capuchin, who also said, that before the famine the city contained 60,000 fighting men, but that now they are not able to muster 10,000. He assures us, that the houses and streets, nay the very mosques, were filled with dead; that every part of the city exhibited a dreadful image of death; and that the surviving inhabitants not only greedily

greedily devoured all kinds of beasts, brutes, and reptiles, but also were obliged to feed on human bodies. Yet, in the midst of this scene of horror, the grandees of the city had every thing in plenty; for they had taken care to monopolize vast quantities of corn, which they sold out to the other inhabitants at most extravagant prices, and thereby acquired for themselves immense fortunes. Corn rose from two piastres a measure to 50, 60, and even 70, in the space of six months. The father added, that the very severe winter of 1756, and the locusts in 1757, were the causes of this dreadful visitation; for by reason of the former, there were but few acres of land sown with corn; and by the latter, the small crop they had was in a great measure destroyed. He spoke of the severity of that winter in terms almost incredible: that it was common to see the people fall down dead in the streets; that he himself once on quitting a warm room, and going into the open air, fell down motionless; and that his brother, in attempting to assist him, met with the same fate. This account of the effects of cold in the city of Diarbekir, which lies only in about 38° north, seems at first very surprising; but considering that the place stands on a rising gronnd in the midst of an extensive plain, and that the high Curdistan mountains lie to the south and east of it, and the Armenian or Turcomanian to the north, whose heads are always covered with snow, and even now in July supply the city with ice; it will not appear at all improbable, that in a very severe winter, such as that was in 1756, the inhabitants of this city should so severely feel the effects of it. This account of the missionary is most probably exaggerated in many particulars. General Gardanne reckons the population at 80,000, and Mr M'Donald Kinneir at no more than 38,000. The truth probably lies between these statements.

DIARRHOEA, or LOOSENESS, in *Medicine*, is a frequent and copious evacuation of liquid excrement by stool. See MEDICINE *Index*.

DIARTHROSIS, in *Anatomy*, a kind of articulation or juncture of the bones; which being pretty lax affords room for a manifest motion. The word comes from δια, and αρθρον, *juncture, assemblage*. It is opposed to *synarthrosis*, wherein the articulation is so close that there is no sensible motion at all. See ANATOMY, N° 2.

DIARY, a term sometimes used for a journal or daybook, containing an account of every day's proceedings. Thus we say, *diaries of the weather*, &c.

DIARY *Fever*, is a fever of one day. See EPHEMERA.

DIASCHISM, among musicians, denotes the difference between the comma and enharmonic diesis, commonly called the *lesser comma*.

DIASCORDIUM, in *Pharmacy*, a celebrated composition, so called from *scordium*, one of its ingredients. See PHARMACY.

DIASTOLE, among physicians, signifies the dilatation of the heart, auricles, and arteries; and stands opposed to the SYSTOLE, or contraction of the same parts. See ANATOMY *Index*.

DIASTOLE, in *Grammar*, a figure in prosody whereby a syllable naturally short is made long. Such is the first syllable of *Priamides* in the following verse of Virgil:

Atque hic Priamides! nihil ô tibi, amice, relictum.

DIASYRMUS, in *Rhetoric*, a kind of hyperbole, being an exaggeration of some low, ridiculous thing.

DIATESSARON, among ancient musicians, a concord or harmonical interval, composed of a greater tone, a less tone, and one greater semitone; its proportion in numbers is as 4 : 3.

DIATONICK, in *Music*, (compounded of two Greek words, viz. the preposition δια, signifying a transition from one thing to another, and the substantive τονος, importing a given degree of tension or musical note), is indifferently applied to a scale or gammut, to intervals of a certain kind, or to a species of music, whether in melody or harmony, composed of these intervals. Thus we say the *diatonick* series, a *diatonick* interval, *diatonick* melody or harmony. As the diatonick scale forms the system of diatonick music, and consists of diatonick intervals, it will be necessary, for understanding the former, that we should explain the latter. See INTERVAL.

DIATRAGACANTH, in *Pharmacy*, a name applied to certain powders, of which gum tragacanth is the chief ingredient.

DIBBLE, or DIBBER, a simple but useful instrument in gardening, used for planting out all sorts of young plants, &c.

DIBBLING WHEAT. See AGRICULTURE *Index*.

DIBIO, or DIVIO, in *Ancient Geography*, the *Divionense Castrum* and the *Divionum* of the lower age: a town of the Lingones, in Gallia Belgica: *Dibionenses* the people. Now *Dijon* the capital of Burgundy. E. Long. 5. 5. N. Lat. 47. 15.

DICE, among gamesters, certain cubical pieces of bone or ivory, marked with dots on each of their faces, from one to six, according to the number of faces.

Sharpers have several ways of falsifying dice. 1. By sticking a hog's bristle in them, so as to make them run high or low as they please. 2. By drilling and loading them with quicksilver; which cheat is found out by holding them gently by two diagonal corners: for if false, the heavy sides will turn always down. 3. By filing and rounding them. But all these ways fall far short of the art of the dice-makers; some of whom are so dexterous this way, that your sharping gamester will give any money for them.

Dice formerly paid 5s. every pair imported, with an additional duty of 4s. 9$\frac{45}{100}$d. for every 20s. value upon oath; but are now prohibited to be imported.

DICÆARCHUS, a scholar of Aristotle, composed a great number of books which were much esteemed. Cicero and his friend Pomponius Atticus valued him highly. He wrote a book to prove, that men suffer more mischief from one another than from all evils beside. And the work he composed concerning the republic of Lacedemon was extremely honoured, and read every year before the youth in the assembly of the ephori. Geography was one of his principal studies, on which science there is a fragment of a treatise of his still extant, and preserved among the *Veteris geographiæ scriptores minores*.

DICHONDRA, a genus of plants belonging to the pentandria class; and in the natural method ranking under the order *Campanaceæ*. See BOTANY *Index*.

DICHOTOMOUS, in *Botany*. See BOTANY *Index*.

DICHOTOMY, a term used by astronomers for that phasis or appearance of the moon, wherein she is bisected, or shows just half her disk. In this situation the moon is said to be in a quadrate aspect, or to be in her quadrature.

DICKER, in old writers, denotes the quantity of ten hides of skins whereof 20 made a last: also 10 pair of gloves, ten bars of iron, and the like, are sometimes expressed by the term *dicker*.

DICKINSON, EDMUND, a celebrated English physician and chemist, was born in 1624. He studied and took his degrees at Merton college, Oxford; and in 1659 published his *Delphi Phœnicizantes*, &c. in which he attempted to prove, that the Greeks borrowed the story of the Pythian Apollo, and all that rendered the oracle at Delphos famous, from the Holy Scriptures, and the book of Joshua in particular: a work that procured him great reputation both at home and abroad. He practised physic first at Oxford; but removing to London in 1684, his good fortune in recovering the earl of Arlington from a dangerous sickness, procured his promotion to be physician in ordinary to Charles II. and to his household. As that prince understood and loved chemistry, Mr Dickinson grew into great favour at court, and was continued in his appointments under James II. After the abdication, he retired from practice, and died in 1707. He published many other things, particularly *Physica vetus et vera*, &c. containing a system of philosophy, chiefly framed on principles collected from the Mosaic history.

DICRANUM, a genus of mosses, including various species, brought together from the *Mnium*, and *Bryum*, chiefly, and partly from the *Hypnum* of Linnæus. See Smith's *Flora Britannica*.

DICTAMNUS, WHITE DITTANY, or *Fraxinella*; a genus of plants belonging to the decandria class; and in the natural method ranking under the 26th order, *Multisiliquæ*. See BOTANY *Index*.

DICTATOR, a magistrate at Rome invested with regal authority. This officer was first chosen during the Roman wars against the Latins. The consuls being unable to raise forces for the defence of the state, because the plebeians refused to inlist if they were not discharged of all the debts they had contracted with the patricians, the senate found it necessary to elect a new magistrate with absolute and uncontrollable power to take care of the state. The dictator remained in office for six months, after which he was again elected if the affairs of the state seemed to be desperate; but if tranquillity was re-established, he generally laid down his power before the time was expired. He knew no superior in the republic, and even the laws were subjected to him. He was called dictator, because *dictus*, named by the consul, or *quoniam dictis ejus parebat populus*, because the people implicitly obeyed his command. He was named by the consul in the night *viva voce*, and his election was confirmed by the augurs. As his power was absolute, he could proclaim war, levy forces, conduct them against an enemy, and disband them at his pleasure. He punished as he pleased, and from his decision there lay no appeal, at least till latter times. He was preceded by 24 lictors with the *fasces*; during his administration, all other officers, except the tribunes of the people, were suspended, and he was the master of the republic. But amidst all this independence, he was not permitted to go beyond the borders of Italy; he was always obliged to march on foot in his expeditions; he never could ride in difficult and laborious marches without previously obtaining a formal leave from the people. He was chosen only when the state was in imminent danger from foreign enemies or inward seditions. In the time of a pestilence, a dictator was sometimes elected, as also to hold the *comitia* or to celebrate the public festivals, or drive a nail into the capitol, by which superstitious ceremony the Romans believed that a plague could be averted or the progress of an enemy stopped. This office, so respectable and illustrious in the first ages of the republic, became odious by the perpetual usurpations of Sylla and Julius Cæsar; and after the death of the latter, the Roman senate passed a decree which for ever after forbade a dictator to exist in Rome. The dictator, as soon as elected, chose a subordinate officer called his master of horse, *magister equitum*. This officer was respectable: but he was totally subservient to the will of the dictator, and could do nothing without his express order. This subordination, however, was some time after removed; and during the second Punic war the master of the horse was invested with a power equal to that of the dictator. A second dictator was also chosen for the election of magistrates at Rome after the battle of Cannæ. The dictatorship was originally confined to the patricians; but the plebeians were afterwards admitted to share it. Titus Lartius Flavus was the first dictator in the year of Rome, 253.

DICTION, the phrase, elocution or style, of a writer or speaker. See ORATORY, N° 99—122.

DICTIONARY, in its original acceptation, is the arranging all the words of a language according to the order of the alphabet, and annexing a definition or explanation to each word. When arts and sciences began to be improved and extended, the multiplicity of technical terms rendered it necessary to compile dictionaries, either of science in general, or of particular sciences, according to the views of the compiler.

DICTIONARY of the English Language. The design of every dictionary of language is to explain, in the most accurate manner, the meaning of every word; and to show the various ways in which it can be combined with others, in as far as this tends to alter its meaning. The dictionary which does this in the most accurate manner is the most complete. Therefore the principal study of a lexicographer ought to be, to discover a method which will be best adapted for that purpose. Dr Johnson, with great labour, has collected the various meanings of every word, and quoted the authorities: but, would it not have been an improvement if he had given an accurate definition of the precise meaning of every word; pointed out the way in which it ought to be employed with the greatest propriety; showed the various deviations from that original meaning, which custom had so far established as to render allowable; and fixed the precise limits beyond which it could not be employed without becoming a vicious expression? With this view, it would have been necessary to exhibit the nice distinctions that take place between words which are nearly synonymous. Without this, many words can only

only be defined in such a manner, as that they must be considered as exactly synonymous. We omit giving any quotations from Johnson, to point out these defects; and shall content ourselves with giving a few examples, to show how, according to our idea, a dictionary of the English language ought to be compiled.

IMMEDIATELY. *adv. of time.*

1. Instantly, without delay. Always employed to denote future time, and never past. Thus, we may say, *I will come immediately;* but not *I am immediately come from such a place.* See PRESENTLY.
2. Without the intervention of any cause or event; as opposed to *mediately.*

PRESENTLY. *adv. of time.*

1. Instantly, without delay. Exactly synonymous with *immediately;* being never with propriety employed to denote any thing but future time.
2. Formerly it was employed to express present time. Thus, *The house presently possessed by such a one,* was often used: but this is now become a vicious expression; and we ought to say, *The house possessed at present.* It differs from *immediately* in this, that even in the most corrupt phrases it never can denote past time.

FORM. *subst.* The external appearance of any object, when considered only with respect to shape or figure. This term therefore, in the literal sense, can only be applied to the objects of the sight and touch; and is nearly synonymous with *figure:* but they differ in some respects. *Form* may be employed to denote more rude and unfinished shapes; *figure,* those which are more perfect and regular. *Form* can never be employed without denoting matter; whereas *figure* may be employed in the abstract; thus, we say a square or a tringular *figure;* but not a square or triangular *form.* And in the same manner we say, the *figure* of a house; but we must denote the substance which forms that figure, if we use the word *form;* as, *a cloud of the form of a house,* &c. See FIGURE.

2. In contrast to irregularity or confusion. As beauty cannot exist without order, it is by a figure of speech employed to denote beauty, order, &c.
3. As *form* respects only the external appearance of bodies, without regard to their internal qualities, it is, by a figure of speech, employed in contrast to these qualities, to denote empty show, without essential qualities. In this sense it is often taken when applied to religious ceremonies, &c.
4. As *form* is employed to denote the external appearance of bodies; so, in a figurative sense, it is applied to reasoning, denoting the particular mode or manner in which this is conducted; as, *the form of a syllogism,* &c.
5. In the same manner it is employed to denote the particular mode of procedure established in courts of law; as, *the forms of law, religion,* &c.
6. *Form* is sometimes, although improperly, used to denote the different circumstances of the same body; as, *water in a fluid or a solid form.* But as this phrase regards the internal qualities rather than the external figure, it is improper; and ought to be, *water in a fluid or a solid state.*
7. But when bodies of different kinds are compared with one another, this term may be employed to denote other circumstances than shape or figure: for we may say, *a juice exsuding from a tree in the form of wax or resin;* although, in this case, the consistence, colour, &c. and not the external arrangement of parts, constitutes the resemblance.
8. From the regular appearance of a number of persons arranged in one long seat, such persons so arranged are sometimes called a *form;* as, *a form of students,* &c. And,
9. By an easy transition, the seat itself has also acquired that name.

GREAT. *adj.* A relative word, denoting largeness of quantity, number, &c. serving to augment the value of those terms with which it is combined, and opposed to *small* or *little.* The principal circumstances in which this word can be employed are the following:

1. When merely *in*animate objects are considered with regard to quantity, *great* is with propriety employed, to denote that the quantity is considerable; as, *a great mountain, great house,* &c. and it is here contrasted with *small.* When *great* is thus employed, we have no other word that is exactly synonymous.
2. When *in*animate objects are considered with regard to their extent, this term is sometimes employed, although with less propriety; as, *a great plain, a great field,* &c. And in this sense it is nearly synonymous with *large;* and they were often used indiscriminately, but with some difference of meaning: for, as *large* is a term chiefly employed to denote extent of superficies, and as *great* more particularly regards the quantity of matter; therefore, when *large* is applied to any object which is not merely superficial, it denotes that it is the extent of surface that is there meant to be considered, without regard to the other dimensions: whereas when the term *great* is employed, it has reference to the whole contents. If, therefore, we say, *a large house,* or *a large river,* we express that the house, the river, have a surface of great extent, without having any necessary connexion with the size in other respects. But if we say, *a great house,* or *a great river,* it at once denotes that they have not only a large surface, but are also of great size in every respect.
3. *Great,* when applied to the human species, never denotes the size or largeness of body, but is applied solely to the qualities of the mind. Thus, when we say that *Socrates was a great man,* we do not mean that he was a man of great size, but that he was a man who excelled in the endowments of the mind. The terms which denote largeness of size in the human body, are *big, bulky, huge,* &c.
4. *Great* is sometimes applied to the human species, as denoting high rank. In this case it is oftener used in the plural number than otherwise. Thus, we say simply *the great,* meaning the whole body of

of men in high station, as opposed to *mean*. It should seldom be employed in this sense, as it tends to confound dignity of rank with elevation of mind.

5. As this is a general term of augmentation, it may be joined with all nouns which denote *quantity*, *quality*, *number*, *excellence*, or *defects ;* or such as imply *praise*, *blame*, *anger*, *contempt*, or any other affection of the mind.

6. It is employed to denote every step of ascending or descending consanguinity ; as *great-grandfather*, *great-grandson*, &c.

HIGH. *adj.* Exalted in a perpendicular direction at a distance from the surface of the earth. Opposed to *low*.

1. *High* is a term altogether indefinite, and is employed to express the degree of elevation of any inanimate body. Thus, we say *a high mountain*, *a high house*, *steeple*, *tower*, *pillar*, &c. Nor is there any other word that can here be considered as synonymous ; *lofty* being employed only to denote a very eminent degree of elevation.

2. To express the perpendicular elevation of vegetables either *high* or *tall* may be employed, as being in this case nearly synonymus. We may therefore say, a *high* or *tall tree*, a *high* or *tall must*, &c. but with this difference between these two expressions, that *tall* can be more properly applied to those that are much elevated and of small dimensions ; and *high*, to such as are more bulky, and of greater size.

3. The perpendicular height of man can never be expressed by the word *high ; tall* being here the proper expression. And although *high* is sometimes used to express the height of other animals, yet it seems to be an improper expression. See TALL.

4. *High*, when applied to the human species, always refers to the mind ; and denotes *haughtiness*, *stateliness*, *pride*, &c. and, when combined with the expressions of any energy of the mind, it denotes that in a higher degree. In this sense, it is opposed to *meanness*, *abjectness*, and *humility*.

5. As this is an indefinite term, tending to denote any thing that is elevated above us, it may be combined with almost every noun which admits of this elevation. And as objects high above us are always out of our reach, it is in a metaphorical sense used to denote any thing that seems to be above the ordinary condition of mankind ; or those qualities or endowments of mind that are not easily acquired ; as, *dignity* or *elevation of sentiment ; dignity of rank ; acuteness in reasoning on difficult subjects ; pride*, *haughtiness*, or any other quality which seems beyond the ordinary level of mankind ; *dearness of price*, &c.

6. In the same manner we apply this term to time ; which having a metaphorical resemblance to a river flowing on with an unceasing current through all successive ages, any thing of remote antiquity is denoted by the term *high*.

7. Likewise those degrees of latitudes far removed from the line, where the pole becomes more elevated.

8. And to some particular crimes, as being attended with peculiar degrees of guilt ; as, *high treason*.

TALL. *adj.* Something elevated to a considerable degree in a perpendicular direction. Opposed to *low*.

1. This term is chiefly employed to express the height of man and other animals : and is applied to denote the height of the body only, without having any reference to the mind. When applied to man, no other word can be substituted in its stead : when applied to other animals, *high* is sometimes considered as nearly synonymous. See HIGH.

2. It is likewise employed to denote the perpendicular height of vegetables ; and in this case, it is nearly synonymous with *high*. See HIGH.

3. It can in no case be employed to express the height of merely inanimate objects ; as we can never say a *tall steeple*, *tower*, or *pillar*, but a *high steeple*, &c. For the distinctions in these cases, see HIGH.

LONG. *adj.* A relative term, denoting the distance between the extremes of any body, which is extended more in one of its geometrical dimensions than another. Opposed to *short*.

1. This term may be applied to all inanimate objects, of whatever kind, whose dimensions in one way exceed the other, and when not in an erect posture, whatever be the other circumstances attending them ; whether it relates to superficies alone, or to solid bodies ; whether these be bounded or open, straight or crooked, flexible or rigid, or in any other circumstances whatever : thus we say, *a long* or *short line*, *a long* or *short ridge*, *street*, *ditch*, *rope*, *chain*, *staff*, &c. But it is to be observed, that although *long* is in the strict sense only opposed to *short ;* yet as it expresses the extension of matter in one of its geometrical proportions, it is often contrasted by those words which express the other proportions when we mean only to describe the several proportions : as, *a table long and broad*. And as these several dimensions are expressed by different words, according to the various forms, modifications, and circumstances, in which bodies are found, therefore it is in this sense contrasted by a great diversity of terms : as, *a long and broad* or *wide*, *narrow* or *strait*, *street* or *lane ; a long and thick*, or *small rope*, *chain*, *staff*. For the distinctions in these cases, see BROAD, WIDE, &c.

2. Objects necessarily fixed in an erect position can never have this term applied to them ; and therefore we cannot say *a long*, but *a high*, *tower* or *steeple*. And for the same reason, while trees are growing and fixed in an erect position, we cannot apply this term to them ; but when they are felled and laid upon the ground, it is quite proper and necessary. Thus, we do not say *a long*, but *a tall* or *high tree*, while it is growing ; but we say *a long*, not *a tall log of wood ;* and in the same manner we say *a tall mast*, when it is fixed in the ship ; but *a long mast*, while it lies upon the beach. See TALL and HIGH.

3. Those vegetables which are of a tender pliant nature,

ture, or so weak as not to be able to retain a fixt position, being considered as of a middle nature between erect and prostrate bodies, admit of either the terms *long, tall, or high;* as *a long* or *tall rush* or *willow wand*, or *a long, tall*, or *high stalk of corn.* See High and Tall.

4. The parts of vegetables, when considered as distinct from the whole, even when growing and erect, assume the term *long:* for we do not say *a tall*, but *a long shoot of a tree;* and *a tree with a long stem*, in preference to *a tree with a high stem.*

5. For the same reason, a staff, and pole, even when fixed in a perpendicular direction, assume the word *long*, in preference to *tall* or *high.*

6. With regard to animals, the general rule is applied, without any exceptions: *tall*, and not *long*, being employed to denote the height of the human body, when in an erect posture; and *long*, and not *tall*, to denote its length when in an incumbent situation. *Long* applied to all other animals which do not walk erect, always denotes their greatest length in a horizontal position from head to tail.

7. In a figurative sense, it denotes, with regard to time, any thing at a great distance from us.

8. As also, any thing that takes up much time before it is finished; as *a long discourse*, *a protracted note in music*, &c.

BROAD. *adj.* The distance between the two nearest sides of any body, whose geometrical dimensions are larger in one direction than in another; and has a reference to superficies only, and never to the solid contents. Opposed to *narrow.*

1. *Broad*, in the strictest acceptation, is applied to denote those bodies only whose sides are altogether open and unconfined; as *a broad table*, *a broad wheel*, &c. and in these cases it is invariably contrasted by the word *narrow;* nor is there any other word which in these cases can be considered as synonymous with it, or used in its stead.

2. When any object is in some sort bounded on the sides, although not quite closed up, as a road, street, ditch, &c. either *broad* or *wide* may be employed, but with some difference of signification; *broad* being most properly used for those that are more open, and *wide* for those which are more confined: nor can this term be ever applied to such objects as are close bounded all around, as a house, a church, &c. *wide* being here employed. For the more accurate distinctions in these cases, see the article Wide.

WIDE. *adj.* A term employed to denote relative extent in certain circumstances. Opposed to *narrow* and *strait.*

1. This term is in its proper sense applied only to denote the space contained within any body closed all round on every side; as a house, gate, &c.: and differs from *broad* in this, that it never relates to the superficies of solid objects, but is employed to express the capaciousness of any body which containeth vacant space; nor can capaciousness in this sense be expressed by any other word but *wide.*

2. As many bodies may be considered either with respect to the capaciousness or superficial extent; in all these cases, either the term *broad* or *wide* may be used; as *a broad* or *wide street* or *ditch*, &c. but with a greater or less degree of propriety, according to the circumstances of the object, or the idea we wish to convey. In a street where the houses are low and the boundaries open, or in a ditch of small depth and large superficies, as this largeness of superficies bears the principal proportion, *broad* would be more proper; but if the houses are of great height, or the ditch of great depth, and capaciousness is the principal property that affects the mind, we would naturally say *a wide street* or *ditch;* and the same may be said of all similar cases. But there are some cases in which both these terms are applied, with a greater difference of meaning; thus we say *a broad* or *a wide gate:* But as the gate is employed to denote either the aperture in the wall, or the matter which closes that aperture, these terms are each of them used to denote that particular quality to which they are generally applied: and as the opening itself can never be considered as a superficies, the term *wide*, in this case, denotes the distance between the sides of the aperture; while on the contrary, *broad* denotes the extent of matter fitted to close that aperture; nor can these two terms in any case be substituted for one another.

3. As a figurative expression, it is used as a cant phrase for a mistake: as, *you are wide of the mark;* that is, not near the truth.

NARROW. *adj.* A relative term, denoting a proportional smallness of distance between the sides of the superficies of plain bodies. Opposed to *broad.*

1. As this is only applied to superficies, it is exactly contrasted by *broad*, and is applied in all cases where the term *broad* can be used, (see Broad); and in no other case but as a contrast to it, except the following.

2. It sometimes is employed to describe the smallness of space circumscribed between certain boundaries, as opposed to *wide*, and nearly synonymous with *straight;* as we say *a wide* or *a narrow house, church*, &c. For the necessary distinctions here, see the article Strait.

3. In a figurative sense it denotes *parsimony, poverty, confined sentiments*, &c.

STRAIT, *adj.* A relative term, denoting the extent of space in certain circumstances. Opposed to *wide;* see Wide.

1. This term is employed, in its proper sense, to denote only space, as contained between surrounding bodies in such circumstances as to denote some degree of confinement; and is exactly opposed to *wide;* as *a wide* or *a strait gate*, &c. See Wide.

2. So necessary is it that the idea of confinement should be connected with this word, that in all those cases where the space contained is large, as in a church, or house, we cannot express a smaller proportional width by this term. And as we have no other word to express space in these circumstances,

cumstances, we have been obliged to force the word *narrow* from its natural signification, and make it express this. See NARROW.

3. In some particular cases, *narrow* or *strait* may be applied to the same object: as, *a narrow* or *a strait line:* but here *strait* is never employed but where an idea of confinement is suggested, and where it is exactly contrasted to *wide:* nor can *narrow* be employed but in such circumstances where *broad* would be a perfect contrast to it. Therefore these two terms may be always used in the same circumstances as those which contrast them may be. For an account of which see WIDE.

4. The term *strait* is likewise in a peculiar manner used to denote the smallness of the internal diameter of those small bodies which are fitted to receive or contain others, as any kind of bag, tube, body clothes, mortoises, and others of the same kind; and in all these cases this term may be employed to denote the smallness of their lesser diameter, and never the term *narrow*. But in certain circumstances the word *tight* may be substituted for it. See TIGHT.

5. *Strait*, in a figurative sense, denotes any sort of confinement of sentiment or disposition.

TIGHT. *adj.* A term employed in certain circumstances to denote the internal capacity of particular bodies. Nearly synonymous with *strait*.

This term is confined entirely to denote the smallness of the internal dimensions of such objects, as are formed to cover or to receive or contain other solid bodies, and can be employed in no other case. And although it agrees with *strait*, in always denoting confinement, and by being applicable to the same species of objects, yet it differs in the following respects: 1. If there be any difference of the diameter of the objects to which the term *strait* can be applied, it always has reference to the smaller; yet *tight* may be applied to any sort of confinement, whether it regards the length or breadth. 2. *Strait* can be applied to all bodies of capacity when of small diameter, without any sort of reference to the nature of the substance which it may be capable of containing. For we can say a *strait bag*, *a strait sleeve*, *a strait mortoise*, *a strait gate*, &c. whereas *tight* can only be applied to any body when it is considered as having reference to another body which is intended to be contained in it, and is pinched from want of room. Thus we say, *the sleeve of a coat is too tight for the arm*, *the mortoise is too tight for the tenon*, &c.: but we cannot say *the bag or the gate is too tight*, because they are fitted to receive any sort of objects. And hence it happens that in many cases the dimensions of the same body may be expressed by *tight* or *strait* when considered in different circumstances. Thus we may say, *this sleeve is too strait*, when we look at a coat when lying on the table and consider its proportions; but it is not till we have tried it upon the arm that it is intended to cover, that we call it *tight*. And we may say, *a gate is too strait* or *too tight:* but in this first case we consider it as being too confined for admitting objects to pass through it; and in the last, as being too confined with respect to the leaves that are to shut the aperture, not allowing them space to move with freedom.

These examples may serve to give some idea of the plan of an English Dictionary composed upon philosophical principles: But, besides the circumstances above enumerated, there are many others which would require particular attention in the execution of a work of this kind. In the English language, a great variety of terms occur, which denote matter under certain general forms or circumstances, without regarding the minute diversities that may take place; as the word *cloth*, which denotes matter as manufactured into a particular form, including under it all the variety of stuffs manufactured in that particular way, of whatever materials, colour, texture or fineness, they may be. The same may be said of *wood*, *iron*, *yarn*, and a great variety of terms of the same nature, some of which cannot assume any plural; while others admit of it in all cases, and others admit or refuse it according to the different circumstances in which they are considered.

In a dictionary, therefore, all this variety of cases ought to be clearly and distinctly pointed out under each particular article: this is the more necessary, as some of these words have others formed from them which might be readily mistaken for their plurals, although they have a very different signification; as *clothes*, which does not denote any number of pieces of different kinds of *cloth*, but *wearing apparel*. The following example will illustrate this head.

WOOD. *subst.* A solid substance of which the trunks and branches of trees consist.

1. This term is employed to denote the solid parts of vegetables of all kinds, in whatever form or circumstances they are found. Nor does this term admit of plural with propriety, unless in the circumstances after mentioned: for we say, many *different kinds of wood*, in preference to *many kinds of woods;* or we say, *oak*, *ash*, or *elm wood*, not *woods*.

2. But where we want to contrast wood of one quality or country with that of another, it admits of a plural: for we say, *white woods are in general softer than red;* or *West Indian woods are in general of greater specific gravity than the European woods:* But unless where the colour, or some quality which distinguishes it from growing wood, is mentioned, this plural ought as much as possible to be avoided, as it always suggests an idea of growing wood.

3. *Wood* likewise denotes a number of trees growing near one another; being nearly synonymous with *forest:* See FOREST. In this sense it always admits of a plural; as, *Ye woods and wilds whose solitary gloom*, &c.

A dictionary cannot be reckoned complete without explaining obsolete words; and if the terms of the several provincial dialects were likewise given, it would be of great utility: nor would this take much time; because a number of these words needs no other explanation than to mark along with them the words which had come in their place, when there happened to be one perfectly synonymous: and in those cases where the

the same idea could not be expressed in modern language without a periphrasis, it would be of use to explain them distinctly; so that, when a writer found himself at a loss for a term, and obliged to search for one beyond the bounds of our own language, he might take one of these, when he found that it was expressive and energetic, in preference to another drawn from a foreign language. This would at least have one good effect: it would make our language more fixed and stable; not to say more accurate and precise, than by borrowing from foreign languages. The following examples may serve to give some idea of the manner of treating this part of the work.

MOE, or MO. *adj.* An obsolete term still employed in the Scotch dialect, and by them pronounced *mae;* denoting a greater number, and nearly synonymous with *more:* but it differs in this respect, that in the Scotch dialect, *mae* and *mair* (English *more*), are each employed in their distinct sphere, without encroaching upon one another; *mae* being employed to denote number, but never quantity or quality; and *mair*, to denote quantity and quality, but never number: thus they say *mae*, not *mair*, *apples*, *men*, &c. and they say *mair*, not *mae*, *cloth*, *earth*, *courage*, &c. See MAIR. Both of these terms are supplied by the word *more;* which in the English language is applied indiscriminately to denote quantity, quality, and number. See MORE.

THIR.pron. Obsolete; still employed in the Scotch dialect: the plural of *this;* and contrasted to *these*, in the same manner as *that* is to *this*.

As there is no word in the English language equivalent to this, we thus show the manner in which it is employed. In the English language we say, *that stone* or *house*, pointing at one at a distance, *is larger* or *more commodious than this stone* or *this house*, which is supposed to be at hand. In the same manner, in the Scotch dialect, they say, *these* (or, as it is pronounced, *thae*) *stones are whiter than thir stones;* denoting, that the former are at a distance, and the latter at hand. And, in the same manner, it is invariably applied to denote any present object in the plural manner, as opposed to *these:* as *these* or *thir apples*, as at hand, or at a distance; *these*, or *thir trees*, &c.; but never in the singular number, as it is always *this* or *that tree*, *house*, &c.

As the English language is so exceedingly irregular in the pronunciation, the same letter in the same situation often assuming sounds totally different in different words, it is impossible to establish any general rules, on this subject, which do not admit of many exceptions: therefore, a dictionary is the best means of ascertaining and pointing out the proper pronunciations of words. For, if the writer first pointed out all the different sounds that the same letter could ever be made to express, and assigned to every particular sound which each letter could be made to assume, a particular mark, which was appropriated to denote that particular sound of the letter whenever it occurred; by placing these particular marks above the letters in the dictionary, the sound of each letter would be pointed out in all cases with the utmost certainty. It would be impossible for us to illustrate this by examples, without first ascertaining all the sounds of each letter; which would lead us into a discussion too long for this place.

We shall only further observe, That, besides having the accented syllable of every word *properly* distinguished in a dictionary to assist in the pronunciation, the English language requires another essential improvement, viz. the use of accents to distinguish the meaning of *words* and *phrases:* which, although, it is not so properly confined to a lexicographer, yet it is not quite without his sphere. Thus the word *as* admits of two very different sounds, as well as different significations; as in this example, "Cicero was nearly *as* eloquent *as* Demosthenes:" in which the first *as* is pronounced *ass*, and the last is pronounced *az*. Now, it often happens, that, in reading, the particular way in which it ought to be understood is not pointed out by the context, till after the word itself is pronounced, which has an equal chance at least of being pronounced wrong; whereas, if it were always accented when employed in the one sense, and not in the other, it would free the reader from this perplexity. There are other cases in which the use of proper accents in writing would be of great consequence; as at the beginning of a sentence, when it was put as a question, or used ironically, &c. the want of which every one must have observed. But as this does not so properly belong to the lexicographer as the grammarian, we shall here take no further notice of it.

The above examples, we hope, will be sufficient to give the reader some idea of the plan that we would propose; and enable him to determine, whether or not a dictionary, executed upon this plan, would convey to his mind a more perfect knowledge of the English language, than those dictionaries that have been hitherto published. These examples were given rather with a view to show the manner in which a work of this kind might be conducted, than as perfect and unexceptionable explanations of the several articles there enumerated; and therefore we did not think it necessary to produce any authorities, although we are sensible that they would be requisite in such a work.

DICTYMNIA, or DICTYNNIA, in *Mythology*, were feasts celebrated at Lacedæmon and in Crete, in honour of Diana Dictymnia or Dictynnia, or of a nymph taken for her, who, having plunged herself into the sea, to escape the passion of Minos, was caught in a fisherman's net or δικτυον, whence the name.

DICTYS CRETENSIS, a very ancient historian, who serving under Idomeneus king of Crete in the Trojan war, wrote the history of that expedition in nine books; and Tzetzes tells us, that Homer formed his Iliad upon the plan of that history. It is however maintained, that the Latin history of Dictys which we have at present is spurious.

DIDACTIC, in the schools, signifies the manner of speaking or writing, adapted to teach or explain the nature of things. The word is formed from the Greek διδασκω, *doceo*, "I teach."

There are many words which are only used in the didactic and dogmatic way; and there are many works, ancient and modern, both in prose and verse, written after this method: such are the Georgics of Virgil, Lucretius's poem De Rerum Natura, and Pope's Essays on Criticism and on Man, &c. &c.

DIDAPPER. See COLYMBUS, ORNITHOLOGY *Index*.

DIDELPHIS, or OPOSSUM, a genus of quadrupeds belonging to the order of feræ. See MAMMALIA *Index*.

DIDEROT, DENYS, an eminent French writer, was the son of a cutler, and born at Langres in the year 1713. He received his education among the Jesuits, and being destined for the church by one of his uncles, who had a canonry to bestow upon him, he had received the tonsure. But he discovered so little inclination for the ecclesiastical profession, that his father sent him to Paris to prosecute his studies, and afterwards placed him with an attorney. It soon appeared, however, that he was more attached to different departments of literature and science, than disposed to submit to the drudgeries of the profession to which his father had destined him; and having thus neglected his business, his allowance was withheld, which obliged him to make provision for himself. The studies to which Diderot devoted his attention were extremely various. Physics, geometry, metaphysics, moral philosophy, and belles lettres, were at different times the objects of his pursuit. He even indulged in poetry and works of invention; but attached himself chiefly to more serious studies. He possessed a ready flow and great animation of language in conversation; and these qualities, with a decisive tone and manner, procured for him partizans and protectors.

One of the first of his publications was a translation of "Stanyan's History of Greece." In the year 1745 he published "Principles of Moral Philosophy," 12mo, a work by which he obtained some reputation. But the year following, when he published a piece entitled *Pensees Philosophiques*, he acquired considerable celebrity. This work was highly commended by the partizans of the new philosophy, among whom he had now enlisted himself, and became one of its most zealous disciples. The same work was afterwards reprinted under the title of *Etrennes aux Esprits Forts*. It was greatly read, and it is supposed contributed much to the diffusion of those free opinions which had now become so prevalent in France. Soon after this period, in conjunction with his friend D'Alembert, the plan of the vast undertaking, the *Dictionaire Encyclopedique*, was laid. The professed object of this work was to become a magazine for every branch of human knowledge: but at the same time, it has been alleged that it was also intended by the authors and editors as the great engine by means of which the established opinions, whether of a religious or political nature, which they supposed had their origin in fraud and superstition, should be subverted. The province of this work which was entrusted to Diderot was the description of Arts and Trades, (*Arts et Metiers*). But, besides, he contributed many other articles in various departments of science. His writings in the Dictionary have been considered as extremely verbose and diffuse; and in all of them he is too fond of metaphysical subtleties and the pompous parade of scientific language. The first edition of the Dictionary was completed between the years 1751 and 1767; and although Diderot was occupied in this laborious undertaking for a period of nearly 20 years, the recompense which he obtained is said to have been extremely small.

During this time he composed various other works. Among these he published, "A letter on the Blind, for the use of those who see." This work made a good deal of noise, and in consequence of some of the sentiments which it contained, had given offence to the government, for which the author was kept in confinement for six months at Vincennes. This piece was soon followed by another, entitled "A letter on the Deaf and Dumb, for the use of those who hear and speak," 2 vols 12mo, 1751. "The sixth Sense," published in 1752; "Thoughts on the interpretation of Nature," 1754; "The Code of Nature," 1755, are similar works, and may be ranked in the same class. His moral character was considerably affected by the publication of *Bijoux Indiscrets*, 2 vols 12mo; which is a collection of licentious tales; for this indeed he made some kind of compensation, when he published two prose comedies, *Le Fils Naturel*, 1757; and *Le Pere de Famille*, 1758; which are not only interesting as dramatic pieces, but exhibit a pure and correct morality. The latter is considered as one of the best comedies of the sentimental kind which has appeared on the French stage. It has indeed received universal admiration. He published afterwards a pamphlet, "On Public Education," which contains undoubtedly some useful hints; but at the same time it proposes many things which are impracticable. To the list of his works now mentioned we may add, "An Eulogy on Richardson," which is full of warmth and enthusiasm; and "An Essay on the Life and Writings of Seneca the Philosopher." This was his last work, and was published in 1779. Among some observations on this work by the Monthly Reviewers, the author of it is thus characterized: "The works of M. Diderot, says the writer, have long since disgusted the modest votaries of true philosophy, by the tone of arrogance and self-sufficiency, and the froth and fumes of a declamatory eloquence, that form their essential and distinctive character." "It contains, it is farther added, like the other writings of that author, a glaring mixture of good and bad; of brilliant thoughts and obscure reasonings; of sentences that dart from the imagination with the energy of lightning, and cloudy periods of metaphysical rhetoric, that convey either no ideas, or false ones."

The character of Diderot suffered considerably from some defamatory attacks which he made on his former friend Rousseau, who had quarrelled with the French philosophers and had separated himself from their school. From the "Confessions" of the Genevan philosopher, it would appear that they expected some anecdotes which would not have been much to their honour. In one of his letters Rousseau thus speaks of Diderot. His words are remarkable, as they are equally applicable to his own character. "Although born with a good heart and an open disposition, he had an unfortunate propensity to misinterpret the words and actions of his friends; and the most ingenuous explanations only supplied his subtle imagination with new interpretations against them." Diderot was married and had a family; and although he possessed some irritability of temper, he was a kind husband and a tender parent. At the conclusion of the Dictionary, the state of his affairs rendered

dered it necessary for him to dispose of his library. It was purchased by the empress of Russia, who, with the king of Prussia, was at that time the great encourager and promoter of literature and literary men. These sovereigns were also considered as disciples of the French school. The price which Diderot received for his library was 50,000 livres; and he was to have the use of it during his life. Some of his biographers, with what truth we pretend not to say, have not hesitated to charge him with disposing of it a second time; and when some person commissioned by the empress wished to see it, the philosopher declined the visit by excuses till he had time to fill it with books borrowed from booksellers. The examination, it is obvious, must have been extremely superficial, otherwise the truth would have been at once detected. Diderot had been admitted a member of the Academy of Sciences at Berlin. He died suddenly, as he rose from table, on July 31st, 1784. His literary and philosophical works have been collected and published in 6 vols 8vo.

DIDO, called also ELISA, a daughter of Belus king of Tyre, who married Sichæus or Sicharbas her uncle, who was priest of Hercules. Pygmalion, who succeeded to the throne of Tyre after Belus, murdered Sichæus to get possession of the immense riches which he had; and Dido, disconsolate for the loss of her husband, whom she tenderly loved, and by whom she was equally esteemed, set sail in quest of a settlement with a number of Tyrians, to whom the cruelty of the tyrant became odious. According to some accounts, she threw into the sea the riches of her husband which Pygmalion so greedily desired, and by that artifice compelled the ships to fly with her that had come by order of the tyrant to obtain the riches of Sichæus. During her voyage, Dido visited the coast of Cyprus; where she carried away 50 women who prostituted themselves on the sea-shore, and gave them as wives to her Tyrian followers. A storm drove her fleet on the African coast, and she bought of the inhabitants as much land as could be covered by a bull's hide cut into thongs. Upon this piece of land she built a citadel called *Byrsa;* and the increase of population, and the rising commerce among her subjects, soon obliged her to enlarge her city and the boundaries of her dominions. Her beauty as well as the fame of her enterprise, gained her many admirers; and her subjects wished to compel her to marry Iarbas king of Mauritania, who threatened them with a dreadful war. Dido begged three months to give her decisive answer: and during that time she erected a funeral pile, as if wishing by a solemn sacrifice to appease the manes of Sichæus, to whom she had promised eternal fidelity. When all was prepared, she stabbed herself on the pile in presence of her people; and by this uncommon action obtained the name of *Dido*, "valiant woman," instead of Elisa. According to Virgil and Ovid, the death of Dido was caused by the sudden departure of Æneas; of whom she was deeply enamoured, and whom she could not obtain as a husband. This poetical fiction represents Æneas as living in the age of Dido, and introduces an anachronism of near 300 years. Dido left Phœnicia 247 years after the Trojan war or the age of Æneas, that is, about 953 years before Christ. This chronological error proceeds not from the ignorance of the poets, but it is supported by the authority of Horace.

Aut famam sequere, aut sibi convenientia finge.

While Virgil describes, in a beautiful episode, the desperate love of Dido, and the submission of Æneas to the will of the gods, he at the same time gives an explanation of the hatred which existed between the republics of Rome and Carthage; and informs his reader, that their mutual enmity originated in their very first foundation, and was apparently kindled by a more remote cause than the jealousy and rivalship of two flourishing empires. Dido after her death was honoured as a deity by her subjects.

DIDUS, or DODO, a genus of birds belonging to the order of gallinæ. See ORNITHOLOGY *Index*.

DIDYMUS of Alexandria, an ecclesiastical writer of the fourth century; who, though he is said to have lost his eyes at five years of age, when he had scarcely learned to read, yet applied so earnestly to study, that he attained all the philosophic arts in a high degree, and was thought worthy to fill the chair in the famous divinity school at Alexandria. He was the author of a great number of works: but all we have now remaining are, a Latin translation of his book upon the Holy Spirit, in the works of St Jerome, who was the translator; short strictures on the Canonical Epistles; and a book against the Manichees.

DIDYNAMIA, (from δις, *twice*, and δυναμις, *power*), the name of the 14th class in Linnæus's sexual method, consisting of plants with hermaphrodite flowers, which have four stamina or male organs, two of which are long and two short. See BOTANY *Index*.

DIEMEN'S LAND, formerly supposed to be the southern coast or point of New Holland, but now found to be an island, as it is separated from New Holland by Bass's strait, which was discovered by Mr Bass and Lieutenant Flinders in the end of the year 1798. The northern coast is in S. Lat. 40° 55′, and between 146° 45′ and 148° 15′ E. Long. This coast was discovered in November 1642, by Tasman, who gave it the name of *Van Diemen's Land*. Captain Furneaux touched at it in March 1773, and the country has since been further explored by other navigators. Here is a very safe road, named by Captain Cook *Adventure Bay*. Two other harbours or bays were discovered or explored by Messrs Bass and Flinders, viz. Port Dalrymple and Frederick Henry bay, and two considerable rivers, which have been called *Port Dalrymple* and *Derwent rivers*. The parts adjoining to Adventure bay are mostly hilly, and form an entire forest of tall trees, rendered almost impassable by brakes of fern, shrubs, &c. The soil on the flat land, and on the lower part of the hills, is sandy, or consists of a yellowish earth, and in some parts of a reddish clay; but further up the hills it is of a gray rough cast. The forest trees are all of one kind, generally quite straight, and bearing clusters of small white flowers. The principal plants observed were wood-sorrel, milk-wort, cudweed, bell-flower, gladiolus, samphire, and several kinds of fern. The only quadruped seen distinctly was a species of opossum, about twice the size of a large rat. The kanguroo, found farther northward in New Holland, may also be supposed to inhabit here, as some of the inhabitants had

had pieces of the skin of that animal. The principal sorts of birds in the woods are brown hawks or eagles, crows, large pigeons, yellowish paroquets, and a species which was called *motacilla cyanea*, from the beautiful azure colour of its head and neck. On the shore were several gulls, black oyster-catchers or sea-pies, and plovers of a stone colour. In the woods were seen some blackish snakes of a pretty large size; and a species of lizard fifteen inches long and six round, beautifully clouded with yellow and black. Among a variety of fish caught, were some large rays, nurses, leather-jackets, bream, soles, flounders, gurnards, and elephant fish. Upon the rocks are muscles and other shell-fish, and upon the beach were found some pretty Medusa's heads. The most troublesome insects met with were the moschettoes; and a large black ant, the bite of which inflicts extreme pain.

The inhabitants seemed mild and cheerful, with little of that wild appearance which savages in general have. They are almost totally devoid of personal activity or genius, and are nearly upon a par with the wretched natives of Terra del Fuego. They display, however, some contrivance in their method of cutting their arms and bodies in lines of different directions, raised above the surface of the skin. Their indifference for presents offered them, their general inattention and want of curiosity, were very remarkable, and testified no acuteness of understanding. Their complexion is a dull black, which they sometimes heighten by smutting their bodies, as was supposed from their leaving a mark behind on any clean substance. Their hair is perfectly woolly, and is clotted with grease and red ochre like that of the Hottentots. Their noses are broad and full, and the lower part of the face projects considerably. Their eyes are of a moderate size; and though they are not very quick or piercing, they give the countenance a frank, cheerful, and pleasing cast. Their teeth are not very white nor well set, and their mouths are wide; they wear their beards long and clotted with paint. They are upon the whole well proportioned, though their belly is rather protuberant. Their favourite attitude is to stand with one side forward, and one hand grasping across the back the opposite arm, which on this occasion hangs down by the side that projects.

A British colony was established here in 1804, and received a considerable augmentation in 1808, when Norfolk island was abandoned. The whole territory is now divided into two counties, Buckingham and Cornwall. Two towns, Port Dalrymple on the north, and Hobart town, 120 miles south from it, have been built, and some subordinate settlements made. A considerable quantity of ground is under cultivation, and affords more certain and abundant harvests than any of the settlements in New Holland. In 1810 the number of settlers was 1321. A regular intercourse is kept up with Botany Bay, and a newspaper is published every fortnight in this remote region.

DIEMERBROEK, Isbrand, a learned professor of physic and anatomy at Utrecht, was born at Montfort, in Holland, in 1609, where he acquired great reputation by his lectures and his practice; and died at Utrecht in 1674. He wrote a treatise on the plague, which is esteemed; and several learned works in anatomy and medicine, which were printed at Utrecht in 1685 in folio.

DIEPPE, a handsome sea-port town of France, in Upper Normandy, in the department of the lower Seine, with a good harbour, an old castle, and two handsome moles. The parish church of St James is an elegant structure; and there is a tower from which, in fine weather, the coast of England may be seen. The population amounts to 20,000. The principal trade consists in the fisheries, ivory, toys, and laces. It was bombarded by the English in 1694, and it is not now so considerable as it was formerly. It is seated at the mouth of the river Bethune, in E. Long. 1. 4. N. Lat. 47. 55.

DIES MARCHIÆ, was the day of congress or meeting of the English and Scots, annually appointed to be held on the marches or borders, in order to adjust all differences between them.

DIESIS in *Music*, is the division of a tone less than a semitone; or an interval consisting of a less or imperfect semitone.

Diesis is the smallest and softest change or inflexion of the voice imaginable; it is called a *faint*, expressed thus X, by a St Andrew's cross or saltier.

DIESPITER, in antiquity, a name given to Jupiter; and signifying *dici pater*, "father of the day." St Augustin derives the name from *dies*, "day," and *partus*, "production, bringing forth;" it being Jupiter that brings forth the day. Of which sentiment were Servius and Macrobius; the former adding, that in the language of the Osci they called him *Lucencius*, as *Diespiter* in Latin.

DIET, in *Medicine*, according to some, comprehends the whole regimen or rule of life with regard to the six non-naturals; air, meats and drinks, sleep and watching, motion and rest, passions of the mind, retentions and excretions. Others restrain the term of *diet* to what regards eating and drinking, or solid aliments and drinks. See Food.

The natural constitution of the body of man is such, that it can easily bear some change and irregularities without much injury. Had it been otherwise, we should be almost constantly put out of order by every slight cause. This advantage arises from those wonderful communications of the inward parts, whereby, when one part is affected, another comes immediately to its relief.

Thus, when the body is too full, nature causes evacuations through some of the outlets; and for this reason it is, that diseases from inanition are generally more dangerous than from repletion; because we can more expeditiously diminish than increase the juices of the body. Upon the same account, also, though temperance be beneficial to all men, the ancient physicians advised persons in good health, and their own masters, to indulge a little now and then, by eating and drinking more plentifully than usual. But, of the two, intemperance in drinking is safer than in eating; and if a person has committed excess in the latter, cold water drank upon a full stomach will help digestion; to which it will be of service to add lemon juice, or elixir of vitriol. If he has eaten high-seasoned things, rich sauces, &c. then let him sit up for some little time, and afterwards sleep. But if a man happen to be obliged to fast, he ought to avoid all laborious work. From satiety it is not proper to pass directly to sharp hunger, nor from hunger to satiety; neither will it be safe to indulge absolute rest immediately after excessive labour, nor suddenly to fall to hard work after long idleness. In a word, therefore, all changes in the way of living should be made by degrees.

The softer and milder kinds of aliment are proper for children, and for youth the stronger. Old people ought to lessen the quantity of their food, and increase that of their drink; but yet some allowance is to be made for custom, especially in the colder climates like ours; for as in these the appetite is keener, so is the digestion better performed. Mead's *Monita et Præcepta.*

Diet Drinks, a form in *Physic*, including all the medicated wines, ales, and wheys, used in chronic cases. They require a course or continuation to answer any intention of moment.

Diet of Appearance, in *Scots Law*, the day to which a defender is cited to appear in court; and every other day to which the court shall afterwards adjourn the consideration of the question.

Diet, or *Dyet*, in matters of policy, is used for the general assembly of the states or circles of the empire of Germany and of Poland, to deliberate and concert measures proper to be taken for the good of the public.

The general diet of the empire is usually held at Ratisbon. It consists of the emperor, the nine electors, and the ecclesiastical princes; viz. the archbishops, bishops, abbots, and abbesses; the secular princes, who are dukes, marquises, counts, viscounts, or barons; and the representatives of the imperial cities.—It meets on the emperor's summons, and any of the princes may send their deputies thither in their stead. The diet makes laws, raises taxes, determines differences between the several princes and states, and can relieve the subjects from the oppressions of their sovereigns.

The diet of Poland, or the assembly of the states, consisted of the senate and deputies, or representative of every palatinate or county and city; and usually met every two years, and oftener upon extraordinary occasions, if summoned by the king, or, in his absence, by the archbishop of Gnesna. The general diet of Poland sat but six weeks, and often broke up in a tumult much sooner; for one dissenting voice prevented their passing any laws, or coming to any resolutions, on what was proposed to them from the throne. Switzerland has also a general diet, which is usually held every year at Baden, and represents the whole Helvetic body; it seldom lasts longer than a month. Besides this general diet, there are diets of the Protestant cantons, and diets of the Catholic ones; the first assemble at Araw, and are convoked by the canton of Zurich; the second at Lucern, convoked by the canton of that name.

DIETETIC, that part of physic which treats of diet. See Diet, Food, and Drink, in this work, and Dietetic in the Supplement.

DIETRICH, or Dietricy, Christian William Ernest, a modern artist, who was born at Weimar in 1712. He resided chiefly at Dresden, where he was professor of the Academy of Arts. He was a painter of very extensive abilities, and succeeded both in history and landscape. We have by him a great number of small subjects, to the amount of 150 or more, which he engraved from his own compositions, in the style (says Basan) of Ostade, of Lairesse, and of Salvator Rosa. Sixty of these etchings are exceedingly rare.

DIETS, a town in the circle of the Upper Rhine in Germany, situated on the river Lohn, 20 miles north of Mentz, and subject to the house of Nassau-Orange. E. Long. 7. 40. N. Lat. 50. 28.

DIEU et mon droit, i. e. *God and my right*, the motto of the royal arms of England, first assumed by King Richard I. to intimate that he did not hold his empire in vassalage of any mortal.

It was afterwards taken up by Edward III. and was continued without interruption to the time of the late King William, who used the motto *Je maintiendray*, though the former was still retained upon the great seal. After him Queen Anne used the motto *Semper eadem*, which had been before used by Queen Elizabeth; but ever since Queen Anne, *Dieu et mon droit* continues to be the royal motto.

DIFF, is the name of an instrument of music among the Arabs, serving chiefly to beat time to the voice; it is a hoop, sometimes with pieces of brass fixed to it to make a jingling, over which a piece of parchment is distended. It is beat with the fingers, and is the true *tympanum* of the ancients.

DIFFARREATION, among the Romans, a ceremony whereby the divorce of their priests was solemnized. The word comes from the preposition *dis;* which is used, in composition, for *division* or *separation;* and *farreatio*, a ceremony with wheat, of *far*, "wheat."

Diffarreation was properly the dissolving of marriages contracted by confarreation; which were those of the pontifices or priests. Festus says, it was performed with a wheaten cake. Vigenere will have confarreation and diffareation to be the same thing.

DIFFERENCE, in *Mathematics*, is the remainder, when one number or quantity is subtracted from another.

Difference, in *Logic*, an essential attribute, belonging to some species, and not found in the genus; being the idea that defines the species. Thus body and spirit are the two species of substance, which in their ideas include something more than is included in the idea of substance. In body, for instance, is found impenetrability and extension; in spirit, a power of thinking and reasoning; so that the difference of body is impenetrable extension, and the difference of spirit is cogitation.

Difference, in *Heraldry*, a term given to a certain figure added to coats of arms, serving to distinguish one family from another; and to show how distant younger branches are from the elder or principal branch.

DIFFERENTIAL, (*Differentiale*,) in the higher geometry, an infinitely small quantity, or a particle of quantity so small as to be less than any assignable one. It is called a *differential*, or *differential quantity*, because frequently considered as the difference of two quantities; and, as such, is the foundation of the *differential calculus:* Sir Isaac Newton, and the English, call it a *moment*, as being considered as the momentary increase of quantity. See Fluxions.

Differential Equation, is an equation involving or containing differential quantities; as the equation

$3x^2dx$

$3x^2dx-2axdx+aydx+axdy=0$. Some mathematicians, as Stirling, &c. have also applied the term differential equation in another sense, to certain equations defining the nature of series.

Differential *Method*, a method of finding quantities by means of their successive differences. See Differential Calculus, Supplement.

It is of very general use, especially in the construction of tables, and the summation of series. It was first used, and the rules of it laid down, by Briggs, in his construction of Logarithms and other Numbers, much the same as they were afterwards taught by Cotes, in his *Constructio Tabularum per Differentias.*

The method was next treated in another form by Newton in the 5th Lemma of the 3d book of his *Principia*, and in his *Methodus Differentialis*, published by Jones in 1711, with the other tracts of Newton. This author here treats it as a method of describing a curve of the parabolic kind, through any given number of points. He distinguishes two cases of this problem; the first when the ordinates drawn from the given points to any line given in position, are at equal distances from one another; and the second, when these ordinates are not at equal distances. He has given a solution of both cases, at first without demonstration, which was afterwards supplied by himself and others: see his *Methodus Differentialis* above mentioned; and Stirling's Explanations of the Newtonian Differential Method, in the Phil. Trans. N° 362.; Cotes, *De Methodo Differentiali Newtoniana*, published with his *Harmonia Mensurarum*: Herman's *Phoronomia*: and Le-Seur and Jacquier, in their Commentary on Newton's *Principia*. It may be observed, that the methods there demonstrated by some of these authors extend to the description of any algebraic curve through a given number of points, which Newton, writing to Leibnitz, mentions as a problem of the greatest use.

By this method, some terms of a series being given and conceived as placed at given intervals, any intermediate term may be found nearly; which therefore gives a method for interpolation. Briggs's *Arith. Log. ubi supra*: Newton, *Method. Differ.* prop. 5.; Stirling, *Methodus Differentialis.*

Thus also may any curvilinear figure be squared nearly, having some few of its ordinates. Newton, *ibid.* prop. 6.; Cotes *De Method. Differ.*; Simpson's Mathematical Dissert. p. 115. And thus may mathematical tables be constructed by interpolation: Briggs, *ibid.* Cotes *Canonotechnia.*

The successive differences of the ordinates of parabolic curves, becoming ultimately equal, and the intermediate ordinate required being determined by these differences of the ordinates, is the reason for the name Differential Method.

To be a little more particular.—The first case of Newton's problem amounts to this: A series of numbers, placed at equal intervals, being given, to find any intermediate number of that series, when its interval or distance from the first term of the series is given. ——Subtract each term of the series from the next following term, and call the remainders first differences, then subtract in like manner each of these differences from the next following one, calling these remainders 2d differences; again, subtract each 2d difference from the next following, for the 3d differences; and so on: then if A be the 1st term of the series,

d' the first of the 1st differences,
d'' the first of the 2d differences,
d''' the first of the 3d differences,

and if x be the interval or distance between the first term of the series and any term sought, T, that is, let the number of terms from A to T, both included, be $=x+1$; then will the term sought, T, be=

$$A+\frac{x}{1}d'+\frac{x}{1}.\frac{x-1}{2}d''+\frac{x}{1}.\frac{x-1}{2}.\frac{x-2}{3}d''', \text{ \&c.}$$

Hence, if the differences of any order become equal, that is, if any of the diffs. d'', d''', &c. become $=0$, the above series will give a finite expression for T the term sought; it being evident, that the series must terminate when any of the differences d'', d''', &c. become $=0$.

It is also evident that the co-efficients $\frac{x}{1}$, $\frac{x}{1}.\frac{x-1}{2}$, &c. of the differences, are the same as to the terms of the binomial theorem.

For ex. Suppose it were required to find the log. tangent of 5′ 1″ 12‴ 24⁗, or 6′ 1″ $\frac{62}{300}$, or 5′ 1″ ·2066, &c.

Take out the log. tangents to several minutes and seconds, and take their first and second differences, as below:

	Tan	d′	d″	
5′ 0″	7·1626964			
5 1	7·1641417	14453	—49	—48
5 2	7·1655821	14404	—47	
5 3	7·1670178	14357		

Here $A=7·1641417$; $x=\frac{62}{300}$; $d'=14404$; and the mean 2d difference $d''=-48$. Hence

A	7.1641417
xd'	2977
$\frac{x}{1}.\frac{x-1}{1}d''$	4

Theref. the tang. of 5′ 1″ 12‴ 24⁗ is 7·1644398

Hence may be deduced a method of finding the sums of the terms of such a series, calling its terms A, B, C, D, &c. For, conceive a new series having its 1st term $=0$, its 2d $=A$, its 3d $=A+B$, its 4th $=A+B+C$, its 5th $=A+B+C+D$, and so on; then it is plain that assigning one term of this series, is finding the sum of all the terms, A, B, C, D, &c. Now since these terms are the differences of the sums, 0, A, A+B, A+B+C, &c.; and as some of the differences of A, B, C, &c. are $=0$ by supposition; it follows that some of the differences of the sums will be $=0$; and since in the series $A+\frac{x}{1}d'+\frac{x}{2}.\frac{x-1}{3}d''$, &c. by which a term was assigned, A represented the 1st term: d' the 1st of the 1st differences, and x the interval between the first term and the last; we are to write 0 instead of A, A instead of d', d' instead of d'',

d'' instead of d''', &c. also $x+1$ instead of x; which being done, the series expressing the sums will be $0+\frac{x+1}{1}A+\frac{x+1}{1}.\frac{x}{2}d'+\frac{x+1}{1}.\frac{x}{2}.\frac{x-1}{3}d''$, &c. Or, if the real number of terms of the lines be called z, that is, if $z=x+1$, or $x=z-1$, the sum of the series will be $Az+\frac{z}{1}.\frac{z-1}{2}d'+\frac{z}{1}.\frac{z-1}{2}.\frac{z-2}{3}d''$, &c. See De Moivre's Doct. of Chances, p. 59, 60; or his Miscel. Analyt. p. 153.; or Simpson's Essays, p. 95.

For ex. To find the sum of six terms of the series of squares $1+4+9+16+25+36$, of the natural numbers.

Terms	d′	d″	d‴
1			
	3		
4		2	
	5		0
9		2	
	7		0
16		2	
	9		
25			

Here $A=1$, $d'=3$, $d''=2$, d''' &c. $=0$, and $z=6$; therefore the sum is $6+\frac{6}{1}.\frac{5}{2}.3+\frac{6}{1}.\frac{5}{2}.\frac{4}{3}.2=6+45+40=91$ the sum required, viz. of $1+4+9+16+25+36$.

A variety of examples may be seen in the places above cited, or in Stirling's *Methodus Differentialis*, &c.

As to the differential method, it may be observed, that though Newton and some others have treated it as a method of describing an algebraic curve, at least of the parabolic kind, through any number of given points; yet the consideration of curves is not at all essential to it, though it may help the imagination. The description of a parabolic curve through given points, is the same problem as the finding of quantities from their given differences, which may always be done by algebra, by the resolution of simple equations. *Hutton's Math. Dict.*

DIFFORM, *Difformis*, (from *forma*, "a shape"), is a word used in opposition to *uniform*; and signifies that there is no regularity in the form or appearance of a thing. The botanists use it as a distinction of the flowers of several species of plants.

DIFFUSE, an epithet applied to such writings as are wrote in a prolix manner. Among historians, Sallust is reckoned sententious, and Livy diffuse. Thus also among the orators, Demosthenes is close and concise; Cicero, on the other hand, diffuse.

DIFFUSION, the dispersion of the subtile effluvia of bodies into a kind of atmosphere all round them. Thus the light diffused by the rays of the sun, issues all round from that amazing body of fire.

DIGASTRICUS, in *Anatomy*, a muscle of the lower jaw, called also *Biventer*. See ANATOMY, *Table of the Muscles*.

DIGBY, SIR KENELM, an English philosopher, was born at Gothurst in Buckinghamshire in 1603, and became very illustrious for his virtue and learning. He was descended of an ancient family. His great-grandfather, accompanied by six of his brothers, fought valiantly at Bosworth field on the side of Henry VII. against the usurper Richard III. His father Sir Everard Digby, was engaged in the gunpowder plot against King James I. and for that crime was beheaded; but his son was restored to his estate. King Charles I. made him gentleman of the bedchamber, commissioner of the navy, and governor of the Trinity-house. He granted him letters of reprisal against the Venetians, by virtue of which he took several prizes with a small fleet under his command. He fought the Venetians near the port of Scanderoon, and bravely made his way through them with his booty. He was a great lover of learning, and translated several authors into English; and his "Treatise of the Nature of Bodies and the Immortality of the Soul," discovers great penetration and extensive knowledge. He applied to chemistry; and found out several useful medicines, which he gave freely away to people of all sorts, especially to the poor. He distinguished himself particularly by his sympathetic powder for the cure of wounds at a distance; his discourse concerning which made a great noise for a while. He had conferences with Des Cartes about the nature of the soul.

In the beginning of the civil wars, he exerted himself very vigorously in the King's cause; but he was afterwards imprisoned by the parliament's order, in Winchester-house, and had leave to depart thence in 1643. He afterwards compounded for his estate, but was ordered to leave the nation; when he went to France, and was sent on two embassies to Pope Innocent X. from the queen, widow to Charles I. whose chancellor he then was. On the restoration of Charles II. he returned to London; where he died in 1663, aged 60.

This eminent person, on account of his early talents, and great proficiency in learning, was compared to the celebrated Picus de Mirandola, who was one of the wonders of human nature. His knowledge, though various and extensive, appeared to be greater than it really was; as he had all the powers of elocution and address to recommend it. He knew how to shine in a circle of ladies or philosophers; and was as much attended to when he spoke on the most trivial subjects, as when he conversed on the most important. It is said that one of the princes of Italy, who had no child, was desirous that his princess should bring him a son by Sir Kenelm, whom he esteemed a just model of perfection.

DIGEST, (*Digestum*), a collection of the Roman laws, ranged and digested under proper titles, by order of the emperor Justinian.

That prince gave his chancellor Tribonianus a commission for this purpose; who, in consequence thereof, chose sixteen jurisconsulti, or lawyers, to work upon the same. These, accordingly, took out the best and finest decisions from the two thousand volumes of the ancient jurisconsulti, and reduced them all into one body; which was published in the year 533, under the name of the *Digest*. To this the emperor gave the force of a law, by a letter at the head of the work, which serves it as a preface.

The Digest makes the first part of the Roman law, and the first volume of the corpus or body of the civil law, contained in fifty books. It was translated into Greek under the same emperor, and called *Pandecta*. See PANDECTS.

Cujas says, that *Digest* is a common name for all books disposed in a good order and economy; and hence it is that Tertullian calls the gospel of St Luke a Digest.

Hence also abridgements of the common law are denominated *digests* of the numerous cases, arguments, readings, pleadings, &c. dispersed in the year books, and other reports and books of law, reduced under proper heads or common places. The first was that of Statham, which comes as low as Henry VI. That of Fitzherbert was published in 1516; Brook's in 1573, of which Hughes's, published in 1663, is a sequel. Rolls, Danvers, and Nelson, have also published Digests or abridgements of this kind, including the cases of later days; to which may be added the New Abridgement, Viner's Abridgement, &c.

DIGESTION, in the animal economy, is the dissolution of the aliments into such minute parts as are fit to enter the lacteal vessels, and circulate with the mass of blood. See ANATOMY *Index*.

DIGESTION, in *Chemistry*, is an operation which consists in exposing bodies to a gentle heat, in proper vessels, and during a certain time. This operation is very useful to favour the action of certain substances upon each other; as, for example, of well calcined, dry, fixed alkali upon rectified spirit of wine. When these two substances are digested together in a matrass, with a gentle sand-bath heat, the spirit of wine acquires a reddish-yellow colour, and an alkaline quality. The spirit would not so well acquire these qualities by a stronger and shorter heat.

DIGESTIVE, in *Medicine*, such remedies as strengthen and increase the tone of the stomach, and assist in the digestion of foods. To this class belong all stomachics and strengtheners or corroborants.

DIGESTIVE, in *Surgery*, denotes a sort of unguent, plaster, or the like, that is supposed to ripen and prepare the matter of wounds, &c for suppuration.

DIGGES, LEONARD, an eminent mathematician in the 16th century, was descended from an ancient family, and born at Digges-court in the parish of Barham in Kent; but in what year is not known. He was educated for some time at Oxford, where he laid a good foundation of learning. Retiring from thence, he prosecuted his studies, and became an excellent mathematician, a skilful architect, and an expert surveyor of land, &c. He composed several books: as, 1. *Tectonicum*: briefly shewing the exact Measuring, and speedy Reckoning of all manner of Lands, Squares, Timber, Stones, Steeples, &c. 1556, 4to. Augmented and published again by his son Thomas Digges, in 1592; and also reprinted in 1647.—2. A Geometrical Practical Treatise, named *Pantometria*, in three books. This he left in manuscript; but after his death, his son supplied such parts of it as were obscure and imperfect, and published it in 1591, folio; subjoining, "A Discourse Geometrical of the five regular and Platonic bodies, containing sundry theoretical and practical propositions, arising by mutual conference of these solids, Inscription, Circumscription, and Transformation."—3. Prognostication Everlasting of right good effect: or Choice Rules to judge the weather by the Sun, Moon, and Stars, &c. in 4to, 1555, 1556, and 1564: corrected and augmented by his son, with divers general tables, and many compendious rules, in 4to, 1502. He died about the year 1574.

DIGGES, *Thomas*, only son of Leonard Digges, after a liberal education from his tenderest years, went and studied for some time at Oxford; and by the improvements he made there, and the subsequent instructions of his learned father, became one of the best mathematicians of his age. When Queen Elizabeth sent some forces to assist the oppressed inhabitants of the Netherlands, Mr Digges was appointed muster-master general of them: by which he became well skilled in military affairs; as his writings afterward shewed. He died in 1595.

Mr Digges, beside revising, correcting, and enlarging some pieces of his father's already mentioned, wrote and published the following learned works himself: viz. 1. *Alæ sive Scalæ Mathematicæ*; or Mathematical Wings or Ladders, 1573, 4to: A book which contains several demonstrations for finding the parallaxes of any comet, or other celestial body, with a correction of the errors in the use of the radius astronomicus.—2. An Arithmetical Military Treatise, containing so much of Arithmetic as is necessary towards military discipline, 1579, 4to.—3. A Geometrical Treatise, named *Stratioticos*, requisite for the perfection of Soldiers, 1579, 4to. This was begun by his father, but finished by himself. They were both reprinted together in 1590, with several additions and amendments, under this title: "An Arithmetical Warlike Treatise, named *Stratioticos*, compendiously teaching the science of Numbers, as well in Fractions as Integers, and so much of the Rules and Equations Algebraical, and art of Numbers Cossical, as are requisite for the profession of a Soldier. Together with the Moderne militaire discipline, offices, lawes, and orders in every well-governed campe and armie, inviolably to be observed." At the end of this work there are two pieces; the first, "A briefe and true report of the proceedings of the earle of Leycester, for the reliefe of the town of Sluce, from his arrival at Vlishing, about the end of June 1587, until the surrendrie thereof 26 Julii next ensuing. Whereby it shall plainlie appear, his excellencie was not in any fault for the losse of that towne:" the second, "A briefe discourse what orders were best for repulsing of foraine forces, if at any time they should invade us by sea in Kent or elsewhere."—4. A perfect Description of the Celestial Orbs, according to the most ancient doctrine of the Pythagoreans, &c. This was placed at the end of his father's "Prognostication Everlasting," &c. printed in 1592, 4to.—5. A humble motive for association to maintain the religion established, 1601, 8vo. To which is added, his Letter to the same purpose to the archbishops and bishops of England.—6. England's Defence: or, A Treatise concerning Invasion. This is a tract of the same nature with that printed at the end of his Stratioticos, and called, A briefe Discourse, &c. It was written in 1599, but not published till 1686.—7. A Letter printed before Dr John Dee's *Parallaticæ Commentationis praxeosque nucleus quidam*, 1573, 4to.—Beside these, and his *Nova Corpora*, he left several mathematical treatises ready for the press; which, by reason of law suits and other avocations, he was hindered from publishing.

DIGGING, among miners, is appropriated to the operation of freeing any kind of ore from the bed or stratum in which it lies, where every stroke of their tools turns to account: in contradistinction to the openings made in search of such ore, which are called *hatches*, or *essay-hatches*; and the operation itself, *tracing of mines*, or *hatching*.

When a bed of ore is discovered, the beele-men, so called

called from the instrument they use, which is a kind of pickaxe, free the ore from the fossils around it; and the shovel-men throw it up from one shamble to another, till it reaches the mouth of the hatch.

In some mines, to save the expence as well as fatigue of the shovel-men, they raise the ore by means of a winder and two buckets, one of which goes up as the other comes down.

DIGIT, in *Astronomy*, the twelfth part of the diameter of the sun and moon, used to express the quantity of an eclipse. Thus an eclipse is said to be of six digits, when six of these parts are hid.

DIGITS, or *Monades*, in *Arithmetic*, signify any integer under 10; as, 1, 2, 3, 4, 5, 6, 7, 8, 9, and by means of which all numbers are expressed.

DIGIT is also a measure taken from the breadth of the finger. It is properly three-fourths of an inch, and contains the measure of four barley corns laid breadthwise.

DIGITALIS, FOX-GLOVE; a genus of plants, belonging to the didynamia class; and in the natural method ranking under the 28th order, *Luridæ*. See BOTANY *Index*.—Fox-glove has been employed in cases of hæmoptysis, of phthisis, and of mania, with apparent good effects: but its use in these diseases is less common and less efficacious than in dropsy. It should be administered with great caution. See MEDICINE and MATERIA MEDICA *Index*.

DIGITATED, among botanists. See BOTANY *Index*.

DIGLYPH, in *Architecture*, a kind of imperfect triglyph, console, or the like; with two channels or engravings, either circular or angular.

DIGNE, an episcopal town in the department of the Lower Alps, formerly Provence, in France, famous for its hot springs. It is seated on a river called Bleonne, 30 miles S. by W. of Embrun, in E. Long. 6. 12. N. Lat. 44. 10. The population is about 3300 souls.

DIGNITARY, in the canon law, a person who holds a dignity, that is, a benefice which gives him some pre-eminence over mere priests and canons. Such is a bishop, dean, archdeacon, prebendary, &c.

DIGNITY, as applied to the titles of noblemen, signifies honour and authority. And dignity may be divided into superior and inferior; as the titles of duke, earl, baron, &c. are the highest names of dignity; and those of baronet, knight, serjeant at law, &c. the lowest. Nobility only can give so high a name of dignity as to supply the want of a surname in legal proceedings; and as the omission of a name of dignity may be pleaded in abatement of a writ, &c. so it may be where a peer who has more than one name of dignity, is not named by the most noble. No temporal dignity of any foreign nation can give a man a higher title here than that of ESQUIRE.

DIGNITY, in the human character, the opposite of *Meanness*.

Man is endued with a SENSE of the worth and excellence of his nature: he deems it more perfect than that of the other beings around him; and he perceives that the perfection of his nature consists in virtue, particularly in virtues of the highest rank. To express that sense, the term *dignity* is appropriated. Further, to behave with dignity, and to refrain from all mean actions, is felt to be, not a virtue only, but a duty: it is a duty every man owes to himself. By acting in that manner, he attracts love and esteem: by acting meanly, or below himself, he is disapproved and contemned.

This sense of the dignity of human nature reaches even our pleasures and amusements. If they enlarge the mind by raising grand or elevated emotions, or if they humanize the mind by exercising our sympathy, they are approved as suited to the dignity of our nature: if they contract the mind by fixing it on trivial objects, they are contemned as not suited to the dignity of our nature. Hence in general, every occupation, whether of use or amusement, that corresponds to the dignity of man, is termed *manly*; and every occupation below his nature, is termed *childish*.

To those who study human nature, there is a point which has always appeared intricate: How comes it that generosity and courage are more esteemed, and bestow more dignity, than good nature, or even justice; though the latter contribute more than the former to private as well as to public happiness? This question, bluntly proposed, might puzzle even a philosopher; but, by means of the foregoing observations, will easily be solved. Human virtues, like other objects, obtain a rank in our estimation, not from their utility, which is a subject of reflection, but from the direct impression they make on us. Justice and good nature are a sort of negative virtues, that scarce make any impression but when they are transgressed: courage and generosity, on the contrary, producing elevated emotions, enliven the great sense of a man's dignity, both in himself and in others; and for that reason, courage and generosity are in higher regard than the other virtues mentioned; we describe them as grand and elevated, as of greater dignity, and more praiseworthy.

This leads us to examine more directly emotions and passions with respect to the present subject: and it will not be difficult to form a scale of them, beginning with the meanest, and ascending gradually to those of the highest rank and dignity. Pleasure felt as at the organ of sense, named *corporeal pleasure*, is perceived to be low; and when indulged to excess, is perceived also to be mean; for that reason, persons of any delicacy dissemble the pleasure they take in eating and drinking. The pleasures of the eye and ear, having no organic feeling, and being free from any sense of meanness, are indulged without any shame: they even rise to a certain degree of dignity when their objects are grand or elevated. The same is the case of the sympathetic passions: a virtuous person behaving with fortitude and dignity under cruel misfortunes, makes a capital figure; and the sympathizing spectator feels in himself the same dignity. Sympathetic distress at the same time is never mean: on the contrary, it is agreeable to the nature of a social being, and has general approbation. The rank that love possesses in the scale depends in a great measure on its objects: it possesses a low place when founded on external properties merely; and is mean when bestowed on a person of inferior rank without any extraordinary qualification: but when founded on the more elevated internal properties, it assumes a considerable degree of dignity. The same is the case of friendship. When gratitude is warm, it animates the mind; but it scarce rises to dignity,

Dignity.

Joy bestows dignity when it proceeds from an elevated cause.

If we can depend upon induction, dignity is not a property of any disagreeable passion: one is slight, another severe; one depresses the mind, another animates it: but there is no elevation, far less dignity, in any of them. Revenge, in particular, though it inflame and swell the mind, is not accompanied with dignity, not even with elevation: it is not however felt as mean or grovelling, unless when it takes indirect measures for gratification. Shame and remorse, though they sink the spirits, are not mean. Pride, a disagreeable passion, bestows no dignity in the eye of a spectator. Vanity always appears mean; and extremely so where founded, as commonly happens, on trivial qualifications.

We proceed to the pleasures of the understanding, which possess a high rank in point of dignity. Of this every one will be sensible, when he considers the important truths that have been laid open by science; such as general theorems, and the general laws that govern the material and moral worlds. The pleasures of the understanding are suited to man as a rational and contemplative being, and they tend not a little to ennoble his nature; even to the Deity he stretcheth his contemplations, which, in the discovery of infinite power, wisdom, and benevolence, afford delight of the most exalted kind. Hence it appears, that the fine arts, studied as a rational science, afford entertainment of great dignity; superior far to what they afford as a subject of taste merely.

But contemplation, however in itself valuable, is chiefly respected as subservient to action; for man is intended to be more an active than a contemplative being. He accordingly shows more dignity in action than in contemplation: generosity, magnanimity, heroism, raise his character to the highest pitch: these best express the dignity of his nature, and advance him nearer to divinity than any other of his attributes.

Having endeavoured to assign the efficient cause of dignity and meanness, by unfolding the principle on which they are founded, we proceed to explain the final cause of the dignity or meanness bestowed upon the several particulars above mentioned, beginning with corporeal pleasures. These, as far as useful, are, like justice, fenced with sufficient sanctions to prevent their being neglected: hunger and thirst are painful sensations; and we are incited to animal love by a vigorous propensity: were corporeal pleasures dignified over and above with a place in a high class, they would infallibly overturn the balance of the mind, by outweighing the social affections. This is a satisfactory final cause for refusing to these pleasures any degree of dignity: and the final cause is not less evident of their meanness when they are indulged to excess. The more refined pleasures of external sense, conveyed by the eye and the ear from natural objects and from the fine arts, deserve a high place in our esteem, because of their singular and extensive utility: in some cases they rise to a considerable dignity; and the very lowest pleasures of the kind are never esteemed mean or grovelling. The pleasure arising from wit, humour, ridicule, or from what is simply ludicrous, is useful, by relaxing the mind after the fatigue of more manly occupations: but the mind, when it surrenders itself to pleasure of that kind, loses its vigour, and sinks gradually into sloth. The place this pleasure occupies in point of dignity is adjusted to these views: to make it useful as a relaxation, it is not branded with meanness; to prevent its usurpation, it is removed from that place but a single degree: no man values himself for that pleasure even during gratification; and if it have engrossed more of his time than is requisite for relaxation, he looks back with some degree of shame.

Dignity ‖ Dii.

In point of dignity, the social emotions rise above the selfish, and much above those of the eye and ear; man is by his nature a social being; and to qualify him for society, it is wisely contrived that he should value himself more for being social than selfish.

The excellency of man is chiefly discernible in the great improvements he is susceptible of in society: these, by perseverance, may be carried on progressively, above any assignable limits; and even abstracting from revelation, there is great probability that the progress begun here will be completed in some future state. Now, as all valuable improvements proceed from the exercise of our rational faculties, the Author of our nature, in order to excite us to a due use of these faculties, hath assigned a high rank to the pleasures of the understanding: their utility, with respect to this life as well as a future, entitles them to that rank.

But as action is the aim of all our improvements, virtuous actions justly possess the highest of all the ranks. These, we find, are by nature distributed into different classes, and the first in point of dignity assigned to actions that appear not the first in point of use: generosity, for example, in the sense of mankind is more respected than justice, though the latter is undoubtedly more essential to society; and magnanimity, heroism, undaunted courage, rise still higher in our esteem; the reason of which is explained above.

Dignity, in *Oratory*, is one of the three parts of general elocution; and consists in the right use of tropes and figures. See Oratory, N° 48.

DIGRESSION, in *Oratory*, is defined by Quintilian, agreeably to the etymology of the word, to be a going off from the subject we are upon to some different thing, which, however, may be of service to it. See Oratory, N° 37.

DIGYNIA, (from δις, *twice*, and γυνη, a *woman*), the name of an order or secondary division in each of the first 13 classes, except the 9th, in Linnæus's sexual method; consisting of plants, which to the classic character, whatever it is, add the circumstance of having two styles or female organs.

DII, the divinities of the ancient inhabitants of the earth, were very numerous. Every object which caused terror, inspired gratitude, or bestowed affluence, received the tribute of veneration. Man saw a superior agent in the stars, the elements, or the trees; and supposed that the waters which communicated fertility to his fields and possessions, were under the influence and direction of some invisible power inclined to favour and to benefit mankind. Thus arose a train of divinities which imagination arrayed in different forms, and armed with different powers. They were endowed with understanding, and were actuated by the same passions which daily afflict the human race; and those children of superstition were appeased or provoked as the imperfect being which gave them birth. Their wrath was mitigated by sacrifices and incense, and sometimes human victims bled to expiate a crime which superstition alone supposed to exist. The sun, from his powerful influence and animating nature, first attracted the notice and claimed the adoration of the uncivilized inhabitants of the earth. The moon also was honoured with sacrifices and addressed in prayers; and after immortality had been liberally bestowed on all the heavenly bodies, mankind classed among their deities the brute creation, and the cat and the sow shared equally with Jupiter himself, the father of gods and men, the devout veneration of their votaries. This immense number of deities has been divided into different classes according to the will and pleasure of the mythologists. The Romans, generally speaking, reckoned two classes of the gods, the *dii majorum gentium*, or *dii consentes*, and the *dii minorum gentium*. The former were 12 in number, six males and six females. [*Vid.* CONSENTES.] In the class of the latter were ranked all the gods which were worshipped in different parts of the earth. Besides these there were some called *dii selecti*, sometimes classed with the 12 greater gods; these were Janus, Saturn, the Genius, the Moon, Pluto, and Bacchus. There were also some called demigods, that is, who deserved immortality by the greatness of their exploits, and for their uncommon services to mankind. Among these were Priapus, Vertumnus, Hercules, and those whose parents were some of the immortal gods. Besides these, all the passions and the moral virtues were reckoned as powerful deities, and temples were raised to a goddess of concord, peace, &c. According to the authority of Hesiod, there were no less than 30,000 gods that inhabited the earth, and were guardians of men, all subservient to the power of Jupiter. To these, succeeding ages have added an almost equal number: and indeed they were so numerous, and their functions so various, that we find temples erected, and sacrifices offered, to unknown gods. It is observable that all the gods of the ancients have lived upon earth as mere mortals; and even Jupiter, who was the ruler of heaven, is represented by the mythologists as a helpless child; and we are acquainted with all the particulars that attended the birth and education of Juno. In process of time, not only good and virtuous men, who had been the patrons of learning and the supporters of liberty, but also thieves and pirates, were admitted among the gods, and the Roman senate courteously granted immortality to the most cruel and abandoned of their emperors.

DIJAMBUS, in *Poetry*, the foot of a Latin verse of four syllables; it is compounded of two *iambics*, as *sĕvērĭtās*.

DIJON, an ancient and very considerable town of France; formerly capital of Burgundy, and of the Dijonois; now the episcopal town of the department of Cote d'Or. Before the revolution it had a parliament, a mint, an university, academy of sciences, an abbey, and a citadel. Most parts of the churches and public structures are very beautiful, and in one of the squares there was an equestrian statue of Louis XIV. It is seated in a very pleasant plain, between two small rivers, which produces excellent wine. It contains 21,600 inhabitants. E. Long. 5. 7. N. Lat. 47. 19.

DIKE, a ditch or drain, made for the passage of waters.—The word seems formed from the verb to *dig*; though others choose to derive it from the Dutch, *diik*, a dam, sea-bank, or wall.

DIKE, or *Dyke*, also denotes a work of stone, timber or fascines, raised to oppose the entrance or passage of the waters of the sea, a river, lake, or the like. —The word comes from the Flemish *dyk*, or *diik*, a heap of earth to bound or stem the water. Junius and Menage take the Flemish to have borrowed their word from the Greek τειχος, *wall*. Guichard derives it from the Hebrew, *daghah*. These dikes are usually elevations of earth, with hurdles of stakes, stones, and other matters. The dike of Rochelle is made with vessels fastened to the bottom. The dikes of Holland are frequently broke through, and drown large tracts of land.

DILAPIDATION, in *Law*, a wasteful destroying, or letting buildings, especially parsonage houses, &c. run to decay, for want of necessary reparation. If the clergy neglect to repair the houses belonging to their benefices, the bishop may sequester the profits thereof for that purpose. And in these cases, a prosecution may be brought, either in the spiritual court or at common law, against the incumbent himself, or against his executor or administrator.

DILATATION, in *Physics*, a motion of the parts of any body, by which it is so expanded as to occupy a greater space. This expansive motion depends upon the elastic power of the body; whence it appears that dilatation is different from rarefaction, this last being produced by means of heat.

DILATATORES, in *Anatomy*, a name given to several muscles of the human body. See ANATOMY, *Tables of the Muscles*.

DILATORY PLEAS, in *Law*, are such as are put in merely for delay; and there may be a demurrer to a dilatory plea, or the defendant shall be ordered to plead better, &c. The truth of dilatory pleas is to be made out by affidavit of the fact, &c. by stat. 4. and 5 Anne. See PLEA.

DILATRIS, a genus of plants belonging to the triandria class. See BOTANY *Index*.

DILEMMA, in *Logic*, an argument equally conclusive by contrary suppositions. See LOGIC.

DILIGENGE, in *Scots Law*, signifies either that care and attention which parties are bound to give, in implementing certain contracts or trusts, and which varies according to the nature of the contract; or it signies certain forms of law, whereby the creditor endeavours to operate his payment, either by affecting the person or estate of the debtor. See LAW *Index*.

DILL. See ANETHUM, BOTANY *Index*.

DILLEMBURG, a town of Germany, in Wetteravia, and capital of a county of the same name. It is subject to a prince of the house of Nassau, and is situated in E. Long. 8. 24, N. Lat. 50. 45.

DILLENGEN, a town of Germany, in the circle of Suabia, formerly with a university, which was converted into a lyceum when the town was transferred to Bavaria in 1802. It is seated near the Danube. E. Long. 10. 30. N. Lat. 48. 34.

DILLENIUS, JOHN JAMES, a distinguished German botanist, see SUPPLEMENT.

DILUTE. To dilute a body is to render it liquid; or if it were liquid before, to render it more so by the addition of a thinner thereto. These things thus added are called *diluents*, or *dilutors*.

DIMACHE, (from δις, *double*, and μαχω, *I fight*), in antiquity, a kind of horsemen first instituted by Alexander. Their armour was lighter than that of the infantry, and at the same time heavier than that used by horsemen, so that they could act as horse or foot as occasion required.

DIMENSION, in *Geometry*, is either length, breadth, or thickness: hence, a line hath one dimensions, viz. length; a superficies two, viz. length and breadth; and a body, or solid, has three, viz. length, breadth, and thickness.

DIMINUTION, in *Architecture*, a contraction of the upper part of a column, by which its diameter is made less than that of the lower part. *

DIMINUTION, in *Music*, is the abating something of the full value or quantity of any note.

DIMINUTIVE, in *Grammar*, a word formed from some other, to soften or diminish the force of it, or to signify a thing is little in its kind. Thus, *cellule* is a diminutive of *cell*, globule of *globe*, hillock of *hill*.

DIMISSORY LETTERS, (*Literæ Dimissoriæ*), in the canon law, a letter given by a bishop to a candidate for holy orders, having a title in his diocese, directed to some other bishop, and giving leave for the bearer to be ordained by him.

When a person produces letters of ordination or tonsure conferred by any other than his own diocesan, he must at the same time produce the letters dimissory given by his own bishop, on pain of nullity.

Letters dimissory cannot be given by the chapter, *sede vacante;* this being deemed an act of voluntary jurisdiction which ought to be reserved to the successor.

DIMOERITÆ, a name given to the Apollinarists, who at first held, that the Word only assumed a human body, without taking a reasonable soul like ours; but being at length convinced by formal texts of Scripture, they allowed, that he did assume a soul, but without understanding; the Word supplying the want of that faculty. From this way of separating the understanding from the soul, they became denominated *dimœrites*, q. d. *dividers*, *separators*, of δια, and μοιραω *I divide*.

DIMSDALE, THOMAS, Baron, greatly distinguished for his practice of inoculation for the small-pox, was the son of a surgeon and apothecary at Theydon Gernon in Essex, and was born in the year 1712. His family belonged to the society of Quakers; and his grandfather accompanied William Penn to America; but soon after returned and settled in his native village. Thomas was brought up to his profession first under his father, and afterwards he became a pupil in St Thomas Hospital, London. He commenced his practice at Hertford about 1734, and married the only daughter of Nathanael Brassey, of Roxford, near that town, an eminent banker in London, and representative of Hertford in four successive parliaments. She died in 1744, and left no children. To relieve his mind under this loss, he voluntarily offered his assistance to the physicians and surgeons in the army under the duke of Cumberland, and continued with it till after the surrender of Carlisle to the king's forces, when he received the duke's thanks, and returned to Hertford. In 1746 he married Anne Iles, a relation of his first wife, and by her fortune, and that which he acquired by the death of the widow of Sir John Dimsdale of Hertford, he retired from practice; but his family becoming numerous, and seven of his ten children being living, he resumed it, and took the degree of doctor of medine, in 1761. Having fully satisfied himself about the new method of treating persons under inoculation for the small-pox, he published his treatise on it in 1776, which was soon circulated all over the continent, and translated into all its languages, not omitting the Russian. He concludes with saying that, "although the whole process may have some share in the success, it, in my opinion, consists chiefly in the method of inoculating with recent fluid matter, and the management of the patients at the time of eruption." This proof of his professional knowledge occasioned his being invited to inoculate the empress Catherine and her son, in 1768, of which he gives a particular account in his Tracts on Inoculation, 1781. His reward for this was an appointment of actual counsellor of state and physician to her imperial majesty, with an annuity of 500l. the rank of a baron of the Russian empire, to be borne by his eldest lawful descendant in succession, and a black wing of the Russian eagle in a gold shield in the middle of his arms, with the customary helmet, adorned with the baron's coronet, over the shield; to receive immediately 10,000l. and 2000l. for travelling charges, miniature pictures of the empress and her son, and the same title to his son, to whom the grand duke gave a gold snuff-box, richly set with diamonds. The baron inoculated numbers of people at Moscow; and, resisting the empress's invitation to reside as her physician in Russia, he and his son were admitted to a private audience of Frederic II. king of Prussia, at Sans Souci, and thence returned to England. In 1779, he lost his second wife, who left him seven children. He afterwards married Elizabeth daughter of William Dimsdale, of Bishops-Stortford, who survived him. He was elected representative of the borough of Hertford in 1780; and declined all practice, except for the relief of the poor. He went to Russia once more, in 1781, to inoculate the late emperor and his brother Constantine, sons of the grand duke; and, as he passed through Brussels, the late emperor Joseph received him in private, and wrote in his presence a letter, which he was to convey to the empress of Russia. In 1790, his son, Baron Nathanael, was elected for the borough of Hertford, on his resignation and retirement to Bath, for several winters; but at last he fixed altogether at Hertford, and died, aged 89, Dec. 30. 1800, after an illness of about three weeks. About 17 years before his death he felt the sight of one eye declining, having before lost that of the other, but recovered both by the operation of the cataract, by Wenzel.

DINDYMA, -ORUM, (Virgil,) from Dindymus, -i; a mountain allotted by many to Phrygia. Strabo has two mountains of this name; one in Mysia near Cyzicus; the other in Gallogræcia near Pessinus; and none in Phrygia. Ptolemy extends this ridge from the borders of Troas, through Phrygia, to Gallogræcia: though therefore there were two mountains called Dindymus in particular, both sacred to the mother of the gods, and none of them in Phrygia Major; yet there

---

* See *Architecture*, N° 38.

here might be several hills and eminences in it, on which this goddess was worshipped, and therefore called *Dindyma* in general. Hence Cybele is surnamed *Dindymane*, (Horace.)

DINGWALL, a royal borough of Scotland in the shire of Ross, seated on the frith of Cromarty, 15 miles west of the town of Cromarty. Near it runs the river Conel, famous for producing pearls. W. Long. 4. 15. N. Lat. 57. 45. Dingwall was a Scotch barony in the person of the duke of Ormond in right of his lady, but forfeited in 1715. Population 800.

DINNER, the meal taken about the middle of the day.—The word is derived from the French *disner*, which Du Cange derives from the barbarous Latin *disnare*. Henry Stephens derives it from the Greek διπνειν; and will have it wrote *dipner*. Menage deduces it from the Italian *desinare*, "to dine"; and that from the Latin *desinere*, "to leave off work."

It is generally agreed to be the most salutary to make a plentiful dinner, and to eat sparingly at supper. This is the general practice among us. The French, however, in imitation of the ancient Romans, defer their good cheer to the evening; and Bernardinus Paternus, an eminent Italian physician, maintains it to be the most wholesome method, in a treatise expressly on the subject.

The grand Tartar emperor of China, after he has dined, makes publication by his heralds, that he gives leave for all the other kings and potentates of the earth to go to dinner; as if they waited for his leave.

DINOCRATES, a celebrated architect of Macedonia, who rebuilt the temple of Ephesus, when burnt by Erostratus, with much more magnificence than before. Vitruvius informs us that Dinocrates proposed to Alexander the Great to convert Mount Athos into the figure of a man, whose left hand should contain a walled city, and all the rivers of the mount flow into his right, and from thence into the sea! He also conceived a scheme for building the dome of the temple of Arsinoe at Alexandria, of loadstone; that should by its attraction uphold her iron image in the centre, suspended in the air! Projects which at least showed a vast extent of imagination.

DIO CHRYSOSTOM, that is, *Golden Mouth*, a celebrated orator and philosopher of Greece, in the first century, was born at Prusa in Bithynia. He attempted to persuade Vespasian to quit the empire: was hated by Domitian; but acquired the esteem of Trajan. This last prince took pleasure in conversing with him, and made him ride with him in his triumphal chariot. There are still extant 80 of Dio's orations, and some other of his works; the best edition of which is that of Hermand Samuel Raimarus, in 1750, in folio.

DIOCESE, or DIOCESS, the circuit or extent of the jurisdiction of a BISHOP. The word is formed from the Greek διοικησις, *government*, *administration*; formed of διοικεω, which the ancient glossaries render *administro*, *moderor*, *ordino*; hence διοικησις της πολεως, the *administration* or *government of a city*.

DIOCESE is also used in ancient authors, &c. for the province of a METROPOLITAN.

Diocæsis (διοικησις), was originally a civil government, or prefecture, composed of divers provinces.

The first division of the empire into dioceses is ordinarily ascribed to Constantine; who distributed the whole Roman state into four, viz. the diocese of Italy, the diocese of Illyria, that of the East, and that of Africa. And yet long before Constantine, Strabo, who wrote under Tiberius, takes notice, lib. xiii. p. 432. that the Romans had divided Asia into dioceses; and complains of the confusion such a division occasioned in geography, Asia being no longer divided by people, but by dioceses, each whereof had a tribunal or court, where justice was administered. Constantine then was only the institutor of those large dioceses, which comprehended several metropoles and governments; the former dioceses only comprehending one jurisdiction or district, or the country that had resort to one judge, as appears from this passage in Strabo, and (before Strabo) from Cicero himself, lib. iii. *epist. ad famil.* 9. and lib. xiii. *ep.* 67.

Thus, at first a province included divers dioceses; and afterwards a diocese came to comprise divers provinces. In after times the Roman empire became divided into 13 dioceses or prefectures; though, including Rome, and the surburbicary regions, there were 14. These 14 dioceses comprehended 120 provinces; each province had a proconsul, who resided in the capital or metropolis; and each diocese of the empire had a consul, who presided in the principal city of the district.

On this civil constitution the ecclesiastical one was afterwards regulated: each diocese had an ecclesiastical vicar or primate, who judged finally of all the concerns of the church within his territory.

At present there is some further alteration: for diocese does not now signify an assemblage of divers provinces; but is limited to a single province under a metropolitan, or more commonly to the single jurisdiction of a bishop.

Gul. Brito affirms diocese to be properly the territory and extent of a baptismal or parochial church; whence divers authors use the word to signify a simple parish. See PARISH.

DIOCLEIA, (Διοκλεια), in antiquity, a solemnity kept in the spring at Megara, in memory of the Athenian hero, who died in the defence of the youth he loved.

DIOCLESIANUS, CAIUS VALERIUS JOVIUS, a celebrated Roman emperor, born of an obscure family in Dalmatia in 245. He was first a common soldier, and by merit and success he gradually rose to the office of a general; and at the death of Numerian in 284 he was invested with imperial power. In this high station he rewarded the virtues and fidelity of Maximian, who had shared with him all the subordinate offices in the army, by making him his colleague on the throne. He created two subordinate emperors, Constantius and Galerius, whom he called Cæsars, whilst he claimed for himself and his colleague the superior title of Augustus. Dioclesian has been celebrated for his military virtues; and though he was naturally unpolished by education and study, yet he was the friend and patron of learning and true genius. He was bold and resolute, active and diligent, and well acquainted with the arts, which will endear a sovereign to his people, and make him respectable even in the eyes of his enemies. His cruelty, however, against the followers of Christianity, has been deservedly branded with infamy. After he had reigned 22 years in the greatest prosperity, he publicly abdicated

dicated the crown at Nicomedia in 305, and retired to a private station at Salona. Maximian his colleague followed his example, but not from voluntary choice; and when he some time after endeavoured to rouse the ambition of Dioclesian, and persuade him to reassume the imperial purple, he received for answer, that Dioclesian took now more delight in cultivating his little garden than he formerly enjoyed in a palace, when his power was extended over all the earth. He lived nine years after his abdication in the greatest security and enjoyment at Salona, and died in 314, in the 68th year of his age. Dioclesian is the first sovereign who voluntarily resigned his power. His bloody persecution of the Christians forms a chronological era, called the *era of Dioclesian*, or of the martyrs. It was for a long time in use in theological writings, and is still followed by the Copts and Abyssinians. It commenced August 29. 284.

DIODATI, John, a famous minister, and professor of theology at Geneva, was born at Lucca in 1579, and died at Geneva in 1652. He is distinguished by translations, 1. Of the Bible into Italian, with notes, Geneva, 1607, 4to. The best edition at Geneva in 1641, folio. This is said to be more a paraphrase than a translation, and the notes rather divine meditations than critical reflections. 2. Of the Bible into French, Geneva, 1644. 3. Of Father Paul's History of the Council of Trent into French.

DIODIA, a genus of plants belonging to the tetrandria class, and in the natural method ranking under the 47th order, *Stellatæ*. See Botany *Index*.

DIODON, or Sun-fish, a genus of fishes belonging to the order of amphibia nantes. See Ichthyology *Index*.

DIODORUS, an historian, surnamed *Siculus* because he was born at Argyra in Sicily. He wrote a history of Egypt, Persia, Syria, Media, Greece, Rome, and Carthage; and it is said that he visited all the places of which he has made mention in his history. It was the labour of 30 years. He is, however, too credulous in some of his narrations; and often wanders far from the truth. He often dwells too long upon fabulous reports and trifling incidents; while events of the greatest importance to history are treated with brevity, and sometimes passed over in silence. He lived in the age of Julius Cæsar and Augustus; and spent much time at Rome to procure information, and authenticate his historical narrations. This important work, which he composed in Greek, contained 40 books, of which there are only 15 remaining. The style is clear and neat, and very suitable to history. The best edition is that of Amsterdam, 1743, in 2 vols folio.

DIOECIA, (from δις, *twice*, and οικος, *a house* or *habitation*) two houses; the name of the 22d class in Linnæus's sexual method, consisting of plants which having no hermaphrodite flowers, produce male and female flowers on separate roots. These latter only ripen seeds; but require for that purpose, according to the sexualists, the vicinity of a male plant; or the aspersion, that is, sprinkling of the male dust. From the seeds of the female flowers are raised both male and female plants. The plants then in the class diœcia are all male and female; not hermaphrodite, as in the greater number of classes; nor with male and female flowers upon one root, as in the class monœcia of the same author. See Botany *Index*.

DIOGENES of Apollonia, in the island of Crete, held a considerable rank among the philosophers who taught in Ionia before Socrates appeared at Athens. He was the scholar and successor of Anaximenes, and in some measure rectified his master's opinion concerning air being the cause of all things. It is said, that he was the first who observed that air was capable of condensation and rarefaction. He passed for an excellent philosopher, and died about the 450th year before the Christian era.

Diogenes *the Cynic*, a famous philosopher, was the son of a banker of Sinope in Pontus. Being banished with his father for coining false money, he retired to Athens, where he studied philosophy under Antisthenes. He added new degrees of austerity to the sect of the Cynics, and never did any philosopher carry so far a contempt for the conveniences of life. He was one of those extraordinary men who run every thing to extremity, without excepting even reason itself; and who confirm the saying, that "there is no great genius without a tincture of madness." He lodged in a tub; and had no other moveables besides his staff, wallet and wooden bowl, which last he threw away on seeing a boy drink out of the hollow of his hand. He used to call himself a vagabond, who had neither house nor country; was obliged to beg, was ill clothed, and lived from hand to mouth; and yet, says Ælian, he took as much pride in these things as Alexander could in the conquest of the world. He was not indeed a jot more humble than those who are clothed in rich apparel, and fare sumptuously every day. He looked down on all the world with scorn; he magisterially censured all mankind, and thought himself unquestionably superior to all other philosophers. Alexander one day paid him a visit, and made him an offer of riches or any thing else; but all that the philosopher requested of him was, to stand from betwixt the sun and him. As if he had said, "Do not deprive me of the benefits of nature, and I leave to you those of fortune." The conqueror was so affected with the vigour and elevation of his soul, as to declare, that, "if he was not Alexander, he would choose to be Diogenes:" that is, if he was not in possession of all that was pompous and splendid in life, he would, like Diogenes, heroically despise it. Diogenes had great presence of mind, as appears from his smart sayings and quick repartees; and Plato seems to have hit off his true character when he called him a Socrates run mad. He spent a great part of his life at Corinth, and the reason of his living there was as follows: as he was going over to the island Ægina, he was taken by pirates, who carried him into Crete, and there exposed him to sale. He answered the crier who asked him what he could do, that "he knew how to command men:" and perceiving a Corinthian who was going by, he shewed him to the crier, and said "Sell me to that gentleman, for he wants a master." Xeniades, for that was the Corinthian's name, bought Diogenes, and carried him with him to Corinth. He appointed him tutor to his children, and intrusted him also with the management of his house. Diogenes's friends being desirous to redeem him, "You are fools (said he); the lions are not the slaves of those who feed them, but they are the servants of the lions." He

therefore

therefore plainly told Xeniades, that he ought to obey him, as people obey their governors and physicians. Some say, that Diogenes spent the remainder of his life in Xeniades's family; but Dion Chrysostom asserts that he passed the winter at Athens, and the summer at Corinth. He died at Corinth when he was about 90 years old: but authors are not agreed either as to the time or manner of his death. The following account, Jerome says, is the true one. As he was going to the Olympic games, a fever seized him in the way; upon which he lay down under a tree, and refused the assistance of those who accompanied him, and who offered him either a horse or a chariot. "Go you to the games (says he), and leave me to contend with my illness. If I conquer, I will follow you; if I am conquered, I shall go to the shades below." He despatched himself that very night; saying, that "he did not so properly die, as get rid of his fever." He had for his disciples Onesicritus, Phocion, Stilpo of Megara, and several other great men. His works are lost.

Diogenes *Laertius*, so called from Laerta in Cilicia where he was born, an ancient Greek author, who wrote ten books of the Lives of the Philosophers, still extant. In what year he flourished, is not easy to determine. The oldest writers who mention him are Sopater Alexandrinus, who lived in the time of Constantine the Great, and Hesychius Milesius, who lived under Justinian. Diogenes often speaks in terms of approbation of Plutarch and Phavorinus; and therefore, as Plutarch lived under Trajan, and Phavorinus under Hadrian, it is certain that he could not flourish before the reigns of those emperors. Menage has fixed him to the time of Severus; that is, about the year of Christ 200. From certain expressions in him, some have fancied him to have been a Christian; but, as Menage observes, the immoderate praises he bestows upon Epicurus will not suffer us to believe this, but incline us rather to suppose that he was an Epicurean. He divided his Lives into books, and inscribed them to a learned lady of the Platonic school, as he himself intimates in his life of Plato. Montaigne was so fond of this author, that instead of one Laertius he wishes we had a dozen; and Vossius says, that his work is as precious as gold. Without doubt we are greatly obliged to him for what we know of the ancient philosophers: and if he had been as exact in the writing part as he was judicious in the choice of his subject, we had been more obliged to him still. Bishop Burnet, in the preface to his Life of Sir Matthew Hale, speaks of him in the following proper manner: "There is no book the ancients have left us (says he), which might have informed us more than Diogenes Laertius's Lives of the Philosophers, if he had had the art of writing equal to that great subject which he undertook: for if he had given the world such an account of them as Gassendus has done of Peiresc, how great a stock of knowledge might we have had, which by his unskilfulness is in a great measure lost! since we must now depend only on him, because we have no other and better author who has written on that argument." There have been several editions of his Lives of the Philosophers; but the best is that printed in two volumes 4to, at Amsterdam, 1693. This contains the advantages of all the former, besides some peculiar to itself: the Greek text and the Latin version corrected and amended by Meibomius; the entire notes of Henry Stephens, both the Casaubons, and of Menage; 24 copperplates of philosophers elegantly engraved: to which is added The History of the Female Philosophers, written by Menage, and dedicated to Madame Dacier. Besides this, Laertius wrote a book of Epigrams upon illustrious Men, called Pammetrus, from its various kinds of metre; but this is not extant.

DIOMEDIA, a genus of birds belonging to the order of anseres. See Ornithology *Index*.

DIOMEDES, son of Tydeus and Deiphyle, was king of Ætolia, and one of the bravest of the Grecian chiefs in the Trojan war. He often engaged Hector and Æneas, and obtained much military glory. He went with Ulysses to steal the Palladium from the temple of Minerva in Troy; and assisted in murdering Rhesus king of Thrace, and carrying away his horses. At his return from the siege of Troy, he lost his way in the darkness of night, and landed in Attica, where his companions plundered the country and lost the Trojan Palladium. During his long absence, his wife Ægiale forgot her marriage vows, and prostituted herself to Cometes one of her servants. This lasciviousness of the queen was attributed by some to the resentment of Venus, whom Diomedes had severely wounded in a battle before Troy. The infidelity of Ægiale was highly displeasing to Diomedes. He resolved to abandon his native country which was the seat of his disgrace; and the attempts of his wife to take away his life, according to some accounts, did not a little contribute to hasten his departure. He came to that part of Italy, which has been called *Magna Græcia*, where he built a city, which he called *Argyrippa*, and married the daughter of Daunus the king of the country. He died there in extreme old age; or according to a certain tradition, he perished by the hand of his father-in-law. His death was greatly lamented by his companions, who in the excess of their grief were changed into birds resembling swans. These birds took flight into a neighbouring island in the Adriatic, and became remarkable for the tameness with which they approached the Greeks, and for the horror with which they shunned all other nations. They are called the birds of Diomedes. Altars were raised to Diomedes as to a god, one of which Strabo mentions at Timavus.

DION, a Syracusan, son of Hipparinus, famous for his power and abilities. He was related to Dionysius, and often advised him, together with the philosopher Plato, who at his request had come to reside at the tyrant's court, to lay aside the supreme power. His great popularity rendered him odious in the eyes of the tyrant, who banished him to Greece. There he collected a numerous force, and resolved to free his country from tyranny. This he easily effected on account of his uncommon popularity. He entered the port of Syracuse only in two ships; and in three days reduced under his power an empire which had already subsisted for 50 years, and which was guarded by 500 ships of war, and above 100,000 troops. The tyrant fled to Corinth, and Dion kept the power in his own hands, fearful of the aspiring ambition of some of the friends of Dionysius; but he was shamefully betrayed and murdered by one of his familiar friends called *Callicrates* or *Callipus*, 354 years before the Christian era.

Dion *Cassius*, a native of Nicæa in Bithynia. His father's name was Apronianus. He was raised to the greatest offices of state in the Roman empire by Pertinax, and his three successors. He was naturally fond of study, and he improved himself by unwearied application. He was ten years in collecting materials for a history of Rome, which he made public in 80 books, after a laborious employment of 12 years in composing it. This valuable history began with the arrival of Æneas in Italy, down to the reign of the emperor Alexander Severus. The first 34 books are totally lost, the 20 following, that is, from the 35th to the 54th, remain entire, the six following are mutilated, and fragments is all that we possess of the last 20. In the compilation of this extensive history, Dion proposed to himself Thucydides for a model, but he is not perfectly happy in his imitation. His style is pure and elegant, and his narrations are judiciously managed, and his reflections learned: but upon the whole, he is credulous, and the bigotted slave of partiality, satire, and flattery. He inveighs against the republican principles of Brutus and Cicero, and extols the cause of Cæsar. Seneca is the object of his satire, and he represents him as debauched and licentious in his morals.

DIONIS, Peter, a distinguished French surgeon, was born in Paris. In the time of Louis XIV. he was appointed anatomical and chirurgical demonstrator in the royal garden, and he was the first who held that place. He was surgeon in ordinary to Maria Theresa of Austria, queen of France, and to two dauphinesses and the royal children. He was the author of several works, both on anatomical and surgical subjects. One of the first of his publications, is entitled *Anatomie de l'Homme, suivant la Circulation du Sang*, 8vo, which appeared in 1690, and has been frequently reprinted, and translated into different languages. It was translated into the Tartarian dialect by a Jesuit for the use of the emperor of China. This work has been considered as a useful compendium of anatomy. In another work which he published in 1698, entitled, *Dissertation Historique et Physique sur la Generation de l'Homme*, he supports the ovarian hypothesis. In 1707 he published a work on surgery, entitled *Cours d'Operations de Chirurgerie*, 8vo, which was several times reprinted; and latterly it was edited with notes by La Faye in 2 vols. This treatise was long received as a standard book on the subject. It contains many useful and pertinent observations detailed in plain, unaffected language. Dionis is the author of two other works; the first, *Sur la Mort subite, et sur la Catalepsie*, published in 1709, and the other *Traité generale des Accouchements*, in 1718. But the last is little else than an abridgement of Mauriçeau's work on the same subject. Dionis died at Paris in 1718.

DIONÆA, Venus's Fly-trap, a genus of plants belonging to the decandria class. See Botany *Index*.

DIONYSIA, in Grecian antiquity, solemnities in honour of Bacchus, sometimes called by the general name of *Orgia*; and by the Romans *Bacchanalia*, and *Liberalia*. See Bacchanalia and Bacchus.

DIONYSIACA, in antiquity, was a designation given to plays and all manner of sports acted on the stage; because playhouses were dedicated to Dionysius, i. e. Bacchus, and Venus, as being the deities of sports and pleasure.

DIONYSIAN period. See Chronology, N° 31.

DIONYSIUS I. from a private secretary became general and tyrant of Syracuse and all Sicily. He was likewise a poet; and having, by bribes, gained the tragedy prize at Athens, he indulged himself so immoderately at table from excess of joy, that he died of the debauch, 386 B. C.; but some authors relate that he was poisoned by his physicians.

Dionysius II. (his son and successor) was a greater tyrant than his father; his subjects were obliged to apply to the Corinthians for succour; and Timoleon their general having conquered the tyrant, he fled to Athens, where he was obliged to keep a school for subsistence. He died 343 B. C.

Dionysius *Halicarnassensis*, a celebrated historian, and one of the most judicious critics of antiquity, was born at Halicarnassus: and went to Rome after the battle of Actium, where he staid 22 years under the reign of Augustus. He there composed in Greek his History of the Roman Antiquities, in 20 books, of which the first 11 only are now remaining. There are also still extant several of his critical works. The best edition of the works of this author is that of Oxford, in 1704, in Greek and Latin, by Dr Hudson.

Dionysius, a learned geographer, to whom is attributed a Periegesis, or Survey of the Earth, in Greek verse. Some suppose that he lived in the time of Augustus; but Scaliger and Saumasius place him under the reign of Severus, or Marcus Aurelius. He wrote many other works, but his Periegesis is the only one we have remaining; the best and most useful edition of which is that improved with notes and illustrations by Hill.

Dionysius *Areopagita*, was born at Athens, and educated there. He went afterwards to Heliopolis in Egypt; where, if we may believe some writers of his life, he saw that wonderful eclipse which happened at our Saviour's passion, and was urged by some extraordinary impulse to cry out, *Aut Deus patitur, aut cum patiente dolet*; "either God himself suffers, or condoles with him who does." At his return to Athens he was elected into the court of Areopagus, from whence he derived his name of *Areopagite*. About the year 50 he embraced Christianity; and, as some say, was appointed first bishop of Athens by St Paul. Of his conversion we have an account in the 17th chapter of the Acts of the Apostles.—He is supposed to have suffered martyrdom; but whether under Domitian, Trajan, or Adrian, is not certain. We have nothing remaining under his name, but what there is the greatest reason to believe spurious.

Dionysius *the Lesser*, a Scythian, became abbot of a monastery at Rome; he was the first who computed time from the birth of Dionysius to Christ, and fixed that great event, according to the vulgar era. He was also a learned canon law writer, and died about the year 540.

DIOPHANTINE problems, in *Mathematics*, certain questions relating to square and cube numbers, and right-angled triangles, &c. the nature of which was

ophan-
tine.

was determined by Diophantus, a mathematician of Alexandria, who is believed to have lived about the third century. We have his works, which were published with notes at Paris, in 1621, by Bachet de Meziriac; and another edition in 1670, with observations on every question by M. Fermat.

In these questions it is endeavoured to find commensurable numbers to answer indeterminate problems; which bring out an infinite number of incommensurable quantities. For example, it is proposed to find a right-angled triangle, whose sides, x, y, z, are expressed by commensurable numbers; it is known that $x^2+y^2=z^2$, z being the supposed hypothenuse. But it is possible to assume x and y so, that z will be incommensurable; for if $x=1$, and $y=2$, $z=\sqrt{5}$.

The art of resolving such problems consists in so managing the unknown quantity or quantities in such a manner, that the square or higher power may vanish out of the equation, and then by means of the unknown quantity in its first dimension, the equation may be resolved without having recourse to incommensurables; e. g. let it be supposed to find x, y, z, the sides of a right-angled triangle, such as will give $x^2+y^2=z^2$. Suppose $z=x+u$, then $x^2+y^2=x^2+2\,x\,u+u^2$; out of which equation x^2 vanishes, and $x=\frac{y^2-u^2}{2\,u}$: then assuming y and u equal to any numbers at pleasure, the sides of the triangle will be y, $\frac{y^2\times u^2}{2\,u}$, and the hypothenuse $x+u=\frac{y^2\times u^2}{2\,u}$; if $y=3$, and $u=1$, then $\frac{y^2-u^2}{2\,u}=4$, and $x+u=5$. It is evident that this problem admits of an infinite number of solutions.

Diophantine
||
Dioptra.

For the resolution of such kind of problems, see Saunderson's Algebra, vol. ii. book 6.

DIOPHANTUS, a celebrated mathematician of Alexandria, has been reputed to be the inventor of algebra; at least his is the earliest work extant on that science. It is not certain when Diophantus lived. Some have placed him before Christ, and some after, in the reigns of Nero and the Antonines: but all with equal uncertainty. It seems he is the same Diophantus who wrote the Canon Astronomicus, which Suidas says was commented on by the celebrated Hypatia, daughter of Theon of Alexandria. His reputation must have been very high among the ancients, since they ranked him with Pythagoras and Euclid in mathematical learning. Bachet, in his notes upon the 5th book *De Arithmeticis*, has collected, from Diophantus's epitaph in the Anthologia, the following circumstances of his life; namely, that he was married when he was 33 years old, and had a son born five years after; that this son died when he was 42 years of age, and that his father did not survive him above four years; from which it appears, that Diophantus was 84 years old when he died.

DIOPTER, or DIOPTRA, the same with the index or alhidade of an astrolabe, or other such instrument.

DIOPTRA was an instrument invented by Hipparchus, which served for several uses; as, to level water-courses; to take the height of towers, or places at a distance; to determine the places, magnitudes, and distances of the planets, &c.

DIOPTRICS,

THAT part of OPTICS which treats of the laws of refraction, and the effects which the refraction of light has in vision. The word is originally Greek, formed of δια, *per*, "*through*," and οπτομαι, *I see*.

As this and the other branches of OPTICS are fully treated under the collective name, we shall here, 1. Just give a summary of the general principles of the branch, in a few plain aphorisms, with some preliminary definitions; and, 2. Present our readers with a set of entertaining experiments, illustrative of, or dependent upon, those principles.

DEFINITIONS.

te
CLXV.

Fig.

1. When a ray of light passing out of one medium into another of a different density, is turned from that straight line in which it would otherwise proceed into one of a different direction, it is said to be refracted. Thus the rays AB, AC, &c. (fig. 1.) by passing out of air into the glass BGC, are turned from their natural course into that of BF, CF, &c. and are therefore said to be refracted by the lens BGC.

2. Any spherical transparent glass, that converges or diverges the rays of light as they pass through it, is called a *lens*.

3. Of lenses there are five sorts: 1. A plane or single convex lens, which is plane on one side and convex on the other; as AZ, fig. 2. 2. A double convex lens, as B. 3. A plano-concave lens, that is, plane on one side and concave on the other, as C. 4. A double concave, as D. And, 5. A meniscus, which is convex on one side and concave on the other, as E.

Fig. 2.

4. The point C, (fig. 2.) round which the spherical surface of a lens, as AZ, is described, is called its *centre;* the line XY, drawn from that centre perpendicular to its two surfaces, is the *axis;* and the point V, to which the axis is drawn, is the *vertex* of that lens.

5. When the rays of light that pass through a single or double convex lens are brought into their smallest compass, that point is the *focus* of the lens.

6. In optical instruments, that lens which is next the object is called the *object glass;* and that next the eye, the *eye glass.*

Fig. 3.

7. The distance between the line AB, (fig. 3.) and the perpendicular EF, is called the *angle of incidence;* and the distance between the line BD and the perpendicular EF, is called the *angle of refraction.*

APHORISMS.

1. A ray of light passing obliquely out of one medium into another that is denser, will be refracted toward the perpendicular; as the ray AB, by passing out of air into glass, is refracted into BF, inclined

to the perpendicular AF. On the contrary, a ray passing out of a denser into a rarer medium, will be refracted from the perpendicular; as the ray BC, passing out of the glass GH into air, is refracted into DI.

2. The sines of the angles of incidence and refraction, when the lines that contain them are all equal, will have a determinate proportion to each other, in the same mediums; which, between air and water, will be as 4 to 3; between air and glass, as 3 to 2, nearly; and in other mediums, in proportion to their densities.

3. Any object viewed through a glass, whose two surfaces are parallel, will appear of its natural shape and dimensions, provided it be only of the size of the pupil of the eye, and the light proceeding from it be received directly through the glass by one eye only. In all other situations an alteration will be perceived not only in its apparent situation, but its dimensions also. This alteration will be greater in proportion to the thickness of the glass, and the obliquity of the rays; in general, it is so small as to be overlooked.

4. All the rays of light which fall upon a convex lens, whether parallel, converging, or diverging to a certain degree, will be made to meet in a focus on the other side; but if they diverge excessively, they will not do so. Thus, if rays diverge from a point placed before the glass, at the focal distance from it, they will become parallel after passing through it; and if the point from which they proceed be nearer the glass than its focal distance, they will still continue to diverge, though in a less degree than before.

5. When parallel rays fall upon a concave lens, they will be made to diverge after passing through it. If they are diverging already before they fall upon the glass, they will diverge more after passing through it; or even if they are converging to a certain degree, they will diverge upon passing through a concave lens; but if the convergence is very great, they will converge after passing through the glass, though to a more distant point than that at which they would otherwise have met.

6. When an object is viewed through two convex lenses, its apparent diameter ought to be to its real one as the distance of the focus of the object glass is to that of the eye glass; but by reason of the aberration of the rays of light, the magnifying power will be somewhat greater or less in proportion to the diameter of the object.

By these aphorisms we are enabled to account for the various effects of dioptric machines, as refracting telescopes, microscopes, the camera obscura, &c. See Optics.

ENTERTAINING EXPERIMENTS.

I. *Optical Illusions.*

Fig. 4. On the bottom of the vessel ABCD, (fig. 4.) place three pieces of money, as a shilling, a half-crown, and crown; the first at E, the second at F, and the last at G. Then place a person at H, where he can see no further into the vessel than I: and tell him, that by pouring water into the vessel you will make him see three different pieces of money; bidding him observe carefully whether any money goes in with the water.

Here you must observe to pour in the water very gently, or contrive to fix the pieces, that they may not move out of their places by its agitation.

When the water comes up to K, the piece at E will become visible; when it comes up to L, the pieces at E and F will appear; and when it rises to M, all the three pieces will be visible.

From what has been said of the refraction of light, the cause of this phenomenon will be evident: for while the vessel is empty, the ray HI will naturally proceed in a straight line: but in proportion as it becomes immersed in water, it will be necessarily refracted into the several directions, NE, OF, PG, and consequently the several pieces must become visible.

II. *Optical Augmentation.*

Take a large drinking glass of a conical figure, that is small at bottom and wide at top; in which put a shilling, and fill the glass about half full with water: then place a plate on the top of it, and turn it quickly over, that the water may not get out. You will then see on the plate, a piece of the size of a half-crown; and somewhat higher up, another piece of the size of a shilling.

This phenomenon arises from seeing the piece through the conical surface of the water at the side of the glass, and through the flat surface at the top of the water, at the same time: for the conical surface dilates the rays, and makes the piece appear larger; but by the flat surface the rays are only refracted, by which the piece is seen higher up in the glass, but still of its natural size. That this is the cause will be further evident by filling the glass with water; for as the shilling cannot be then seen from the top, the large piece only will be visible.

III. *Optical Subtraction.*

Against the wainscot of a room fix three small pieces of paper, as A, B, C, (fig. 5.) at the height of your eye; Fig. 5 and placing yourself directly before them, shut your right eye and look at them with the left; when you will see only two of those papers, suppose A and B; but altering the position of your eye, you will then see the third and one of the first, suppose A; and by altering your position a second time, you will see B and C; but never all three of them together.

The cause of this phenomenon is, that one of the three pencils of rays that come from those objects, falls constantly on the optic nerve at D; whereas to produce distinct vision, it is necessary that the rays of light fall on some part of the retina E, F, G, H. We see by this experiment, one of the uses of having two eyes; for he that has one only, can never see three objects placed in this position, nor all the parts of one object of the same extent, without altering the situation of his eye.

IV. *Alternate Illusion.*

With a convex lens of about an inch focus, look attentively at a silver seal, on which a cipher is engraved.

graved. It will at first appear cut in, as to the naked eye; but if you continue to observe it some time, without changing your situation, it will seem to be in relief, and the lights and shades will appear the same as they did before. If you regard it with the same attention still longer, it will again appear to be engraved: and so on alternately.

If you look off the seal for a few moments, when you view it again, instead of seeing it, as at first, engraved, it will appear in relief. If, while you are turned toward the light, you suddenly incline the seal, while you continue to regard it, those parts that seemed to be engraved will immediately appear in relief; and if, when you are regarding these seeming prominent parts, you turn yourself so that the light may fall on the right hand, you will see the shadows on the same side from whence the light comes, which will appear not a little extraordinary. In like manner the shadows will appear on the left, if the light fall on that side. If, instead of a seal, you look at a piece of money, these alterations will not be visible, in whatever situation you place yourself.

It has been suspected that this illusion arises from the situation of the light: and, in fact, "I have observed (says M. Guyot, from whom this article is taken), that when I have viewed it with a candle on the right, it has appeared engraved; but by changing the light to the left side, it has immediately appeared in relief." It still, however, remains to be explained, why we see it alternately hollow and prominent, without either changing the situation or the light. Perhaps it is in the sight itself that we must look for the cause of this phenomenon; and this seems the more probable, as all these appearances are not discernible by all persons.

Mr William Jones of Holborn, has remarked to us, that this illusion is still more extraordinary and permanent, when you look at a cavity in a seal or other object through the three eye glasses of a common four glass refracting telescope: all cavities viewed through these glasses appear constantly reliefs, in almost all situations of the light you see them with.

V. *The Dioptrical Paradox.*

A new and curious optical, or what may be called properly a *dioptrical*, deception, has been made by Mr W. Jones. Its effect is, that a print, or an ornamented drawing, with any object, such as an *ace of diamonds*, &c. in the centre F, (fig. 6.) will be seen as the *ace of clubs* when it is placed in the machine ABDC, and viewed through a single glass only contained in the tube E. The construction of this machine is truly simple. The glass in the tube F, which brings about this surprising change, is somewhat on the principle of the common multiplying glass, as represented at G, which by the number of its inclined surfaces, and from the refractive power of the rays proceeding from the objects placed before it, shows it in a multiplied state or quantity. Its only difference is, that the sides of this glass are flat, and diverge upwards from the base to a point in the axis of the glass like a cone: the number of the sides is six; and each side, from its angular position to the eye, has the property of refracting from the border of the print F such a portion of it (designedly there placed), as will make a part in the composition of the figure to be represented: for the hexagonal and conical figure of this glass prevents any sight of the ace of diamonds in the centre being seen; consequently the ace of clubs being previously and mechanically drawn in the circle of refraction in six different parts of the border, at 1, 2, 3, 4, 5, 6, and artfully disguised in the ornamental border by blending them with it, the glass in the tube at E will change the appearance of the ace of diamonds F into the ace of clubs G. In the same manner may other prints undergo similar changes, according to the will of an ingenious draughtsman who may design them. The figure of the glass is clearly shown at H.

Fig. 6.

VI. *Camera Obscura*, or *Dark Chamber*.

Make a circular hole in the shutter of a window, from whence there is a prospect of the fields, or any other object not too near; and in this hole place a convex glass, either double or single, whose focus is at the distance of five or six feet (A). Take care that no light enter the room but by this glass: at a distance from it equal to that of its focus, place a pasteboard, covered with the whitest paper; which should have a black border, to prevent any of the side rays from disturbing the picture. Let it be two feet and a half long, and 18 or 20 inches high: bend the length of it inwards, to the form of part of a circle, whose diameter is equal to double the focal distance of the glass. Then fix it on a frame of the same figure, and put it on a moveable foot, that it may be easily fixed at that exact distance from the glass where the objects paint themselves to the greatest perfection. When it is thus placed, all the objects that are in the front of the window will be painted on the paper, in an inverted position (B), with the greatest regularity and in the most natural colours.

If you place a moveable mirror without the window; by turning it more or less, you will have on the paper

---

(A) The distance should not be less than three feet; for if it be, the images will be too small, and there will not be sufficient room for the spectators to stand conveniently. On the other hand, the focus should never be more than 15 or 20 feet, for then the images will be obscure, and the colouring faint. The best distance is from 6 to 12 feet.

(B) This inverted position of the images may be deemed an imperfection, but is easily remedied: for if you stand above the board on which they are received, and look down on it, they will appear in their natural position: or if you stand before, and placing a common mirror against your breast in an oblique direction, look down in it, you will there see the images erect, and they will receive an additional lustre from the reflection of the glass; or place two lenses, in a tube that draws out; or, lastly, if you place a large concave mirror at a proper distance before the picture, it will appear before the mirror, and in an erect position.

paper all the objects that are on each side of the window (C).

If instead of placing the mirror without the window you place it in the room, and above the hole (which must then be made near the top of the shutter), you may receive the representation on a paper placed horizontally on a table; and draw, at your leisure, all the objects that are there painted.

Nothing can be more pleasing than this experiment, especially when the objects are strongly enlightened by the sun: and not only land prospects, but a sea-port, when the water is somewhat agitated, or at the setting of the sun, presents a very delightful appearance.

This representation affords the most perfect model for painters, as well for the tone of colours, as that degradation of shades, occasioned by the interposition of the air, which has been so justly expressed by some modern painters.

It is necessary that the paper have a circular form; for otherwise, when the centre of it was in the focus of the glass, the two sides would be beyond it, and consequently the images would be confused. If the frame were contrived of a spherical figure, and the glass were in its centre, the representation would be still more accurate. If the object without be at the distance of twice the focal length of the glass, the image in the room will be of the same magnitude with the object.

The lights, shades, and colours, in the camera obscura, appear not only just, but, by the images being reduced to a smaller compass, much stronger than in nature. Add to this, that these pictures exceed all others, by representing the motion of the several objects; thus we see the animals walk, run, or fly; the clouds float in the air; the leaves quiver; the waves roll, &c.; and all in strict conformity to the laws of nature. The best situation for a dark chamber is directly north, and the best time of the day is noon.

VII. *To show the Spots on the Sun's Disk, by its image in the Camera Obscura.*

Put the object glass of a 10 or 12 feet telescope into the scioptric ball, and turn it about till it be directly opposite to the sun (D). Then place the pasteboard, mentioned in the last experiment, in the focus of the lens; and you will see a clear bright image of the sun, of about an inch in diameter, in which the spots on the sun's surface will be exactly described.

As this image is too bright to be seen with pleasure by the naked eye, you may view it through a lens whose focus is at six or eight inches distance; which at the same time that it prevents the light from being offensive, will, by magnifying both the image and the spots, make them appear to greater advantage.

VIII. *To magnify small Objects by means of the Sun's Rays let into a Dark Chamber.*

Let the rays of light that pass through the lens in the shutter be thrown on a large concave mirror, properly fixed in a frame. Then take a slip or thin plate of glass; and sticking any small object on it, hold it in the incident rays, at a little more than the focal distance from the mirror; and you will see on the opposite wall, amidst the reflected rays, the image of that object, very large, and extremely clear and bright. This experiment never fails to give the spectator the highest satisfaction.

IX. *The Portable Camera Obscura.*

The great pleasure produced by the camera obscura in the common form, has excited several to render it more universally useful by making it portable, easily fixed on any spot, and adapted to every prospect. We shall not here examine the merits of the various sorts that have been invented; but content ourselves with describing of two late improved constructions, as made and sold by the opticians of the present time, and that appear in their construction the most convenient and advantageous of any yet contrived.

The pocket or portable camera obscura, with a drawer to draw out in the front, is represented in fig. 7. Fig. 7.
The images of the objects before the instrument are reflected upon a glass ground rough on its upper side, and that is placed at top of the hinder part of the box, under the moveable cover represented in the figure. The images represented thereon will afford a most beautiful and perfect piece of perspective or landscape of whatever is before the camera, and more particularly so if the sun shines upon the objects. The outlines of them may easily be traced on the glass by a black lead pencil. There is sometimes a scale of proportions placed in the upper surface of the drawer, by which any particular building or other object may be drawn in a given proportion or magnitude, and according to the figures inserted on the scale, which are adapted to the focus or foci of the lenses made use of in the camera. The glasses that are made use of in this camera are only three, and are represented in fig. 8. The con- Fig. 8.
vex glass A is placed in the front of the drawer of the camera, and is of a focus agreeable to the length of the box. The mirror CE reclines in the box in an angle of 45 degrees from a perpendicular situation. The rays flowing from the object F through the convex glass A to the plane mirror CE will be reflected from it, and meet in points on the glass placed horizontally in the direction CD, and will form thereon the forementioned images. If on this glass and oiled paper or any other transparent substance be placed the images

---

(C) There is another method of making the dark chamber; which is by a scioptric ball, that is, a ball of wood, through which a hole is made, in which hole a lens is fixed: this ball is placed in a wooden frame, in which it turns freely round. The frame is fixed to the hole in the shutter; and the ball, by turning about, answers, in great part, the use of the mirror, on the outside of the window. If the hole in the window be no bigger than a pea, the object will be represented without any lens, though by no means so distinctly, or with such vivid colours.

(D) When the sun is directly opposite to the hole, the lens will itself be sufficient: or by means of the mirror on the outside window, as in Experiment VI. the lens will answer the purpose at any time.

images will be clearly represented, and sufficiently so to delineate them by a black lead pencil or crayon. Instead of the glass CD, or sometimes underneath it, is often placed a double convex lens, of a focus somewhat shorter than the length of the box; this alteration considerably brightens the appearance of the images, and renders them as vivid as the objects themselves, though not quite so accurate in their contours or outlines as by the preceding method.

Another kind of portable camera obscura is, where the images are formed upon white paper, and the several parts of the camera fold up out of a box shaped like a book or chest. This way of the images being formed on paper is a much preferable one to the preceding method, and admits of their being traced on the paper with the utmost readiness. This instrument, as open out of its case and ready for use, is represented in fig. 9. F. 9. The front and sides fold up to the height of about two feet from the case EFG, by means of hinges placed at PH, &c. The head of ABCD, about five inches square and high, containing the mirror L and the convex lens beneath it, fits on at CD, and the inner square tube of it is moved up and down by rack-work and a pinion NM. This motion serves to adjust the convex lens *d* to its proper focal distance from the white paper placed within side at the bottom of the box EFG, so that the images may be formed with the greatest possible distinctness. In tracing these images the face is applied close to the hole in the front at K, and the hand in the sleeve in the front at the bottom of FG. When the sides and front are unhooked and folded down, they all lie close in the box EFG, and the lid O folds down as a top on them close, and the box remains then the common size of a folio book; and is covered with calf leather and lettered on the back in perfect imitation of one.

By the diagonal position of a plane mirror the curious opera glass is constructed, by which any person may be viewed in a theatre or public company, and yet know nothing of it. It consists only in placing a concave glass near the plane mirror, in the end of a short round tube, and a convex glass in a hole in the side of the tube. Then holding the end of the tube with the glass to the eye, all objects next to the hole in the side will be reflected so as to appear in a direct line forward, or in a position at right angles to the person's situation who is looked at. Plane glasses instead of a concave and convex may be used; but in this case there will be no magnitude of the object, but it will appear brighter. It is called by opticians the *diagonal opera glass*.

X. *The Magic Lantern.*

This very remarkable machine, which is now known over all the world, caused great astonishment at its origin. It is still beheld with pleasing admiration; and the spectator very frequently contents himself with wondering at its effects, without endeavouring to investigate their cause. The invention of this ingenious illusion is attributed to the celebrated P. Kircher, who has published on various sciences, works equally learned, curious, and entertaining. Its design is to represent at large, on a cloth or board, placed in the dark, the images of small objects, painted with transparent colours on plates of glass.

The construction is as follows: Let ABCD (fig. 10.) Fig. 10. be the side of a tin box, eight inches high, eight inches long, and ten broad (or any other similar dimensions), the top of which must have a funnel, with a cover, as represented in fig. 11.; which at the same time it gives Fig. 11. a passage to the smoke, prevents the light from coming out of the box. In the middle of the bottom of the box must be placed a low tin lamp E, which is to be moveable. It should have three or four lights, that must be at the height of the centre of the glasses in the tubes N and O. In the largest of these tubes must be placed a glass semiglobular lens N, about four inches diameter; and in the smaller one a double convex lens o, about $2\frac{1}{4}$ inches diameter, and six inches focus, the length of the tubes holding them about $4\frac{1}{2}$ inches each; the inner tube containing the small lens o must be a sliding one, in order to adjust it at a proper distance from the painted sliders, so that the objects thereon may be distinctly represented on the cloth or white wall. A slit or opening between the glass N and the front side BGDH of the box must be made large enough to admit the sliders to be passed through, (as in fig. 11.). The clearness of the light, and the objects upon the cloth, will depend much upon the light of the lamp; it will therefore be proved best, to place, instead of the common lamp E, a kind of the new or Argand's patent lamp, which will be found considerably to improve the effect of the lantern by its superior strength of light.

From the construction of this lantern it is evident that when the glass sliders, with the painted figures, are placed in the groove or slit in the lantern for that purpose, and the room darkened, a quantity of light from the lamp at E will be collected by the lens N, and refracted upon the cloth placed opposite, and that by moving the sliding tube containing the small lens o gradually in or out as occasion may require, this lens will form images of the figures on the sliders in their distinct colours and proportions, with the appearance of life itself, and of any size from six inches to seven feet, according to the distance of the lantern from the cloth. The lantern, with one of the sliders ready for use, is clearly represented in fig. 11. By the aid of the new patent lamp aforementioned, considerable useful improvements are made to the lantern. Mr Jones, optician, of Holborn, has contrived an apparatus to be applied to it, that converts it into a microscope by night, and it shows all the variety of transparent and many of the opaque objects magnified upon a cloth or skreen opposite, similar to the figures above mentioned, but not in so large a degree; about one or two feet diameter is the utmost that can at present be obtained.

Method of painting the Glasses for the lantern. Draw on a paper the subject you desire to paint, and fix it at each end to the glass. Provide a varnish with which you have mixed some black paint; and with a fine pencil draw on the other side of the glass, with very light touches, the design drawn on the paper. If you are desirous of making the painting as perfect as possible, you should draw some of the outlines in their proper colours, provided they are the strongest tints of these colours that are used. When the outlines are dry, you colour the figures with their proper tints or degradations.

degradations. Transparent colours are most proper for this purpose, such as carmine, lake, Prussian blue, verdigrise, &c. and these may be tempered with a strong white varnish, to prevent their peeling off. You are then to shade them with black mixed with the same varnish, or with bistre, as you find convenient. You may also leave strong lights in some parts, without any colours, in order to produce a more striking effect. Observe, in particular, not to use more than four or five colours, such as blue, red, green, and yellow. You should employ, however, a great variety of tints, to give your painting a more natural air; without which they will represent vulgar objects, which are by no means the more pleasing because they are gawdy.

When the lamp in the lantern is lighted, and, by drawing out the tube to a proper length, the figures painted on the glass appear bright and well defined, the spectator cannot fail of being highly entertained by the succession of natural or grotesque figures that are painted on the glasses. This piece of optics may be rendered much more amusing, and at the same time more marvellous, by preparing figures to which different natural motions may be given (E), which every one may perform according to his own taste; either by movements in the figures themselves, or by painting the subject on two glasses, and passing them at the same time through the groove, as will be seen in the next experiment.

XI. *To represent a Tempest by a Magic Lantern.*

Fig. 12. Provide two plates of glass, whose frames are so thin that they may both pass freely through the slit or groove of the common magic lantern at the same time.

On one of these glasses you are to paint the appearance of the sea from the slightest agitation to the most violent commotion. Representing from A to B (fig. 12.) a calm; from B to C a small agitation, with some clouds; and so on to F and G, which should exhibit a furious storm. Observe, that these representations are not to be distinct, but run into each other, that they may form a natural gradation; remember also, that great part of the effect depends on the perfection of the painting, and the picturesque appearance of the design.

Fig. 13. On the other glass (fig. 13.) you are to paint vessels of different forms and dimensions, and in different directions, together with the appearance of clouds in the tempestuous parts.

You are then to pass the glass slowly through the groove; and when you come to that part where the storm begins, you are to move the glass gently up and down, which will give it the appearance of a sea that begins to be agitated; and so increase the motion till you come to the height of the storm. At the same time you are to introduce the other glass with the ships, and moving that in like manner, you will have a natural representation of the sea, and of ships in a calm and in a storm. As you draw the glasses slowly back, the tempest will seem to subside, the sky grow clear, and the ships glide gently over the waves.—By means of two glasses disposed in this manner you may likewise represent a battle or sea-fight, and numberless other subjects, that every one will contrive according to his own taste. They may also be made to represent some remarkable or ludicrous action between different persons, and many other amusements that a lively imagination willl easily suggest.

XII. *The Nebulous Magic Lantern.*

The light of the magic lantern, and the colour of images, may not only be painted on a cloth, but also reflected by a cloud of smoke.

Provide a box of wood or pasteboard (fig. 14.) of about four feet high, and of seven or eight inches square at bottom, but diminishing as it ascends, so that its aperture at top is but six inches long, and half an inch wide. At the bottom of this box there must be a door that shuts quite close, by which you are to place in the box a chafing-dish with hot coals, on which is to be thrown incense, whose smoke goes out in a cloud at the top of the box. It is on this cloud that you are to throw the light that comes out of the lantern, and which you bring into a smaller compass by drawing ont the moveable tube. The common figures will here serve. It is remarkable in this representation, that the motion of the smoke does not at all change the figures; which appear so conspicuous, that the spectator thinks he can grasp them with his hand. Fig. 14.

Note. In this experiment some of the rays passing through the smoke, the representation will be much less vivid than on the cloth; and if care be not taken to reduce the light to its smallest focus, it will be still more imperfect.

XIII. *To produce the Appearance of a Phantom upon a Pedestal placed on the middle of a Table.*

Enclose a common small magic lantern in a box ABCD (fig. 15.) that is large enough to contain also an inclined mirror M, which must be moveable, that it may reflect the cone of light thrown on it by the lantern, in such a manner that it may pass out at the aperture made in the top of the box. There should be a flap with hinges to cover the opening, that the inside of the box may not be seen when the experiment is making. This aperture should likewise be oval, and of a size adapted to the cone of light that is to pass through it. There must be holes made in that part of the box which is over the lantern, to let out the smoke: and over that part must be placed a chafing-dish of an oblong figure, and large enough to hold several lighted coals. This chafing-dish may be enclosed in a painted tin box of about a foot high, and with an aperture at top something like fig. 14. It should stand on four short feet, to give room for the smoke of the lamp to pass out. There must also be a glass that will ascend and descend at pleasure in a vertical groove *a b*. To this glass let there be fixed a cord, that, going over a pulley *c*, passes ont of the box at the side CD, by which the Fig. 15.

(E) There are in the Philosophical Essays of M. Muschenbroek, different method, of performing all these various movements, by some mechanical contrivances that are not difficult to execute.

the glass may be drawn up, and will descend by its own weight. On this glass may be painted a spectre, or any other more pleasing figure. Observe, that the figures must be contracted in drawing, as the cloud of smoke does not cut the cone of light at right angles, and therefore the figures will appear longer than they do on the glass.

After you have lighted the lamp in the lantern, and put the mirror in a proper direction, you place the box or pedestal ABCD on a table; and putting the chafing dish in it, throw some incense in powder on the coals. You then open a trap door, and let down the glass slowly; and, when you perceive the smoke diminish, you draw up the glass, that the figure may disappear, and shut the trap-door. This appearance will occasion no small surprise, as the spectre will seem to rise gradually out of the pedestal, and on drawing up the glass will disappear in an instant. Observe, that when you exhibit this experiment, you must put out all the lights in the room; and the box should be placed on a high table, that the spectators may not perceive the aperture by which the light comes out. Though we have mentioned a small magic lantern, yet the whole apparatus may be so enlarged, that the phantom may appear of a formidable size.

XIV. *The Magic Theatre.*

By making some few additions to the magic lantern with the square tube, used in Experiment X. various scenes, characters, and decorations of a theatre, may be represented in a lively manner. In this experiment it is quite necessary to make the lantern much larger than common, that the objects painted on the glasses, being of a larger size, may be represented with greater precision, and consequently their several characters more strongly marked.

Fig. 5. Let there be made a wooden box ABCD, fig. 16. a foot and a half long, 15 inches high, and 10 wide. Let it be placed on a stand EF, that must go round it, and by which it may be fixed with two screws to a table. Place over it a tin cover, as in the common lantern. Make an opening in its two narrowest sides; in one of which place the tube H, and in the other the tube I: let each of them be six inches wide, and five inches high: in each of these tubes place another that is moveable, in order to bring the glasses, or concave mirror, that are contained in them, to a proper distance. In the middle of the bottom of this box place a tin lamp M; which must be moveable in a groove, that it may be placed at a proper distance with regard to the glasses and mirror; this lamp should have five or six lights, each of them about an inch long. At the beginning of the tube H, toward the part N, make an opening of an inch wide, which must cross it laterally: another of three quarters of an inch, that must cross it vertically, and be nearer the box than the first; and a third of half an inch, that must be before the first. The opening made laterally must have three or four grooves, the second two, and the third one: that different subjects of figures and decorations may be passed, either sidewise, ascending or descending, so that the scenes of a theatre may be the more exactly imitated (F). Enclose these grooves between two convex rectangular glasses, of six inches long, and five inches high, and of about 20 inches focus; one of which must be placed at O, and the other toward P. Have another tube Q, of about a foot long, which must enter that marked H; and at its outward extremity place a lens of about 15 inches focus. There must also be a third tube R, four inches long, into which that marked I is to enter: to the exterior end of this adjust a concave mirror, whose focus must be at seven or eight inches from its reflecting surface.

The magic lantern being thus adjusted, nothing more is necessary than to provide glasses, painted with such subjects as you would represent, according to the grooves they are to enter. The lamp is then to be lighted; and placing a glass in one of the grooves, you draw out the moveable tubes till the object paints itself on a cloth to the most advantage: by which you determine the distance of the lantern and the size of the image. You then make a hole in the partition of that size, and fix it in a plate of clear glass, over which you paste a very thin paper, which must be varnished, that it may be as transparent as possible.

On this paper are to be exhibited the images of all those objects, that by passing successively through the grooves, are to represent a theatric entertainment. The exhibition will be very agreeable; because the magic lantern being concealed behind the partition, the cause of the illusion cannot by any means be discovered.

In order to show more clearly in what manner a subject of this sort should be painted, and the glasses disposed, we will here make choice of the siege of Troy for a theatric subject; in which will be found all the incidents necessary to the exhibition of any other subject whatever.—In the first act the theatre may represent, on one side, the ramparts of Troy; toward the back part, the Grecian camp; and at a farther distance, the sea, and the isle of Tenedos. We will suppose the time to be that when the Greeks feigned to raise the siege; and embarked, leaving behind them the wooden horse, in which were contained the Grecian soldiers. —On a glass, therefore, of the same width with the aperture made in the side AC of the box, you are to paint a deep blue curtain, lightly charged with ornaments, quite transparent. This glass is to be placed in the first vertical groove; so that by letting it gently down, its image may appear to rise in the same manner as the curtain of a theatre. All the glasses that are to ascend or descend must be bordered with thin pieces of wood, and so exactly fill the grooves, that they may not slide down of themselves.—You must have several glasses of a proper size to pass through the horizontal grooves, and of different lengths according to the extent of the subject. You may paint on

---

(F) In the decorations, the clouds and the palaces of the gods should descend; caves and infernal palaces should ascend; earthly palaces, gardens, &c. enter at the sides.

on the first, the walls of Troy. On the second, the Grecian camp. On the third, the sea, the isle of Tenedos, and a serene sky. On the fourth, the Grecian troops by detached figures. On the fifth, other troops, disposed in battalions, and placed at a distance. On the sixth, divers vessels, which as the glass advances in the groove diminish in size. On the seventh, the wooden horse and Sinon. On the eighth, Trojan men and women.

These glasses being properly painted, you place in the horizontal grooves the first, second, third, and fourth. Then draw up the curtain, by letting down the glass on which it is painted, and draw away gently the fourth glass, and after that the second; then advance very gently the fifth that represents the embarkment, and pass it quite through. Next pass, the opposite way, the sixth, which represents the Grecian fleet. The objects painted on the fourth, fifth, and sixth, quite disappearing, you are to advance the seventh, on which is painted the wooden horse; and at the same time the eighth, where the Trojans will appear to draw the horse into the city. The curtain is then to be let down, that you may withdraw the scenes of the first act, and place in the grooves those that are to compose the second.—In the second act may be represented the interior part of the city of Troy; on one side may be seen the wooden horse, and in the back part the temple of Pallas. The glasses for this act may be painted in the following manner. On the first may be palaces and houses, representing the inside of a city. On the second, the temple of Pallas in the centre, with a clear night and the moon. In the front may be seen the wooden horse, that the Trojans have placed near the temple of Pallas. On the third, a troop of Greeks, with Sinon at their head, who are going to open the gates of the city to the Grecians. On the fourth, different troops of armed Greeks, painted on a long glass, to afford variety. On the fifth, several troops of Trojans. On the sixth, various appearances of fire and smoke, so disposed, that this glass being drawn up above the others, the objects painted on the first glass may appear in a conflagration.

Before you draw up the curtain, you should place the first and second glasses. You then pass the whole third glass slowly; a little after, the fourth, on which are painted the different bodies of armed Greeks; and at the same time, from the opposite side, the sixth glass, that represents the Trojan troops; observing to move them slowly both in advancing and retreating, to imitate a combat (G). Then draw up, by degrees, the sixth, on which are painted the fire, flame, and smoke, so that the palaces and houses painted on the first glass may appear to take fire gradually, and at last present a general conflagration. After having represented these incidents with the greatest attention, you let fall the curtain to prepare for the third act. In this may be represented the inside of Priam's palace; where is seen an altar, round which several Trojan princesses appear, who have fled thither for safety. On the first glass may be painted the palace. On the second, a view of the back part of the palace, with the altar. On the third, Priam with several Trojan men and women. On the fourth, Pyrrhus and a troop of Greeks. On the fifth, the same actors, with the palace in flames. On the sixth, a conflagration.—The two first glasses which are to be drawn up, should be placed before you raise the curtain. Then pass the third; next advance the fourth; which being drawn up, discovers on the fifth the palace in flames; then drawing up the sixth, let down the first, that the palace may appear entirely destroyed by the conflagration.

The fourth act may represent the environs of Troy, with a distant prospect of the sea. The first and third glasses of the first act may be here used; to which may be added a third, representing Æneas bearing his father Anchises, followed by his son Iulus and some Trojans. With this glass may be represented the flight of the Trojans; and the embarkment of Æneas with another glass, on which are painted certain vessels.—To this act the following scenes may be added: The cave of Æolus; the back part of the cave; Æolus; the winds; Juno in her chariot.

The fifth act should represent the open sea, with the fleet of Æneas sailing for Italy. On the first glass must be painted the sea, as in the eleventh experiment, or else the waves should be imitated by another glass under the first. On the second, the Trojan fleet. On the third, Neptune in his car. On the fourth, the palace of Jupiter. On the fifth, the inside of the palace; the gods assembled in council, with Venus obtaining leave of Jupiter for Æneas to land in Italy.—After having placed the first glass, that represents a calm sea, the curtain is raised, and the second scene is advanced, which contains the Trojan fleet. The first is then brought forward, to represent a violent tempest: then raising the third glass, Neptune appears, who commands the waves to be still, which is done by making the tempest subside by degrees. The fleet then advances, and passes over the whole theatre; presently after the fourth and fifth scenes descend, that represent Olympus, and finish the exhibition.

Note, We must here repeat, that if you would represent a subject of this sort to advantage, it is quite necessary that the glasses be well painted; and those that are to be in front should be in stronger and more opaque colours, that the images of those behind may not appear mixed with them, which will be the case if they are all equally transparent. The glasses should also be of different lengths; that some being placed before the others are drawn away, their extremities may not be perceived.

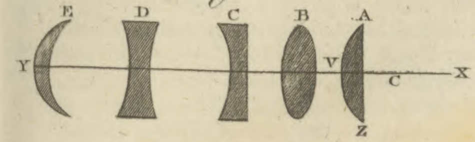
The larger these subjects are represented, the better effect they will have: the front of the theatre should appear to be about three feet wide; and if some parts of the figures were moveable, it would still add to the variety of the entertainment.

DIOSCOREA,

(G) He that moves the glasses, seeing the effect they produce, is the better able to render the representation as natural as possible.

DIVISIBILITY.

Fig. 2.



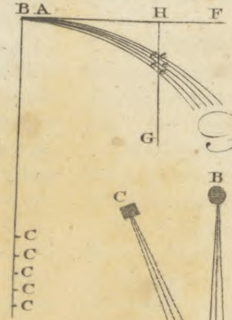


Fig. 1.

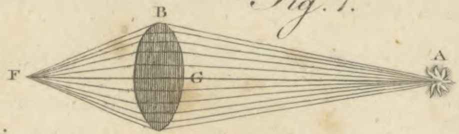


Fig. 6.

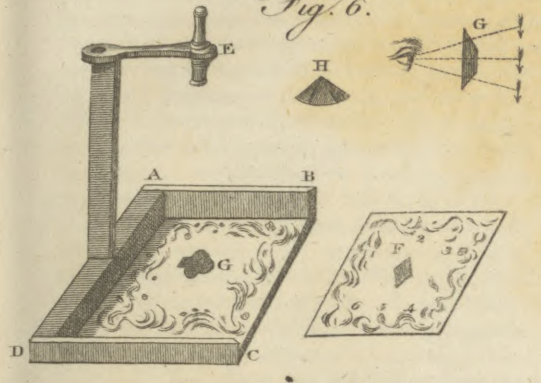


Fig. 5.

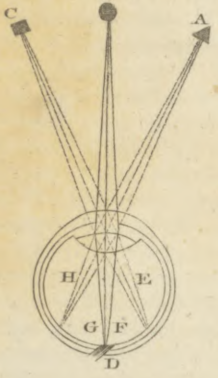


Fig. 4.

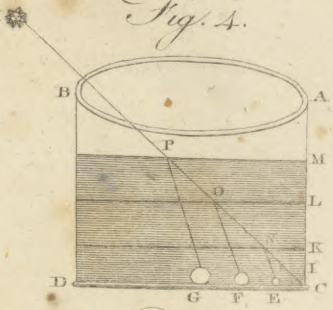


Fig. 8.

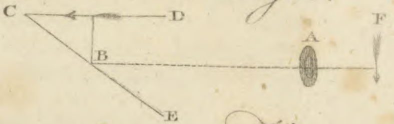


Fig. 10.

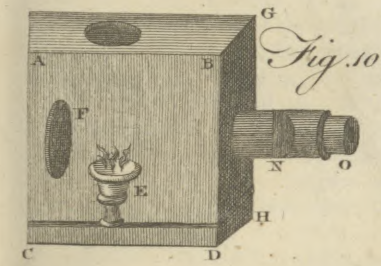


Fig. 7.

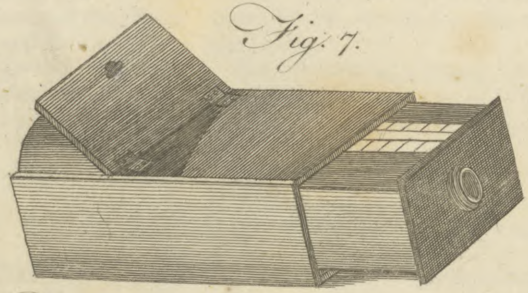


Fig. 9.

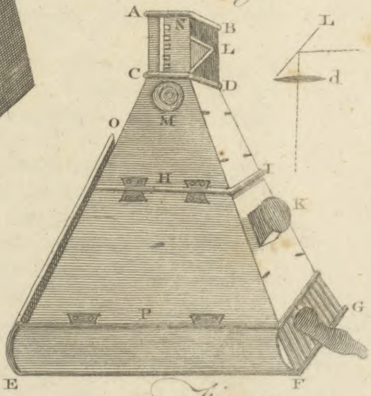


Fig. 11.

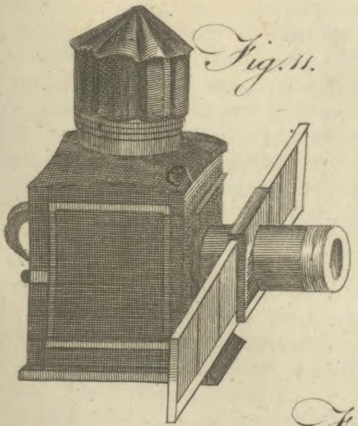


Fig. 14.

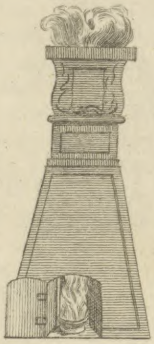


Fig. 16.

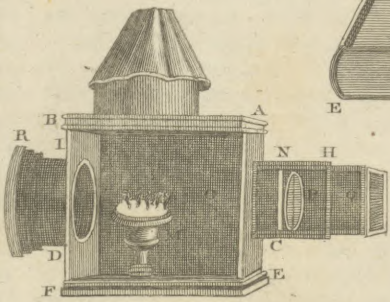


Fig. 3.

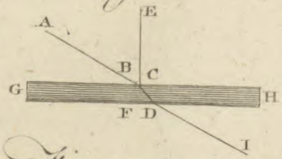
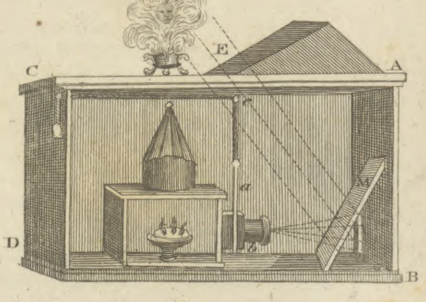


Fig. 12.

Fig. 13.

Fig. 15.



A. Bell Prin. Wal. Sculptor fecit.

DIOSCOREA, a genus of plants belonging to the diœcia class; and in the natural method ranking under the 11th order, *Sarmentaceæ*. See BOTANY *Index*.

The only remarkable and useful species is the bulbifera or yam. The roots of it are eaten by the inhabitants of both the Indies; and are particularly serviceable in the West India islands, where they make the greatest part of the negroes food. The plant is supposed to have been brought from the East to the West Indies; for it has never been observed to grow wild in any part of America; but in the island of Ceylon, and on the coast of Malabar, it grows in the woods, and there are in those places a great variety of sorts. It is propagated by cutting the root in pieces, observing to preserve an eye in each, as is practised in planting potatoes. One plant will produce three or four large roots. The skin of these roots is pretty thick, rough, unequal, covered with many stringy fibres or filaments, and of a violet colour approaching to black. The inside is white, and of the consistence of red beet. It resembles the potato in its mealiness, but is of a closer texture. When raw, the yams are viscous and clammy; when roasted or boiled, they afford very nourishing food; and are often preferred to bread by the inhabitants of the West Indies, on account of their lightness and facility of digestion. When first dug out of the ground, the roots are placed in the sun to dry; after which they are either put into sand, dry garrets, or casks; where, if kept from moisture, they may be preserved whole years, without being spoiled or diminished in their goodness. The root commonly weighs two or three pounds; though some yams have been found upwards of 20 pounds weight.

DIOSCORIDES, a physician of Cilicia, who lived, as some suppose, in the age of Nero. He was originally a soldier; but afterwards he applied himself to study, and wrote a book upon medicinal herbs.

DIOSCURIA (*διοσκουρια*; from Διος, *Jupiter*, and κουροι, *infants*), in antiquity, a festival in honour of the Διοσκουροι, or Castor and Pollux, who were reputed to be the sons of Jupiter. It was observed by the Cyreneans, but more especially by the Spartans, whose country was honoured by the birth of these heroes. The solemnity was full of mirth, being a time wherein they shared plentifully of the gifts of Bacchus, and diverted themselves with sports, of which wrestling matches always made a part.

DIOSMA, AFRICAN SPIRÆA, a genus of plants belonging to the pentandria class; and in the natural method ranking with those of which the order is doubtful. See BOTANY *Index*.

DIOSPOLIS, in *Ancient Geography*, a city of the Delta, or Lower Egypt; to the south of the Busiritic branch, before it divides into two.—Another of Bithynia, in the territory of Heraclea.—A third, called *Magna*, denoting Thebæ of the Higher Egypt.—A fourth, *Diospolis Parva*, the metropolis of the Nomos Diospolites of the Higher Egypt.—A fifth *Diospolis*, of Samaria, the same with Lydda.—A sixth *Diospolis*, the ancient name of Laodicea of Phrygia, on the Lycus.

DIOSPOLITES NOMOS, (Ptolemy,) a division of Thebais or the Higher Egypt, to distinguish it from another of the Lower Egypt or the Delta; to the south of the Nomos Thinites, on the west side of the Nile.

DIOSPYROS, the INDIAN DATE PLUM; a genus of plants belonging to the polygamia class; and in the natural method ranking under the 18th order, *Bicornes*. See BOTANY *Index*.

DIPHTHONG, in *Grammar*, a double vowel, or the mixture of two vowels pronounced together, so as to make one syllable.

The Latins pronounced the two vowels in their diphthongs ae or æ, oe or œ, much as we do; only that the one was heard much weaker than the other, though the division was made with all the delicacy imaginable. Diphthongs, with regard to the eyes, are distinguished from those with regard to the ears: in the former either the particular sound of each vowel is heard in the pronunciation; or the sound of one of them is drowned; or lastly, a new sound, different from either, results from both; the first of these only are real diphthongs, as being such both to the eye and ear. Diphthongs with regard to the ear are either formed of two vowels meeting in the same syllable, or whose sounds are severally heard; or of three vowels in the same syllable, which only afford two sounds in the pronunciation.

English diphthongs, with regard to the eye and ear, are *ai, au, ea, ee, ei, oo, ou*. Improper English diphthongs, with regard to the eye only, are *aa, ae, eo, eu, ie, ei, oe, ue, ui*.

DIPLOE, in *Anatomy*, the soft meditullium, or medullary substance which lies between the two laminæ of the bones of the cranium. See ANATOMY *Index*.

DIPLOMA. See DIPLOMATICS.

In a peculiar sense, it is used for an instrument or license given by colleges, societies, &c. to a clergyman to exercise the ministerial function, or to a physician to practise the profession, &c. after passing examination, or admitting him to a degree.

DIPLOMATICS, the science of diplomas, or of ancient literary monuments, public documents, &c. It does not, however, nor can it, absolutely extend its researches to antiquity; but is chiefly confined to the middle age, and the first centuries of modern times. For though the ancients were accustomed to reduce their contracts and treaties into writing; yet they graved them on tables, or covered them over with wax, or brass, copper, stone, or wood, &c. And all that in the first ages were not traced on brass or marble, has perished by the length of time, and the number of destructive events.

Bielfield's Elements.

1. The word *diploma* signifies properly a letter or epistle, that is folded in the middle, and that is not open. But, in more modern times, the title has been given to all ancient epistles, letters, literary monuments, and public documents, and to all those pieces of writing which the ancients called *Syngraphia Chirographa, Codicilli*, &c. In the middle age, and in the diplomas themselves, these writings are called *Litteræ, Præcepta, Placita, Chartæ indiculæ; Sagilla*, and *Bullæ;* as also *Panchartæ, Pantochartæ, Tractoriæ, Descriptiones*, &c. The originals of these pieces are named *Examplaria*, or *Autographa, Chartæ authenticæ, Originalia*, &c. and the copies, *Apographa, Copiæ, Particulæ*, and so forth.

forth. The collections that have been made of them are called *Chartaria* and *Chartulia*. The place where these papers and documents were kept, the ancients named *Scrinia*, *Tabularium*, or *Ærarium*, words that were derived from the tables of brass, and, according to the Greek idiom, *Archeium* or *Archivum*.

2. In order to understand the nature of these ancient papers, diplomas, and manuscripts, and to distinguish the authentic from the counterfeit, it is necessary to know that the paper of the ancients came from Egypt, and was formed of thin leaves or membranes, taken from the branches of a tree named *Papyrus*, or *Biblum Ægyptiacum*, and which were pasted one over the other with the slime of the Nile, and were pressed and polished with a pumice stone. This paper was very scarce; and it was of various qualities, forms, and prices, which they distinguished by the name of *charta hieratica*, *luria*, *augusta*, *amphitheatrica*, *saïtica*, *tanirica*, *cmporetica*, &c. They cut this paper into square leaves, which they pasted one to the other, in order to make rolls of them: from whence an entire book was called *volumen*, from *volvendo;* and the leaves of which it consisted, *paginæ*. Sometimes, also, they pasted the leaves all together by one of their extremities, as is now practised in binding; by this method they formed the back of a book, and these the learned called *codices*. They rolled the volume round a stick, which they named *umbilicus;* and the two ends that came out beyond the paper, *cornua*. The title, wrote on parchment, in purple characters, was joined to the last sheet, and served it as a cover. They made use of all sorts of strings or ribbands, and even sometimes of locks, to close the book; and sometimes also it was put into a case. But there is not now to be found, in any library or cabinet whatever, any one of these volumes. We have been assured, however, by a traveller, that he had seen several of them in the ruins of Herculaneum; but so damaged, the paper so stiff and brittle, by the length of time, that it was impossible to unrol them, and consequently to make use of any of them; for on the first touch they fell into shatters.

3. We are ignorant of the precise time when our modern paper was invented; and when they began to make use of pens in writing, instead of the stalks of reeds. The ink that the ancients used, was not made of vitriol and galls, like the modern, but of soot. Sometimes also they wrote with red ink made of vermilion; or in letters of gold, on purple or violet parchment. It is not difficult for those who apply themselves to this study, to distinguish the parchment of the ancients from that of the moderns, as well as their ink and various exterior characters: but that which best distinguishes the original from the counterfeit is, the writing or character itself; which is so distinctly different from one century to another, that we may tell with certainty, within about 40 or 50 years, when any diploma was written. There are two works which furnish the clearest lights on this matter, and which may serve as sure guides in the judgments we may have occasion to make on what are called *ancient diplomas*. The one is the celebrated treatise on the Diplomatic, by F. Mabillon; and the other, the first volume of the Chronicon Gotvicense. We there find specimens of all the characters, the flourishes, and different methods of writing, of every age. For these matters, therefore, we must refer our readers to those authors; and shall here only add, that,

4. All the diplomas are written in Latin, and consequently the letters and characters have a resemblance to each other: but there are certain strokes of the pen which distinguish not only the ages, but also the different nations; as the writings of the Lombards, French, Saxons, &c. The letters in the diplomas are also usually longer, and not so strong as those of manuscripts. There has been also introduced a kind of court band, of a very disproportionate length, and the letters of which are called *Exiles litteræ crispæ, ac protractiores*. The first line of the diploma, the signature of the sovereign, that of the chancellor, notary, &c. are usually wrote in this character.

5. The signature of a diploma consists either of the sign of the cross, or of a monogram or cipher, composed of the letters of the names of those who subscribed it. The initial letters of the name, and sometimes also the titles, were placed about this cross. By degrees the custom changed, and they invented other marks, as, for example, the sign of Charlemagne was thus:

R
K——A——S
V
L

They sometimes also added the dates and epoch of the signature, the feasts of the church, the days of the kalendar, and other like matters. The successive corruption of the Latin language, the style and orthography of each age, as well as their different titles and forms; the abbreviations, accentuation, and punctuation, and the various methods of writing the diphthongs; all these matters united, form so many characters and marks by which the authenticity of a diploma is to be known.

6. The seal annexed to a diploma was anciently of white wax, and artfully imprinted on the parchment itself. It was afterwards pendant from the paper, and inclosed in a box or case, which they called *bulla*. There are some also that are stamped on metal, and even on pure gold. When a diploma bears all the characters that are requisite to the time and place where it is supposed to be written, its authenticity is not to be doubted: but at the same time we cannot examine them too scrupulously, seeing that the monks and priests of former ages have been very adroit in making of counterfeits, and the more as they enjoyed the confidence of princes and statesmen, and were even sometimes in possession of their rings or seals.

7. With regard to manuscripts that were wrote before the invention of printing, it is necessary (1.) to know their nature, their essential qualities, and matter; (2.) to be able to read them freely, and without error; (3.) to judge of their antiquity by those characters which we have just mentioned with regard to the diplomas; and (4.) to render them of use in the sciences. As there are scarce any of the ancient codes now remaining (see par. 2.), wrote on the Egyptian paper, or on wood, ivory, &c. we have only to consider those that are written on parchment or vellum (*membrancos*), and such as are wrote on our paper (*chartaccos*). The

former of these are in most esteem. With regard to the character, these codes are written either in square and capital letters, or in half square, or round and small letters. Those of the first kind are the most ancient. There are no intervals between the words, no letters different from the others at the beginning of any word, no points, nor any other distinction. The codes which are wrote in letters that are half square, resemble those we have in Gothic characters, as well for the age as the form of the letters. Such as are wrote in round letters are not so ancient as the former, and do not go higher than the ninth or tenth century. These have spaces between the words, and some punctuation. They are likewise not so well wrote as the preceding, and are frequently disfigured with comments. The codes are divided, according to the country, into Lombard, Italian, Gaulic, Franco-Gaulic, Saxon, Anglo-Saxon, &c.

8. In the ancient Greek books, they frequently terminated the periods of a discourse, instead of all other division, by lines; and these divisions were called, in Latin, *versus*, from *vertendo*: for which reason these lines are still more properly named *versus* than *lineæ*. At the end of a work, they put down the number of verses of which it consisted, that the copies might be more easily collated: and it is in this sense we are to understand Trebonius, when he says, that the Pandects contain 150,000 *pæne versuum*. These codes were likewise *vel probæ vel deterioris notæ*, more or less perfect, not only with regard to the calligraphy or beauty of the character, but to the correction of the text also.

9. It is likewise necessary to observe, in ancient codes, the abbreviations, as they have been used in different centuries. Thus, for example, A. C. D. signifies Aulus Caius Decimus; Ap. Cn. Appius Cneius; Aug. Imp. Augustus Imperator. The characters that are called *notæ*, are such as are not to be found in the alphabet; but which, notwithstanding, signify certain words. All these matters are explained in a copious manner by Vossius, and in the Chronicon Gotvicense. Lastly, The learned divide all the ancient codes into *codices minus raros, rariores, editos, et anecdotos*. The critical art is here indispensably necessary: its researches, moreover, have no bounds; and the more, as the use of it augments every day, by the discoveries that are made in languages, and by the increase of erudition.

DIPONDIUS, in the scripture language, is used by St Luke to signify a certain coin which was of very little value. Our translation of the passage is, "Are not two sparrows sold for two farthings?" In St Matthew, who relates the same thing, we read "Are not two sparrows sold for a farthing?" The Greek reads *assarion* instead of *as*. Now *assarion*, as some say, was worth half an *as*, that is to say, four French deniers and $\frac{1}{8}$th; and, according to others, two deniers and $\frac{5}{16}$ths. *Dipondius* seems rather to signify half an *as*. Calmet, Diction. Bibl. Luke xii. 6. Matt. x. 29.

Dr Arbuthnot differs in opinion from the author last quoted. He says, that this coin was at first *libralis*, or of a pound weight; and even when diminished, it retained the name of *libella*. So that *dipondius* denotes two asses.

DIPPING, among miners, signifies the interruption or breaking off the veins of ore; an accident that gives them a great deal of trouble before they can discover the ore again. A great deal of the skill of the miners consists in the understanding this dipping of the veins, and knowing how to manage in it. In Cornwall they have this general rule to guide them in this respect: most of their tin-loads, which run from east to west, constantly dip towards the north. Sometimes they underlie; that is, they slope down towards the north three feet in height perpendicular. This must carefully be observed by the miners, that they may exactly know where to make their air-shafts when occasion requires; yet, in the higher mountains of Dartmaer, there are some considerable loads, which run north and south; these always underlie toward the east. Four or five loads may run nearly parallel to each other in the same hill; and yet, which is rare, they may meet altogether in one hatch, as it were a knot, which well tins the place, and so separate again, and keep their former distances.

Dipping Needle, an instrument used for observing the quantity of inclination towards the earth, assumed by any needle or other body after it has acquired the magnetic virtue. This was first observed by one Robert Norman, an Englishman, and maker of compasses for mariners, in the end of the 16th century; who finding that he was always obliged to counterbalance that end which turns to the north by a bit of wax or such other substance, though the balance had been ever so exact before, published an account of his discovery as a matter of importance. The subject was instantly attended to; and instruments were not only contrived for ascertaining the quantity of the dip, but various speculations formed concerning the cause of such a surprising phenomenon.

The general phenomena of the dipping needle are: that about the equatorial parts of the earth it remains in a horizontal position, but depresses one end as we recede from these; the north end, if we go towards the north, and the south end if we proceed towards the south pole. The farther north or south that we go, the inclination becomes the greater; but there is no place of the globe hitherto discovered where it points directly downwards, though it is supposed that it would do so in some part very near the pole. Its inclination is likewise found to vary very considerably at different times in different places of the earth, and by some changes of situation, in such a manner as must appear at first sight very unaccountable. Of all those who have attempted the investigation of this obscure subject, none have been more successful than M. Cavallo, who in his Treatise on Magnetism has given particular attention to all the phenomena, and accounted for them upon plain and rational principles, in the following manner:

The dip of the magnetical needle in general may be understood from the following easy experiment:—Lay an oblong magnet horizontally upon a table, and over it suspend another smaller magnet (a sewing needle to which the magnetic virtue has been communicated will answer the purpose), in such a manner as to remain in a horizontal position when not disturbed by another magnet. Now, if this last small magnet or sewing needle, suspended by the middle, be brought just over the middle of the large one, it will turn itself in such a manner that the south pole of the small magnet

net will point towards the north pole of the large one; and if at an equal distance from both, will remain in a horizontal position. But if we move it nearer to one of the poles than the other, it will readily be understood that the corresponding end of the needle will be attracted by the pole to which it approaches, and of consequence inclined downwards; the contrary end being proportionably elevated. It is likewise evident, that this inclination will be greater or less according to the distance at which the small magnet is placed from the pole of the large one; the attraction of the nearest pole having always the greatest effect upon it. And it is equally plain, that when brought directly over one of the poles of the large magnet, it will turn its own contrary one directly towards it, and thus lie exactly in the axis of the large one.

The application of this experiment to the phenomena of the dipping needle is obvious, as nothing more is requisite for solving the whole mystery than to suppose the earth itself to be the large magnet, and the magnetic needle or any other magnetic body the small magnet in the experiment: for admitting that the *north* pole of the earth possesses a *south* magnetism, and that the opposite pole is possessed of a north magnetical polarity; it appears, and the theory is confirmed by experiment, that when a magnet is suspended properly in the equatorial parts of the world, it must remain in a horizontal position; but when removed nearer to one of the poles, it must decline one of its extremities, viz. that which is possessed of the contrary magnetic polarity, and that this inclination must increase in proportion as the magnet or magnetic needle recedes from the equator of the earth; and, lastly, when brought exactly upon either of the poles of the earth it must stand perpendicular to the ground, or in the same direction with the axis of the earth.

The only difficulty in this explanation arises from the attributing a south magnetism to the north pole of the earth: but by this our author means only that its magnetism is contrary to that end of the magnetic needle which turns towards it; and in the same manner it must be understood, that the south pole of the earth has a north magnetic polarity.

If the extremities of the axis of the earth, or the poles about which it performs its diurnal revolution, coincided with its magnetic poles, or even if the magnetic poles were always at a certain distance from them, the inclination of the needle would be always the same at equal distances from the equator, and might be very useful for determining the latitudes. But it would seem, that these poles are perpetually shifting their place, since both the inclination and horizontal direction of the needle are continually varying even in the same place, so that its quantity of inclination cannot be exactly calculated. Two general remarks may be made upon this subject. 1. That the inclination of the needle does not alter regularly in going from north to south, or from south to north, in any meridian.—2. That its alteration in the same place, and at different times, is but small. Thus, in London, about the year 1576, the dip was 71° 50′ below the horizon, and in 1775 it stood at 72° 3′; the alteration in near 200 years scarce amounting to three quarters of a degree; which may be attributed to the errors of the instruments; as these were at first exceedingly erroneous and even yet are far from being arrived at perfection.

The general method of constructing dipping needles is, to pass an axis quite through the needle itself, and to let the extremities of the axis rest upon two supports, like the beam of a pair of scales, that the needle may move vertically round; and hence, when placed in the magnetic meridian, it will naturally assume that position which is called the *magnetic line*, viz. the two ends nearly north and south, and one of them inclined considerably to the horizon. The degrees of the inclination are shown upon a graduated circle; and when the instrument is made use of at land it has a stand, but at sea a ring is necessary to suspend it. When furnished with a stand, it has also a spirit-level; and the stand has three screws, by which the whole is adjusted in such a manner as to let the centre of motion in the needle, and the mark of 90° on the lower part of the divided circle, be exactly in the same line perpendicular to the horizon.

The greatest imperfections attending this instrument are the balancing of the needle itself, and the difficulty of knowing whether, after being made magnetic, it be properly balanced or not. The inaccuracy here indeed can be but very small, as arising only from dust or moisture. The method recommended by Mr Cavallo to obviate these inconveniences, is first to observe the dip of the needle; then to reverse its magnetism by the application of magnets, so that the end of it which before was elevated above the horizon may now be below it; and, lastly, to observe its dip again; for a mean of the two observations will be pretty near the truth, though the needle may not be perfectly balanced. See MAGNETISM and *MAGNETICAL Needle*.

DIPSACUS, TEAZEL; a genus of plants belonging to the tetrandria class; and in the natural method ranking under the 48th order, *Aggregatæ*. See BOTANY *Index*.

DIPSAS, a sort of serpent, the bite of which produces such a thirst as proves mortal; whence its name *dipsas*, which signifies thirsty. In Latin it is called *situla*, "a pail." Moses speaks of it in Deut. viii. 15.

DIPTERA (from δις, and πτερον, *wing*), in *Zoology*, an order of insects, which have only two wings, and under each wing a style, or oblong body, terminated by a protuberance or head, and called a *balancer*. See ENTOMOLOGY *Index*.

DIPTOTES, in *Grammar*, are such nouns as have only two cases, as *suppetiæ*, *suppetias*, &c.

DIPTYCHA, in antiquity, a public register, wherein were written the names of the consuls, and other magistrates, among the heathens; and of bishops, and defunct as well as surviving brethren, among the Christians.

The word is formed from the Greek διπτυχων, or διπτυχα, and that from διπτυξ, a masculine noun derived from πτυσσω, *I fold* or *plait*. From its future πτυξω is formed πτυξ, a *fold* or *plait*, to which adding δις, *twice*, we have διπτυξ, in the genitive διπτυχος, whence the nominative neuter διπτυχον, q. d. *a book folded in two leaves*; though there were some in three, and others in four or five leaves. An ingenious author imagines this name to have been first given them, to distinguish them from the books that were rolled, called *volumina*.

It is certain there were profane diptycha in the Greek empire, as well as sacred ones in the Greek church. The former were the matricula, or registers, wherein the names of the magistrates were entered: in which sense diptycha is a term in the Greek chancery.

Sacred DIPTYCHA. The word is plural; diptycha being a double catalogue, in one whereof were written the names of the living, and in the other those of the dead, which were to be rehearsed during the office. We meet with something not unlike the sacred diptycha of the Greeks, in the canon of the mass according to the Latin usage; where the people are enjoined to pray once for the living, and once for the dead; several saints are invoked in different times, &c. In these diptycha were entered the names of bishops, who had governed their flock aright; and these were never expunged out of the same, unless they were convicted of heresy, or some other gross crime. In the diptycha were likewise entered the names of such as had done any signal service to the church, whether they were living or dead, and mention was made of them in the celebration of the liturgy.

Casaubon, in his observations on Athenæus, lib. vi. cap. 14. supposes the Christians to have borrowed the custom of writing names in a book, and rehearsing them at mass, from the heathens, who entered the names of persons they would do any signal honour to, in the verses of the Salii; as was done to Germanicus and Verus, sons of the emperor Marcus Aurelius, and a long time before, during the age of the republic, to Mamercus Veturius, and Lucia Volumnia, as we are told by Tacitus, lib. ii. Spartian, Ovid, Festus, Plutarch, &c. But Fa. Rosweyd does not approve this notion of Casaubon. The pretended St Dionysius, a very ancient author, says the contrary, and asserts the first establishment of this usage to have been founded on Scripture, 2 Tim. ii. 19. Psal. cxvi. 15. Rosweyd adds Ecclesiastic. xliv. 1. and takes these to have been the passages the ancient church had a view to, rather than the Salian verses.

The profane diptycha were frequently sent as presents to princes, &c. on which occasions they were finely gilt, and embellished; as appears from Symmachus, lib. ii. ep. 81. Those presented were usually of ivory. The first law, De Expens. Ludor. C. Theod. forbids all magistrates below consuls to make presents of diptycha of ivory in the public ceremonies.

DIRÆ, the general name of the three furies in the Pagan system of theology. They were so called, as being *quasi Deorum iræ*, the ministers of divine vengeance in punishing guilty souls after death. They were the daughters of *Night* and *Acheron*. See FURIES.

DIRCA, a genus of plants belonging to the octandria class; and in the natural method ranking under the 31st order, *Vepreculæ*. See BOTANY *Index*.

DIRECT, in *Arithmetic*, is when the proportion of any terms, or quantities, is in the natural or direct order in which they stand, being the opposite to inverse, which considers the proportion in the inverted order of the terms. So, 3 : 4 :: 6 : 8 directly; or 3 : 4 :: 8 : 6 inversely.

DIRECTION, in *Mechanics*, signifies the line or path of a body's motion, along which it endeavours to proceed according to the force impressed upon it. See MECHANICS.

DIRECTION, in *Astronomy*, the motion and other phenomena of a planet when direct.

DIRECTION, in *Astrology*, is a kind of calculus, by which it is pretended to find the time in which any notable accident shall befal the person whose horoscope is drawn.

DIRECTOR, in commercial polity, a person who has the management of the affairs of a trading company: thus we say, the directors of the India Company, South Sea Company, &c. See COMPANY.

The directors are considerable proprietors in the stock of their respective companies, being chosen by plurality of votes from among the body of proprietors. The Dutch East India Company had formerly 60 such directors; that of France, 21: the British East India Company has 24, including the chairman, who may be re-elected for four years successively. The last have salaries of 150l. a-year each, and the chairman 200l. They meet at least once a-week, and commonly oftener, being summoned as occasion requires. The directors of the Bank of England are 24 in number, including the governor and deputy-governor.

DIRECTOR, in *Surgery*, a grooved probe, to direct the edge of the knife or scissars in opening sinuses or fistulæ, that by this means the adjacent vessels, nerves, and tendons, may remain unhurt. See SURGERY *Index*.

DIRIBITORES, among the Romans, officers appointed to distribute tablets to the people at the comitia. See COMITIA.

DIRIGENT, or DIRECTRIX, a term in geometry, signifying the line of motion, along which the describent line or surface is carried in the genesis of any plane or solid figure.

DIS, an inseparable article prefixed to divers words; the effect whereof is either to give them a signification contrary to what the simple words have, as *disoblige*, *disobey*, &c.; or to signify a separation, detachment, &c. as *disposing*, *distributing*.

DIS, a town of Norfolk, seated on the river Waveney, on the side of a hill. It is a neat flourishing town, with one large church, a Presbyterian and a Quaker meeting. It has about 600 good houses; the streets are well paved, pretty wide, and always clean. At the west end of the town is a large meer or lake; but so muddy, that the inhabitants can make no other use of it but in catching of eels. In the town are carried on manufactories of sail-cloth, hose, and the making of stays. E. Long. 1. 16. N. Lat. 52. 25.

DIS, a god of the Gauls, the same as Pluto the god of hell. The inhabitants of Gaul supposed themselves descended from that deity.

DISA, a genus of plants belonging to the gynandria class. See BOTANY *Index*.

DISABILITY, in *Law*, is when a man is disabled, or made incapable to inherit any lands, or take that benefit which otherwise he might have done: and this may happen four ways; by the act of an ancestor, or of the party himself, by the act of God, or of the law. 1. Disability by the act of the ancestor, is where the ancestor is attainted of high treason, &c. which corrupts the blood of his children, so that they may not inherit his estate. 2. Disability by the act of the party, is where a man binds himself by obligation, that, upon surrender of a lease, he will grant a new estate to a lessee; and afterwards he grants over the reversion to another, which puts it out of his power to perform it. 3. Disability by the act of God, is where a man is *non sanæ memoriæ*, whereby he is incapable to make any grant, &c. So that, if he passeth an estate out of him, it may after his death be made void; but it is a maxim in law, "That a man of full age shall never be received to disable his own person." 4. Disability by the act of the law, is where a man by the law, without any thing by him done, is rendered incapable of the benefit of the law; as an alien born, &c.

DISANDRIA, a genus of plants, belonging to the heptandria class. See Botany *Index*.

Islands of DISAPPOINTMENT, a cluster of small islands, lying in S. Lat. 14. 10. W. Long. 141. 16. They were discovered by Commodore Byron in 1765, who gave them their name from the shores affording no anchorage for his ships; for which reason he was obliged to quit them without landing, or procuring any refreshments for his crew, who were then languishing with sickness. They are inhabited by Indians, who appeared on the beach with spears in their hands, that were at least 16 feet long. They everywhere discovered hostile intentions, and seemed by signs to threaten the people in the boat with death if they came ashore. There are cocoa trees in great abundance, and the shore abounds with turtle.

DISC, in antiquity, a quoit made of stone, iron, or copper, five or six fingers broad, and more than a foot long, inclining to an oval figure, which they hurled in form of a bowl, to a vast distance, by the help of a leathern thong tied round the person's hand who threw it, and put through a hole in the middle. Homer has made Ajax and Ulysses great artists at this sport.

Disc, in *Astronomy*, the body and face of the sun and moon, such as they appear to us on the earth; or the body and face of the earth, such as it appears to a spectator in the moon.

Disc, in *Optics*, is the width of the aperture of telescope glasses, whatever their form be, whether plane, convex, concave, &c.

DISCERNING, or Discernment, a faculty of the mind whereby it distinguishes between ideas. See Metaphysics.

DISCIPLE, one who learns any thing from another: thus, the followers of any teacher, philosopher, &c. are called *disciples*. In the Christian sense, they were followers of Jesus Christ, in general: but in a more restrained sense, the disciples denote those alone who were the immediate followers and attendants on his person, of which there were 70 or 72. The names *disciples* and *apostles* are often synonymously used in the gospel history; but sometimes the apostles are distinguished from disciples, or persons selected out of the number of disciples, to be the principal ministers of his religion: of these there were only 12. The Latins kept the festival of the 70 or 72 disciples on July 15th, and the Greeks on January 4th.

DISCIPLINE, in a general sense, denotes instruction and government, as military discipline, ecclesiastical discipline, &c.

Ecclesiastical discipline consists in putting those laws in execution by which the church is governed, and inflicting the penalties enjoined by them against the several sorts of offenders that profess the religion of Jesus. The primitive church never pretended to exercise discipline upon any but such as are within her pale, in the largest sense, by some act of their own profession; and even upon these she never pretended to exercise her discipline so far as to cancel or disannul their baptism: all that she pretended to was to deprive men of the benefits of external communion, such as public prayer, receiving the eucharist, and other acts of divine worship. The church discipline was only confined to the admonition of the party, and to the lesser and greater excommunication.

As to the objects of ecclesiastical discipline, they were all such delinquents as fell into great and scandalous crimes after baptism.

Discipline, in a more peculiar sense, is used for the chastisements or bodily punishments inflicted on a religious of the Romish church who has been found a delinquent; or even for that which the religious voluntarily undergo or inflict on themselves by way of mortification.

Book of Discipline, in the history of the church of Scotland, is a common order, drawn up by the assembly of ministers in 1650, for the reformation and uniformity to be observed in the discipline and policy of the church. In this book the government of the church by prelates is set aside, church sessions are established, the superstitious observation of fast days and saints days is condemned, and other regulations for the government of the church are determined. This book was approved by the privy council, and is called *the First Book of Discipline.*

DISCORD, in general, signifies disagreement, or opposition between different persons or things.

Discord, in *Music*, every sound which, joined with another, forms an assemblage disagreeable to the ear; or rather, every interval whose extremes do not coalesce. Now, as there are no other concords or consonances, except those which form amongst themselves, and with their fundamental sound, perfect chords, it follows, that every interval must be a real dissonance or discord: even the third and sixth were reckoned such among the ancients, who excluded them from the number of consonant chords.

The term *dissonance*, which is synonymous with discord, is compounded of two words, the inseparable preposition *dis* and the verb *sonare*; which, both in a literal and metaphorical sense, signifies *disagreement* or *disunion*. In reality, that which renders dissonances grating, is, that the sounds which form them, far from uniting in the ear, seem to repel each other, and are heard each by itself as two distinct sounds, though produced at the same time.

This repulsion or violent oscillation of sounds is heard more or less, as the vibrations which produce it are more or less frequently coincident. When two vocal strings are gradually tuned, till they approach a consonant interval, the pulsations become slower as the chord grows more just, till at last they are scarcely heard, if heard at all; from whence it appears certain, that the pleasure produced in us by harmony results from the more or less exact and frequent coincidence or vibration; though the reason why this coincidence should give pleasure, more than any other modification or combination of sounds, appears to us inscrutable. The agreeable effects of dissonance in harmony, are no objection to this theory; since it is allowed, that the sensations excited by discord are not in themselves immediately and necessarily pleasing, but only please by auricular deception. The ear is surprised with the shock it receives, without being able to imagine how it should have happened; and in proportion as it is harsh and grating, we feel the pleasure of returning harmony enhanced, and the disappointment of being artfully and insensibly extricated more agreeable.

The name of *dissonance* is given sometimes to the interval, and sometimes to each of the two sounds which form it. But though two sounds equally form a dissonance between themselves, the name is most frequently given to that sound in particular which is most extraneous to the chord.

The number of possible dissonances is indefinite; but as in music we exclude all intervals which are not found in the system received, the number of dissonances is reduced to a very few: besides, in practice, we can only select from those few such as are agreeable to the species, and the mode in which we compose; and from this last number we must exclude such as cannot be used consistently with the rules prescribed. But what are these rules? Have they any foundation in nature, or are they merely arbitrary? This is what Rousseau, whom in this article we have followed or abandoned as his observations appeared useful or frivolous, purposes to investigate as its principal object.

But where does his scrutiny terminate? Not in the abolition of the rules prescribed. These have still subsisted, and will still subsist, while the frame of man, and the nature of music, remain what they are. If then the rules be permanent and universal, the principle upon which they are founded may be latent or ambiguous; but the rules themselves can never be purely arbitrary. How else could it happen, that Rameau, D'Alembert, and Rousseau, should admit the force and effect of these rules, whilst each of those masters exerts his whole genius to give a different account of their cause and origin? Rousseau himself, as we have seen in a former article, inculcates the necessity of dissonances for the completion of harmony; (see Chord). Now, if this be true, the easiest methods of introducing and dismissing these discords must be the most eligible, and of consequence the rules for using them must be established. It is not then upon the subsistence or demolition of any particular theory that they depend. Should we attend to the particular objections which may be urged against any system whatever; where is the theory which will be found proof against the efforts of scepticism? After all, the objections of Rousseau against Rameau's theory, as applied by D'Alembert to the origin of consonances, (see Music, art. 94, 95, 96, 97, 98, 99.), appear to be much more frivolous than the analogies from which he pretends this origin to be deduced. It appears from D'Alembert's exposition to this theory, that, if not for all, it affords a solution for the most material and essential phenomena in harmony; which is sufficient for its establishment, till another can be found, which gives a rational and consistent account of the whole: a discovery which has not yet been made. But whilst we acknowledge the futility of Rousseau's objections against D'Alembert's explication of dissonances, we must at the same time admire the ingenuity with which he has deduced them from principles purely mechanical, without departing from the system of M. Rameau. This mechanical explication will be found in his Musical Dictionary, under the article *Dissonance*.

Discord (the goddess of), in Pagan theology. She is represented by Aristides with fiery eyes, a pale countenance, livid lips, and wearing a dagger in her bosom. It was she who at the marriage of Peleus and Thetis threw in the golden apple, whereon was written "To the fairest:" which occasioned a contention between the goddesses Juno, Minerva, and Venus; each pretending a title to the apple. She was likewise called *Ate* and *Eris*.

DISCOVERY, in dramatic poetry, a manner of unravelling a plot or fable in tragedies, comedies, and romances; wherein, by some unforeseen accident, a discovery is made of the name, fortune, quality, &c. of a principal person, which were before unknown. See Catastrophe.

DISCOUNT, in commerce, a term among traders, merchants, and bankers. It is used by the two former on occasion of their buying commodities on the usual time of credit, with a condition that the seller shall allow the buyer a certain discount at the rate of so much per cent. per annum, for the time for which the credit is generally given, upon condition that the buyer pays ready money for such commodities, instead of taking the time of credit. Traders and merchants also frequently taking promissory notes for moneys due payable to them or order at a certain time, and sometimes having occasion for money before the time is elapsed, procure these notes to be discounted by bankers before the time of payment. Bills of exchange are also discounted by bankers; and in this consists one article of the profits of banking. See Bank.

DISCRETE, or Disjunct, Proportion, is when the ratio of two or more pairs of numbers or quantities is the same, but there is not the same proportion between all the four numbers. Thus, if the numbers 3 : 6 :: 8 : 16 be considered, the ratio between 3 : 6 is the same, as that between 8 : 16, and therefore the numbers are proportional: but it is only discretely or disjunctly, for 3 is not to 6 as 6 to 8; that is, the proportion is broken off between 8 and 3, and is not continued as in the following continual proportionals, 3 : 6 :: 12 : 24.

Discrete Quantity, is such as is not continued and joined together. Such, for instance, is any number.

DISCRETION; prudence, or knowledge to govern one's self.

There are many more shining qualities in the mind of man, but there is none so useful as discretion; it is this indeed that gives a value to all the rest, which sets them at work in their proper times and places; and turns them to the advantage of the person who is possessed of them. Without it learning is pedantry, and wit impertinence; virtue itself looks like weakness; the best parts only qualify a man to be more sprightly in errors, and active to his own prejudice.

Nor does discretion only make a man master of his own parts, but of other men's. The discreet man finds out the talents of those he converses with, and knows how to apply them to proper uses. Accordingly, if we look into particular communities and divisions of men, we may observe that it is the discreet man, not the witty, nor the learned, nor the brave, who guides the conversation, and gives measures to the society. A man with great talents, but void of discretion, is like Polyphemus in the fable, strong and blind, endued with an irresistible force, which for want of sight is of no use to him. Though a man has all other perfections, and wants discretion, he will be of no great consequence in the world; but if he has this single talent in perfection, and but a common share of others, he may do what he pleases in his particular station of life.

It is proper, however, to distinguish between *discretion* and *cunning*, the latter being the accomplishment only of little mean, ungenerous minds. Discretion points out the noblest ends to us, and pursues the most proper and laudable methods of attaining them; cunning has only private selfish aims, and sticks at nothing which may make them succeed. Discretion has large and extensive views, and, like a well-formed eye, commands a whole horizon: cunning is a kind of short-sightedness, that discovers the minutest objects which are near at hand, but is not able to discern things at a distance. Discretion, the more it is discovered, gives the greater authority to the person who possesses it; cunning, when it is once detected, loses its force, and makes a man incapable of bringing about even those events which he might have done, had he passed only for a plain man. Discretion is the perfection of reason, and a guide to us in all the duties of life; cunning is a kind of instinct, that only looks out after our immediate interest and welfare. Discretion is only found in men of strong sense and good understanding: cunning is often to be met with in brutes themselves, and in persons who are but the fewest removes from them. In short, cunning is only the mimic of discretion, and may pass upon weak men, in the same manner as vivacity is often mistaken for wit, and gravity for wisdom.

DISCUS, in antiquity. See Disc.

Discus, in *Botany*, the middle part of a radiated compound flower, generally consisting of small florets, with a hollow regular petal. It is commonly surrounded by large, plain, or flat, tongue-shaped petals, in the circumference or margin; as in daisy, groundsel, and leopard's-bane; sometimes the circumference is naked, as in cotton-weed and some species of coltsfoot.

Discus Folii, the surface of the leaf.

DISCUSSION, in matters of literature, signifies the clear treating or handling of any particular point, or problem, so as to shake off the difficulties with which it is embarrassed: thus we say, *such a point was well discussed*, when it was well treated of and cleared up.

DISCUTIENTS, in *Medicine*, are such remedies, as, by their subtility, dissolve a stagnating or coagulated fluid, and dissipate the same without an external solution of continuity.

DISDIACLASTIC crystal, in *Natural History*, a name given, by Bartholine, and some others, to a mineral substance, more usually called, from the place whence it was first brought, *Iceland crystal*. See Mineralogy *Index*.

DISDIAPASON, or Bisdiapason, in *Music*, a compound concord, described by F. Parran, in the quadruple ratio of 4 : 1, or 8 : 2.

Disdiapason Diapente, a concord in a sextuple ratio of 1 : 6.

Disdiapason Semi-Diapente, a compound concord in the proportion of 16 : 3.

Disdiapason Ditone, a compound consonance in the proportion of 10 : 2.

Disdiapason Semi-Ditone, a compound concord in the proportion of 24 : 5.

DISEASE, has been variously defined by physicians, almost every founder of a new system having given a definition of *disease*, differing in some respects from his predecessors. For a particular account of these definitions, see Medicine.

Of all animals, man is subject to the most diseases; and of men, the studious and speculative are most exposed thereto. Other animals have their diseases; but they are in smaller number: nor are plants without them; though their maladies scarce exceed half a score. The ancients deified their diseases. Some diseases only impair the use of the part immediately affected; as the ophthalmia, gout, &c. Others destroy it entirely; as the *gutta serena*, palsy, &c. Some affect the whole body; as the fever, apoplexy, epilepsy, &c. Others only impair a part; as the asthma, colic, dropsy, &c. Some only affect the body; as the gout: others disturb the mind; as melancholy, delirium, &c. Lastly, others affect both the body and mind; as the mania, phrensy, &c.

The colder the country, in general, the fewer and the less violent are the diseases. Scheffer tells us that the Laplanders know no such thing as the plague, or fevers of the burning kind, nor are subject to half the distempers we are. They are robust and strong, and live to 80, 90, and many of them to more than 100 years; and at this great age they are not feeble and decrepid as with us; but a man of 90 is able to work or travel as well as a man of 60 with us. They are subject, however, to some diseases more than other nations; thus they have often distempers of the eyes, which is owing to their living in smoke, or being blinded by the snow. Pleurisies and inflammations of the lungs are also very frequent among them; and the small-pox often rages with great violence. They have one general remedy against these and all other internal diseases: this is the root of that sort of moss, as Scheffer expresses it, which they call *jerth*. They make a decoction of this root in the whey of rein-deer milk, and drink very large doses of it warm, to keep up a breathing sweat; if they cannot get this, they use the stalks of angelica boiled in the same manner: they have not so great an opinion of this as of the other remedy: but the keeping in a sweat, and drinking plentifully of diluting liquors, may go a great way in the cure of their diseases, whether either the one or the other of the drugs have any virtue or not. They cure pleurisies by this method in a very few days; and get so well through the small-pox with it, that very few die of it.

It has been always observed, that people of particular places were peculiarly subject to particular diseases, which isease.

which are owing to their manner of living, or to the air and effluvia of the earth and water. Hoffman has made some curious observations on diseases of this kind. He observes, that swellings of the throat have always been common to the inhabitants of mountainous countries: and the old Roman authors say, Who wonders at a swelled throat in the Alps? The people of Swisserland, Carinthia, Stiria, the Hartz forest, Transylvania, and the inhabitants of Cronstadt, he observes, are all subject to this disease from the same cause.

The French are peculiarly troubled with fevers, with worms, and with hydroceles and sarcoceles; and all these disorders seem to be owing originally to their eating very large quantities of chesnuts. The people of our own nation are peculiarly afflicted with hoarsenesses, catarrhs, coughs, dysenteries, consumptions, and the scurvy; and the women with the *fluor albus* or whites; and children with a disease scarce known elsewhere, which we call the *rickets*. In different parts of Italy different diseases reign. At Naples the venereal disease is more common than in any other part of the world. At Venice, people are peculiarly subject to the bleeding piles. At Rome, tertian agues and lethargic distempers are most common. In Tuscany the epilepsy or falling sickness. And in Apulia they are most subject to burning fevers, pleurisies, and to that sort of madness which is attributed to the bite of the tarantula, and which, it is said, is only to be cured by music. In Spain apoplexies are common, as also melancholy, hypochondriacal complaints, and bleeding piles. The Dutch are peculiarly subject to the scurvy, and to the stone in the kidneys. Denmark, Norway, Sweden, Pomerania, and Livonia, are all terribly afflicted with the scurvy: and it is remarkable, that in Denmark, Sweden, and Norway, fevers are very common; but in Iceland, Lapland, and Finland, there is scarce ever such a disease met with; though peripneumonies are very common in these places, as also diseases of the eyes and violent pains of the head. The Russians and Tartars are afflicted with ulcers, made by the cold, of the nature of what we call chilblains, but greatly worse; and in Poland and Lithuania there reigns a peculiar disease, called the *plica polonica*, so terribly painful and offensive, that scarce any thing can be thought of worse. The people of Hungary are very subject to the gout and rheumatism: they are more infested also with lice and fleas than any other people in the world, and they have a peculiar disease which they call *cremor*. The Germans, in different parts of the empire, are subject to different reigning diseases. In Westphalia, they are peculiarly troubled with peripneumonies and the itch. In Silesia, Franconia, Austria, and other places thereabout, they are very liable to fevers of the burning kind, to bleedings at the nose, and other hæmorrhages; and to the gout, inflammations, and consumptions. In Misnia they have purple fevers; and the children are peculiarly infested with worms. In Greece, Macedonia, and Thrace, there are very few diseases; and what they have are principally burning fevers and frenzies. At Constantinople the plague often rages; and in the West Indian islands, malignant fevers, and the most terrible colics. These diseases are called *endemic*.

Diseases of Horses. See FARRIERY.

Diseases of Dogs. See DOGS.

Diseases of Plants. See AGRICULTURE *Index*.

Diseases of Plants ‖ Dispatch.

DISEMBOGUE. When a ship passes out of the mouth of some great gulf or bay, they call it *disemboguing*. They say also of a river, that at such a place, or after it has run so many leagues, it disembogues itself into the sea.

DISFRANCHIZING, among civilians, signifies the depriving a person of the rights and privileges of a free citizen or subject.

DISGUISE, a counterfeit habit. Persons doing unlawful acts in disguise are by our statutes sometimes subjected to great penalties, and even declared felons. Thus, by an act commonly called the *black act*, persons appearing disguised and armed in a forest or grounds enclosed, or hunting deer, or robbing a warren or a fish-pond, are declared felons.

DISH, in mining, is a trough made of wood, about 28 inches long, four inches deep, and six inches wide; by which all miners measure their ore. If any be taken selling their ore, not first measuring it by the bar-master's dish, and paying the king's duty, the seller forfeits his ore, and the buyer forfeits for every such offence 40s. to the lord of the field or farmer.

DISJUNCTIVE, something that separates or disjoins. Thus, *or*, *neither*, &c. which in connecting a discourse, yet separate the parts of it, are called *disjunctive conjunctions*.

DISK. See DISC.

DISLOCATION, the putting a bone out of joint by some violence, usually called by the physicians *luxation*.

DISMISSION *of a* BILL in *Chancery*. If the plaintiff does not attend on the day fixed for the hearing, his bill is dismissed with costs. It may be also dismissed for want of prosecution, which is in the nature of a non-suit at law, if he suffers three terms to elapse without moving forward in the cause.

DISMOUNTING, in the military art, the act of unhorsing. Thus, to dismount the cavalry, the dragoons, or the like, is to make them alight. To dismount the cannon, is to break their carriages, wheels, and axletrees, so as to render them unfit for service. Horses are also dismounted when they are rendered unfit for service.

DISPARAGEMENT, in *Law*, is used for the matching an heir, &c. in marriage, below his or her degree or condition, or against the rules of decency. The word is a compound of the privative particle *dis*, and *par*, "equal."

DISPART, in *Gunnery*, is the setting a mark upon the muzzle ring, or thereabouts, of a piece of ordnance, so that a sight line taken upon the top of the base ring against the touch-hole, by the mark set on or near the muzzle, may be parallel to the axis of the concave cylinder. The common way of doing this, is to take the two diameters of the base ring, and of the place where the dispart is to stand, and divide the difference between them into two equal parts, one of which will be the length of the dispart which is set on the gun with wax or pitch, or fastened there with a piece of twine or marlin. By means of an instrument it may be done with all possible nicety.

DISPATCH, a letter on some affair of state, or other business of importance, sent with care and expedition, by a courier express. The business of dis-

Dispatch || Dispersion of Mankind.

patches lies on the secretaries of state and their clerks. The king gives directions to his ministers abroad by dispatches. The word is also used for the packet or mail containing such letters. The French, during the reign of Louis XIV had a *conseil des depeches*, "council of dispatches," held in the king's presence, at which the dauphin, the duke of Orleans, the chancellor, and four secretaries of state, assisted.

DISPAUPER. A person suing *in forma pauperis* is said to be dispaupered, if, before the suit is ended, he has any lands or other estate fallen to him, or if he has any thing to make him lose his privilege. See the article *Forma Pauperis.*

DISPENSARY, or DISPENSATORY, denotes a book containing the method of preparing the various kinds of medicines used in pharmacy. Such are those of Bauderon, Quercetan, Zwelfer, Charas, Bate, Mesue, Salmon, Lemery, Quincy, &c.; but the latest and most esteemed, besides the London and Edinburgh pharmacopœias, is the Edinburgh New Dispensatory, being an improvement upon that of Dr Lewis's.

DISPENSARY, or *Dispensatory*, is likewise a magazine or office for selling medicines at prime cost to the poor. The College of Physicians maintain three of these in London; one at the college itself in Warwick-lane; another in St Peter's alley, Cornhill; and a third in St Martin's lane. Dispensaries have also been established in several of the principal towns in Scotland and England; particularly in Edinburgh, Dundee, and Kelso; as also at Newcastle upon Tyne.

DISPENSATION, in *Law*, the granting a license of doing some certain action that otherwise is not permitted.

DISPERSION, in general, signifies the scattering or dissipating something. Hence

DISPERSION, in *Optics*, is the same with the divergency of the rays of light.

Point of DISPERSION, in *Dioptrics*, the point from which refracted rays begin to diverge, where their refraction renders them divergent.

DISPERSION *of Inflammation*, in *Medicine* and *Surgery*, is the removing the inflammation, and restoring the inflamed part to its natural state.

DISPERSION *of Mankind*, in the history of the world, was occasioned by the confusion of tongues, and took place in consequence of the overthrow of Babel at the birth of Peleg; whence he derived his name: and it appears by the account given of his ancestors, Gen. chap. xi. 10—16. to have happened in the 101st year after the flood according to the Hebrew chronology, and by the Samaritan computation in the 401st. However, various difficulties have been suggested by chronologers concerning the true era of this event. Sir John Marsham and others, in order to reconcile the Hebrew and Egyptian chronologies, maintain a dispersion of mankind before the birth of Peleg. Others, unable to find numbers sufficient for the plantation of colonies in the space of 101 years, according to the Hebrew computation, fix the dispersion towards the end of Peleg's life, thus following the computation of the Jews. Petavius assigns the 153d year after the flood; Cumberland the 180th; and Usher, though he generally refers it to the time of Peleg's birth, in one place assigns the 131st after the flood for this event. Mr Shuckford supposes the dispersion to have been gradual, and to have commenced with the separation of some companies at the birth of Peleg, and to have been completed 31 years after. According to the calculation of Petavius, the number of inhabitants on the earth at the birth of Peleg amounted to 32,768: Cumberland makes them 30,000; Mr Mede states them at 7000 men, besides women and children: and Mr Whiston, who supposes that mankind now double themselves in 400 years, and that they doubled themselves between the deluge and the time of David in 60 years at a medium, when their lives were six or seven times as long as they have been since, by his computation produces about 2389; a number much too inconsiderable for the purposes of separating and forming distinct nations. This difficulty induced Mr Whiston to reject the Hebrew and to adopt the Samaritan chronology, as many others have done; which, by allowing an interval of 401 years between the flood and the birth of Peleg, furnishes, by the last-mentioned mode of computation, more than 240,000 persons.

Dispersion of Mankind

As to the manner of the dispersion of the posterity of Noah from the plain of Shinar, it was undoubtedly conducted with the utmost regularity and order. The sacred historian informs us, that they were divided in their lands, every one according to his tongue, according to his family, and according to his nation, Gen. x. 5, 20, 31.; and thus, as Mr Mede observes, they were ranged according to their nations, and every nation was ranged by their families; so that each nation had a separate lot, and each family in every nation. The following abstract will serve to give a general idea of their respective settlements: Japhet, Noah's eldest son, had seven sons; viz. Gomer, whose descendants inhabited those parts of Asia which lie upon the Ægean sea and Hellespont northward, containing Phrygia, Pontus, Bithynia, and a great part of Galatia. The Galatians, according to Josephus, were called *Gomeræi;* and the Cimmerii, according to Herodotus, occupied this tract of country; and from these Gomerians, Cimmerii, or Celts, Mr Camden derives our ancient Britons, who still retain the name *Cymro* or *Cymru*. Magog, the second son of Japhet, was probably the father of the Scythians on the east and north-east of the Euxine sea. Madai planted Media, though Mr Mede assigns Macedonia to his share. Javan was the father of the Grecians about Ionia, whose country lies along upon the Mediterranean sea; the radicles of Javan and Ionia being the same, יון. To Tubal and Mescech belonged Cappadocia and the country which lies on the borders of the Euxine sea; and from them, migrating over Caucasus, it is supposed the Russians and Muscovites are descended. And Tiras occupied Thrace. The sons of Shem were five: Elam, whose country lay between the Medes and Mesopotamians, and was called by the Gentile writers *Elemais;* and Josephus calls the Elamites the founders of the Persians: Ashur, who was driven out of Shinar by Nimrod, afterwards settled in Assyria, and there built Nineveh, and other cities; Arphaxad, who gave name to the country which Ptolemy calls *Arraphacitis*, a province of Assyria, though Josephus makes him the father of the Chaldees; Lud who inhabited and gave name to the country of Lydia about

about the river Mæander, remarkable for its windings, in Asia Minor: and Aram, the father of the Syrians. Ham, the youngest son of Noah, had four sons; viz. Cush, whose posterity spread into the several parts of Arabia over the borders of the land of Edom, into Arabia Felix, up to Midian and Egypt; Mizraim, the father of them who inhabited Egypt and other parts of Africa; Phut, to whom Bochart assigns the remaining part of Africa, from the lake of Tritonides to the Atlantic ocean, called *Libya:* and Canaan, to whom belonged the land of Canaan, whence the Phenicians derived their origin.

Dr Bryant has advanced a new hypothesis on this subject, and supported it with his usual acuteness and learning. He maintains, that the dispersion as well as the confusion of tongues was local, and limited to the inhabitants of the province of Babel; that the separation and distribution recorded to have taken place in the days of Peleg, Gen. x. 25, 31, 32, which was the result of divine appointment, occasioned a general migration: and that all the families among the sons of men were concerned in it. The house of Shem, from which the Messiah was to spring, was particularly regarded in this distribution: the portion of his children was near the place of separation; they in general had Asia to their lot; as Japhet had Europe, and Ham the large continent of Africa. But the sons of Chus would not submit to the divine dispensation: they went off under the conduct of Nimrod, and seem to have been for a long time in a roving state. However, at last they arrived at the plains of Shinar; and having ejected Ashur and his sons, who were placed there by divine appointment, seized his dominions, and laid there the foundation of a great monarchy. But afterwards fearing lest they should be divided and scattered abroad, they built the tower of Babel as a land-mark to which they might repair; and probably to answer the purposes of an idolatrous temple, or high altar, dedicated to the host of heaven, from which they were never long to be absent. They only, viz. the sons of Chus or the Cuthites, and their associates from other families, who had been guilty of rebellion against divine authority, and of wicked ambition and tyranny, were punished with the judgment of confounded speech through a failure in labial utterance, and of the dispersion recorded in Gen. x. 8, 9: in consequence of which they were scattered abroad from this city and tower, without any certain place of destination. The Cuthites invaded Egypt or the land of Mizraim in its infant state, seized the whole country, and held it for some ages in subjection: and they extended likewise to the Indies and Ganges, and still farther in China and Japan. From them the province of Cushan or Goshen in Egypt derived its name. Here they obtained the appellation of *royal shepherds;* and when they were by force driven out of the country, after having been in possession of it for 260 or 280 years, the land which they had been obliged to quit was given to the Israelites, who were also denominated *shepherds*, but should not be confounded with the former or the antecedent inhabitants of Goshen.

DISPLAYED, in *Heraldry*, is understood of the position of an eagle, or any other bird, when it is erect, with its wings expanded or spread forth.

DISPONDEE, in the Greek and Latin poetry, a double spondee or foot, consisting of four long syllables; as māēcēnātēs, cōnclūdēntēs.

DISPOSITION, in *Scots Law*, is that deed or writing which contains the scale or grant of any subject: when applied to heritable subjects, it in some cases gets the name of *charter*, which differs from a disposition in nothing else than a few immaterial forms.

Disposition, in *Architecture*, the just placing the several parts of an edifice according to their nature and office. See Architecture, N° 31, &c.

Disposition, in *Oratory*. See Oratory, Part I.

Disposition, in *Painting*. See Painting.

Disposition, in human nature.—In every man there is something original, that serves to distinguish him from others, that tends to form a character, and to make him meek or fiery, candid or deceitful, resolute or timorous, cheerful or morose. This original bent, termed *disposition*, must be distinguished from a *principle:* the latter, signifying a law of human nature, makes part of the common nature of man; the former makes part of the nature of this or that man. *Propensity* is a name common to both; for it signifies a principle as well as a disposition.

DISQUISITION (from *dis*, and *quæro*, "I inquire"), an inquiry into the nature, kinds, and circumstances of any problem, question, or topic; in order to gain a right notion of it, and to discourse clearly about it.

DISSECTION, in *Anatomy*, the cutting up a body with a view of examining the structure and use of the parts. See Anatomy.

Le Gendre observes, that the dissection of a human body, even dead, was held a sacrilege till the time of Francis I. And the same author assures us, he has seen a consultation held by the diviners of Salamanca, at the request of Charles V. to settle the question whether or no it were lawful in point of conscience to dissect a human body in order to learn the structure thereof.

DISSEISIN, in *Law*, an unlawful dispossessing a person of his lands or tenements.

DISSEPIMENTUM, in *Botany*, the name by which Linnæus denominates the partitions which in dry seed-vessels, as capsules and pods (*siliqua*), divide the fruit internally into cells.

DISSENTERS, separatists from the service and worship of any established church.

DISSIDENTS, a denomination applied in Poland to those of the Lutheran, Calvinistic, and Greek profession. The king of Poland engages by the *pacta conventa* to tolerate them in the free exercise of their religion, but they have often had reason to complain of the violation of these promises. See (*History of*) Poland.

DISSIMILITUDE, unlikeness or want of similitude. See the article Resemblance *and Dissimilitude*.

DISSIMULATION, in morals, the act of dissembling, by fallacious appearances, or false pretensions.

Good princes regard dissimulation as a necessary vice; but tyrants consider it as a virtue.

It is apparent that secrecy is often necessary, to oppose those who may be willing to circumvent our lawful intentions. But the necessity of precaution would become very rare, were no enterprises to be formed, but such as could be avowed openly. The frankness with which we could then act, would engage

engage people in our interests. Marshal Biron would have saved his life, by dealing ingenuously with Henry IV.

With respect to dissimulation, three things are to be observed: 1. That the characters of those are not to be esteemed, who are reserved and cautious without distinction. 2. Not to make secrets of unimportant matters. 3. To conduct ourselves in such manner, as to have as few secrets as possible.

DISSIPATION, in *Physics*, an insensible loss or consumption of the minute parts of the body; or that flux whereby they fly off, and are lost.

Circle of DISSIPATION, in *Optics*, is used for that circular space upon the retina, which is taken up by one of the extreme pencils of rays issuing from an object.

DISSOLVENT, in general, whatever dissolves or reduces a solid body into such minute parts as to be sustained in a fluid.

Universal DISSOLVENT. See the article ALKAHEST.

DISSOLUTION, in *Physics*, a discontinuation, or analysis, of the structure of a mixed body; whereby what was one, and contiguous, is divided into little parts, either homogeneous or heterogeneous.

Dissolution, then, is a general name for all reductions of concrete bodies into their smallest parts, without any regard either to solidity or fluidity: though in the usual acceptation of the word among authors, it is restrained to the reduction of solid bodies into a state of fluidity; which is more properly expressed by *solution*, as a branch of *dissolution*.

According to the opinion of Fr. Tertius de Lanis, Boerhaave, and some other learned men, the power or faculty of dissolving is lodged in fire alone.

According to this hypothesis, other fluids commonly supposed dissolvents, only produce their effect by means of the fiery spicula they abound with: and even air, which is judged a powerful menstruum, owes all its force to the rays of light diffused therein.

Sir Isaac Newton accounts for all dissolutions, and the several phenomena thereof, from the great principle of attraction; and, in effect, the phenomena of dissolution furnish a great part of the arguments and considerations whereby he proves the reality of that principle. The following is a specimen of that great author's way of philosophizing on the subject of dissolution.

When salt of tartar dissolves by lying in a moist place, is not this done by an attraction between the particles of the salt of tartar and those of the water which float in the air in form of vapours? and why does not common salt, or saltpetre, or vitriol, do the like, but for want of such an attraction? And when aquafortis, or spirit of vitriol, poured on steel filings, dissolves the filings with a great heat and ebullition; is not this heat and ebullition effected by a violent motion of the parts; and does not that motion argue, that the acid parts of the liquor rush towards the parts of the metal with violence, and run forcibly into its pores; till, getting between the utmost particles and the main mass of metal, they loosen them therefrom, and set them at liberty to float off into the water? When a solution of iron in aquafortis dissolves lapis calaminaris, and lets go the iron; or a solution of copper dissolves iron immersed in it, and lets go the copper; or a solution of mercury in aquafortis poured on iron, copper, tin, or lead, dissolves the metal, and lets go the mercury; does not this argue, that the acid particles of the aquafortis are attracted more strongly by the lapis calaminaris than by iron; by iron than by copper; by copper than by silver; and by iron, tin, copper, and lead, than by mercury? And is it not for the same reason, that iron requires more aquafortis to dissolve it than copper, and copper more than the other metals; and that of all metals iron is dissolved most easily, and is most apt to rust; and next after iron, copper? When aquafortis dissolves silver, and not gold; and aqua regia dissolves gold, and not silver; may it not be said, that aquafortis is subtile enough to penetrate the pores of gold as well as of silver, but wants the attractive force to give it entrance; and the same of aqua regia and silver? And when metals are dissolved in acid menstruums, and the acids in conjunction with the metal act after a different manner, so as that the taste of the compound is milder than that of the simples, and sometimes a sweet one; is it not because the acids adhere to the metallic particles, and thereby lose much of their activity? And if the acid be in too small a proportion to make the compound dissoluble in water, will it not, by adhering strongly to the metal, become inactive, and lose its taste, and the compound become a tasteless earth? for such things as are not dissoluble by the moisture of the tongue are insipid.

Dr Freind gives us a mechanical account of dissolution, in the instance of salt dissolved in water, which is the most simple operation that falls under this head. This motion he ascribes to that attractive force, which is so very extensive in natural philosophy, that there is no kind of matter but what is under its influence. It may be observed, says he, that the corpuscles of salts, which are the most simple of any, are withal very minute, and for their bulk very solid; and therefore exert a very strong attractive force, which, *cæteris paribus*, is proportional to the quantity of matter. Hence it comes to pass, that the particles of water are more strongly attracted by the saline particles than they are by one another: the particles of water, therefore, cohering but loosely, and being easily moveable, approach the corpuscles of salts, and run, as it were, into their embraces; and the motion of them is quicker or slower, according to their less or greater distances; the attractive force in all bodies being strongest at the point of contact. Therefore, if salt be thrown into the middle of a dish full of water, we shall find the aqueous particles which are in the middle of the dish sharp and pungent to the taste, but the water upon the sides of the vessel almost insipid; so that, when such a motion once arises, the aqueous particles are carried with an equal force towards the salts, and the moment of them is to be estimated from the ratio of their weight and celerity conjunctly. By the force of this impulse, they open to themselves a passage into the pores of the salts, which are very numerous; and at length so break and divide their texture, that all cohesion of their parts is destroyed: hereupon, being separated, and removed to a convenient distance from one another, they are dispersed, and float here and there about the water.

The simple dissolution of saline substances of every kind in water, may indeed be plausibly enough explained

plained on the hypothesis of attraction; but where the dissolution is attended with heat, the emission of vapour, &c. it seems necessary to seek for some other principle than mere attraction to solve these phenomena. When diluted oil of vitriol, for instance, is poured upon iron filings, a great quantity of vapour arises, which, if it was attempted to be confined, would certainly break the containing vessel. It is impossible to imagine any connection between attraction and the emission of a vapour; and what is still more unaccountable, this vapour is inflammable, though neither the oil of vitriol nor the iron are so by themselves. Another very strong objection against the hypothesis of attraction may be derived from the phenomena of metallic dissolutions in general; for they do not dissolve completely in acids, as salts do in water. By dissolution they are always decomposed, and cannot be recovered in their proper form without a good deal of trouble. One metal, indeed, will very often precipitate another from an acid in its metalline form; but this is attended with the decomposition of the second metal; so that this can by no means be reckoned a fair experiment. But, whatever other method is used, the dissolved metal is always recovered in form of an earthy powder, that we could scarcely imagine capable of ever becoming malleable, and assuming the splendid appearance of a metal. Now, if there was a strong attraction between this and the acid, we might very justly conjecture, that the dissolution happened by means of that attraction; but so far from this, after a metal has been dissolved by any acid, and the calx has been separated from it, it is always difficult, and very often impossible, to procure a dissolution of the calx in the same acid. The action of the acid in this case seems not unlike that of fire upon wood or any other inflammable substance. Dry wood, thrown into the fire, burns and flames with great violence; but the same wood, reduced to ashes, instead of burning, extinguishes fire already kindled. In like manner, a piece of clear metal thrown into an acid, dissolves with great violence: but the same metal, deprived of its phlogistic principle, and reduced to a calx, cannot be acted upon by acids, in whatever manner they are applied: at least, not without the greatest difficulty; and the more perfect the calx is, i. e. the more completely it is deprived of its inflammable principle, the greater the difficulty is of combining it afterwards with an acid.

Another thing in which the dissolution of metals by an acid resembles the burning of combustibles by fire, is, that in both cases there is a separation of the principle of inflammability. In the case of oil of vitriol and iron filings, this is exceedingly obvious; for there the vapour which arises from the mixture takes fire, and explodes with great vehemence. In all other cases, it is very easily proved; for the calx is always capable of being revived into metal by the addition of any substance containing phlogiston. The calces prepared by fire, and by precipitation from acids, also resemble one another so much, that in many cases they are scarce to be distinguished.

These considerations seem to favour the hypothesis of Dr Boerhaave; and much more does the following, namely, that almost all metallic solutions produce some degree of sensible heat. In some metals this is very considerable; but the greatest heat producible by an aqueous solution of any substance is by dissolving quicklime in the nitrous acid. The heat here greatly exceeds that of boiling water. In some dissolutions of inflammable matters by a mixture of the vitriolic and nitrous acids, the heat is so great, that the whole mixture takes fire almost instantaneously. Hence the Boerhaavians think they have sufficient grounds to conclude, that fire alone is the agent by which all dissolutions are performed.

These appearances have also been explained on the principles of attraction; and it has been said that the heat, &c. were owing to nothing but the violent action of the particles of the acid and metal upon each other (A).

DISSONANCE, in *Music*. See DISCORD.

DISSYLLABLE, among grammarians, a word consisting only of two syllables: such are nature, science, &c.

DISTAFF, an instrument about which flax is tied in order to be spun.

DISTANCE, in general, an interval between two things, either with regard to time or place. See METAPHYSICS.

Accessible DISTANCES, in *Geometry*, are such as may be measured by the chain. See GEOMETRY.

Inaccessible DISTANCES, are such as cannot be measured by the chain, &c. by reason of some river, or the like, &c. which obstructs our passing from one object to another. See GEOMETRY.

DISTANCE, in *Astronomy*. The distance of the sun, planets, and comets, is found only from their parallax, as it cannot be found either by eclipses or their different phases: for from the theory of the motions of the earth and planets we know, at any time, the proportion of the distances of the sun and planets from us; and the horizontal parallaxes are in a reciprocal proportion to these distances. See ASTRONOMY.

DISTASTE properly signifies an aversion or dislike to certain foods; and may be either constitutional, or owing to some disorder of the stomach.

DISTEMPER, among *Physicians*, the same with DISEASE.

DISTEMPER, in *Painting*, a term used for the working up of colours with something besides water or oil. If the colours are prepared with water, that kind of painting is called *limning*; and if with oil, it is called *painting in oil*, and simply *painting*. If the colours are mixed with size, whites of eggs, or any such proper glutinous or unctuous matter, and not with oil, then they say it is done in *distemper*.

DISTENSION, in general, signifies the stretching or extending a thing to its full length or breadth.

(A) We have retained these observations, as an instance of the speculations and opinions concerning these subjects before the discovery of the present theory of Chemistry with regard to the oxidation of metals and the decomposition of water.

DISTICH, a couplet of verses making a complete sense. Thus hexameter and pentameter verses are disposed in distichs. There are excellent morals in Cato's distichs.

DISTICHIASIS, in *Surgery*, a disease of the eyelids, when under the ordinary eyelashes there grows another extraordinary row of hairs, which frequently eradicates the former, and, pricking the membrane of the eye, excites pain, and brings on a defluxion.—It is cured by pulling out the second row of hairs with nippers, and cauterizing the pores out of which they issued.

DISTILLATION. For the principles of this process, see DISTILLATION, SUPPLEMENT.

1
Difference between distillers and rectifiers.

The objects of distillation, considered as a trade distinct from the other branches of chemistry, are chiefly spirituous liquors, and those waters impregnated with the essential oil of plants, commonly called *simple distilled* waters. The distilling compound spirits and waters is reckoned a different branch of business, and they who deal in that way are commonly called *rectifiers*. This difference, however, though it exists among commercial people, is not at all founded in the nature of the thing; compound spirits being made, and simple spirits being rectified, by the very same operations by which they are at first distilled, or with at least very trifling alterations.

2
Spirits perfectly flavourless, how obtained.

The great object with every distiller ought to be, to procure a spirit perfectly flavourless, or at least as well freed from any particular flavour as may be; and in this country the procuring of such a spirit is no easy matter. The only materials for distillation that have been used in large quantity, are malt, and molasses or treacle. Both of these, especially the first, abound with an oily matter, which, rising along with the spirit, communicates a disagreeable flavour to it, and from which it can scarce be freed afterwards by any means whatever.—Some experiments have been made upon carrots, as a subject for the distillers; but these are not as yet sufficiently decisive; nor is it probable that a spirit drawn from carrots would be at all devoid of flavour, more than one drawn from malt.—To dissipate the essential oil which gives the disagreeable flavour to malt spirits, it has been proposed to inspissate the wort into a rob, or thin extract like a syrup; afterwards to thin it with water, and ferment it in the usual manner. This certainly promises great success; there is no subject we know of that is possessed of any kind of essential oil, but what will part with it by distillation or by long boiling. The inspissating of the wort, however, does not seem to be either necessary or safe to be attempted; for, in this case, there is great danger of its contracting an empyreuma, which could never be remedied. The quantity lost by evaporation, therefore, might be occasionally added, with an equal certainty of dissipating the obnoxious oil. Whether the yield of spirit would be as great in this case as in the other, is a question that can by no means be discussed without further experiments. According to a theory adopted by some distillers, namely, that essential oils are convertible into ardent spirits; and that the more oily any subject is, the greater quantity of spirits is obtainable from it; the practice of dissipating the oil before fermentation must certainly be a loss. But we are too little acquainted with the composition of vinous spirits, to have any just foundation for adopting such theories. Besides, it is certain, that the quantity of ardent spirit producible from any substance, malt for instance, very greatly exceeds the quantity of essential oil which can by any means be obtained from the same; nor do we find that those substances, which abound most in essential oil, yield the greatest quantity of spirits. So far from this, fine sugar, which contains little or no essential oil, yields a great deal of ardent spirit.

2
Essential oil by some thought convertible into spirit.

4
Directio
concerni
fermenta-
tion.

Previous to the operation of distilling, those of brewing and fermentation are necessary; but as these are fully treated of under the article BREWING, we shall here only observe, that unless the boiling of the wort, before fermentation, is found to dissipate the essential oil, so as to take away the flavour of the malt, there is no necessity for being at the trouble of that operation. The wort may be immediately cooled and fermented.—The fermentation ought always to be carried on as slowly as possible, and performed in vessels closely stopped; only having at the bung a valve pressed down by a spring, which will yield with less force than is sufficient to burst the vessel. It should even be suffered to remain till it has become perfectly fine and transparent; as by this means the spirit will not only be superior in quantity, but also in fragrance, pungency, and vinosity, to that commonly produced.

5
For disti
lation.

With regard to performing the operation of distilling, there is only one general rule that can be given, namely, to let the heat, in all cases, be as gentle as possible. Accidents will be effectually prevented by having the worm of a proper wideness, and by rectifying the spirit in a water bath; which, if sufficiently large, will perform the operation with all the dispatch requisite for the most extensive business. The vessel in which the rectification is performed, ought to be covered with water up to the neck, and to be loaded with lead at the bottom, so that it may sink in the water. Thus the operation will go on as quickly as if it was on an open fire, and without the least danger of a miscarriage, nor will it ever be necessary to make the water in the bath come to a boiling heat.

6
For rect
cation.

As the end of rectification is to make the spirit *clean* as well as *strong*, or to deprive it of the essential oil as well as the aqueous part, it will be proper to have regard to this event in the first distillation. For this purpose, the spirit, as it first comes over, should be received into a quantity of cold water; as by this means the connexion betwixt it and the oily matter will be considerably lessened. For the same reason, after it has been once rectified in the water bath, it should be again mixed with an equal quantity of water, and distilled a second time. Thus the spirit will be freed from most of the oily matter, even though it hath been very much impregnated with it at first. It is necessary to observe, however, that by using such a quantity of water, a considerable part of the water will be left in the residuum of each rectification. All these residuums, therefore, must be mixed together, and distilled on an open fire, with a brisk heat, that the remainder of the spirit may be got out.

After the spirit has been distilled once or twice in this manner from water, it may be distilled in a water bath without any addition; and this last rectification will free it from most of the water it contains. But if it is required to be highly dephlegmated, a quantity of pure and dry salt of tartar must be added. The attraction between this salt and water is greater than that betwixt water and the spirit of wine. The salt therefore imbibes the water contained in the spirit, and sinks with it to the bottom. The spirit, by a single distillation, may then be rendered perfectly free from water; but there is great danger of some of the alkaline salt rising along with it, and impregnating it with what is called an *urinous flavour*. When this once happens, it is impossible to be remedied; and the only way to prevent it is, to make the heat with which the spirit is distilled as gentle as possible. It hath been proposed, indeed, to prevent the rising of any thing alkaline, by the admixture of some calcinated vitriol, sal catharticus amarus, or other imperfect neutral salt; but this can scarcely be supposed to answer any good purpose, as the alkali unites itself with the oily matter of the spirit, and forms a kind of saponaceous compound, which is not so easily affected by the acid of the vitriol or other salt, especially as these salts will not dissolve in the spirit itself.

7
imita-
g foreign
rits.

One very great desideratum among the distillers of this country is, a method of imitating the foreign spirits, brandy, rum, gin, &c. to a tolerable degree of perfection; and notwithstanding the many attempts that are daily made for this purpose, the success in general hath been very indifferent. On this subject, Mr Cooper has the following observations, in his Complete System of Distillation: which, as they are applicable to all other spirits as well as brandy, we shall here transcribe.—"The general method of distilling brandies in France need not be formally described, as it differs in nothing from that practised here in working from malt, wash, or molasses; nor are they in the least more cleanly or exact in the operation. They only observe more particularly to throw in a little of the natural ley into the still along with the wine, as finding this gives their spirit the flavour for which it is generally admired abroad.—But, though brandy is extracted from wine, experience tells us, that there is a great difference in the grapes from which the wine is made. Every soil, every climate, every kind of grapes, varies with regard to the quantity and quality of the spirits extracted from them. There are some grapes which are only fit for eating; others for drying, as those of Damascus, Corinth, Provence, and Avignon, but not fit to make wine.—Some wines are very proper for distillation, and others much less so. The wines of Languedoc and Provence afford a great deal of brandy by distillation, when the operation is performed on them in their full strength. The Orleans wines, and those of Blois, afford yet more; but the best are those of the territories of Cogniac and Andaye; which are, however, in the number of those the least drunk in France. Whereas those of Burgundy and Champagne, though of a very fine flavour, are improper, because they yield but very little in distillation.

8
thod of
king
ndies in
nce.

"It must also be farther observed, that all the wines for distillation, as those of Spain, the Canaries, of Alicant, of Cyprus, of St Peres, of Toquet, of Grave, of Hungary, and others of the same kind, yield very little brandy by distillation; and consequently would cost the distiller considerably more than he could sell it for. What is drawn from them is indeed very good, always retaining the saccharine quality and rich flavour of the wine from whence it is drawn; but as it grows old, this flavour often becomes aromatic, and is not agreeable to all palates.

"Hence we see that brandies always differ according as they are extracted from different species of grapes. Nor would there be so great a similarity as there is between the different kinds of French brandies, were the strongest wines used for this purpose; but this is rarely the case; the weakest and lowest flavoured wines only are distilled for their spirit, or such as prove absolutely unfit for any other use.

"A large quantity of brandy is distilled in France during the time of the vintage; for all those poor grapes that prove unfit for wine, are usually first gathered, pressed, their juice fermented, and directly distilled. This rids their hands of their poor wines at once, and leaves their casks empty for the reception of better. It is a general rule with them not to distil wine that will fetch any price as wine; for, in this state, the profits upon them are vastly greater than when reduced to brandies. This large stock of small wines, with which they are almost overrun in France, sufficiently accounts for their making such vast quantities of brandy in that country, more than in others which lie in warmer climates, and are much better adapted to the production of grapes.—Nor is this the only fund of their brandies; for all the wine that turns eager, is also condemned to the still; and, in short, all that they can neither export nor consume at home, which amounts to a large quantity; since much of the wine laid in for their family provision is so poor as not to keep during the time of spending.

9
How brandy may be imitated in this country.

"Hence many of our English spirits, with proper management, are convertible into brandies that shall hardly be distinguished from the foreign in many respects, provided the operation be neatly performed.

"The common method of rectifying spirits from alkaline salts, destroys their vinosity, and in its stead introduces an urinous or lixivious taste. But as it is absolutely necessary to restore, or at least to substitute in its room, some degree of vinosity, several methods have been proposed, and a multitude of experiments performed, in order to discover this great desideratum. But none has succeeded equal to the spirit of nitre; and accordingly this spirit, either strong or dulcified, has been used by most distillers to give an agreeable vinosity to their spirits. Several difficulties, however, occur in the method of using it; the principal of which is, its being apt to quit the liquor in a short time, and consequently depriving the liquor of that vinosity it was intended to give. In order to remove this difficulty, and prevent the vinosity from quitting the goods, the dulcified spirit of nitre, which is much better than the strong spirit, should be prepared by a previous digestion, continued for some time, with alcohol; the longer the digestion is continued, the more intimately will they be blended, and the compound rendered the milder and softer.

"After a proper digestion, the dulcified spirit should be mixed with the brandy, by which the vinosity will be intimately blended with the goods, and not disposed to fly off for a very considerable time.—No general rule can be given for the quantity of this mineral acid requisite to be employed; because different proportions of it are necessary in different spirits. It should, however, be carefully attended to, that though a small quantity of it will undoubtedly give an agreeable vinosity, resembling that naturally found in the fine subtile spirits drawn from wines, yet an over large dose of it will not only cause a disagreeable flavour, but also render the whole design abortive, by discovering the imposition. Those, therefore, who endeavour to cover a foul taste in goods by large doses of dulcified spirit of nitre, will find themselves deceived.

"But the best, and indeed the only method of imitating French brandies to perfection, is by an essential oil of wine; this being the very thing that gives the French brandies their flavour. It must, however, be remembered, that, in order to use even this ingredient to advantage, a pure tasteless spirit must first be procured; for it is ridiculous to expect that this essential oil should be able to give the agreeable flavour of French brandies to our fulsome malt spirit, already loaded with its own nauseous oil, or strongly impregnated with a lixivious taste from the alkaline salts used in rectification. How a pure insipid spirit may be obtained, has already been considered; it only therefore remains to show the method of procuring this essential oil of wine, which is this:

"Take some cakes of dry wine lees, such as are used by our hatters; dissolve them in six or eight times their weight of water; distil the liquor with a slow fire, and separate the oil with a separating glass; reserving for the nicest uses only that which comes over first, the succeeding oil being coarser and more resinous.—Having procured this fine oil of wine, it may be mixed into a quintessence with pure alcohol; by which means it may be preserved a long time fully possessed of all its flavour and virtues; but, without such management, it will soon grow resinous and rancid.

"When a fine essential oil of wine is thus procured, and also a pure and insipid spirit, French brandies may be imitated to perfection, with regard to the flavour. It must, however, be remembered, and carefully adverted to, that the essential oil be drawn from the same kind of lees as the brandy to be imitated was procured from; we mean, in order to imitate Cogniac brandy, it will be necessary to distil the essential oil from Cogniac lees; and the same for any other kind of brandy. For, as different brandies have different flavours, and as these flavours are entirely owing to the essential oil of the grape, it would be preposterous to endeavour to imitate the flavour of Cogniac brandy with an essential oil procured from the lees of Bourdeaux wine.—When the flavour of the brandy is well imitated by a proper dose of the essential oil, and the whole reduced into one simple and homogeneous fluid, other difficulties are still behind: The flavour, though the essential part, is not, however, the only one; the colour, the proof, and the softness, must also be regarded, before a spirit that perfectly resembles brandy can be procured. With regard to the proof it may be easily hit, by using a spirit rectified above proof: which, after being intimately mixed with the essential oil of wine, may be let down to a proper standard with fair water. And the softness may, in a great measure, be obtained by distilling and rectifying the spirit with a gentle fire: and what is wanting of this criterion in the liquor when first made, will be supplied by time; for it must be remembered, that it is time alone that gives this property to French brandies; they being at first acrid, foul, and fiery. But, with regard to the colour, a particular method is required to imitate it to perfection.

10 Spirits h coloured.

"The art of colouring spirits owes its rise to observations on foreign brandies. A piece of French brandy that has acquired by age a great degree of softness and ripeness, is observed at the same time to have acquired a yellowish brown colour; and hence our distillers have endeavoured to imitate this colour in such spirits as are intended to pass for French brandy. And in order to this, a great variety of experiments have been made on different substances. But in order to know a direct and sure method of imitating this colour to perfection, it is necessary we should be informed whence the French brandies themselves acquire their colour. This discovery is very easily made. The common experiment of trying whether brandy will turn blackish with a solution of iron, shows that the colour is owing to some of the resinous matter of the oak cask dissolved in the spirit. There can be no difficulty, therefore, in imitating this colour to perfection. A small quantity of the extract of oak, or the shavings of that wood, properly digested, will furnish us with a tincture capable of giving the spirit any degree of colour required. But it must be remembered, that as the tincture is extracted from the cask by brandy, that is, alcohol and water, it is necessary to use both in extracting the tincture; for each of these dissolves different parts of the wood. Let, therefore, a sufficient quantity of oak shavings be digested in strong spirit of wine, and also at the same time other oak shavings be digested in water; and when the liquors have acquired a strong tincture from the oak, let both be poured off from the shavings into different vessels, and both placed over a gentle fire till reduced to the consistence of treacle. In this condition let the two extracts be intimately mixed together; which may be effectually done by adding a small quantity of loaf-sugar, in fine powder, and rubbing the whole well together. By this means a liquid essential extract of oak will be procured, and always ready to be used as occasion shall require.

"There are other methods in use for colouring brandies; but the best, besides the extract of oak above mentioned, are treacle and burnt sugar. The treacle gives the spirit a fine colour, nearly resembling that of French brandy; but as its colour is dilute, a large quantity must be used; this is not, however, attended with any bad consequences; for notwithstanding the spirit is really weakened, by this addition, yet the bubble proof, the general criterion of spirits, is greatly mended, by the tenacity imparted to the liquor by the treacle. The spirit also acquires from the mixture a sweetish or luscious taste, and a fulness in the mouth; both which properties render it very agreeable to the palates of the common people, who are in fact the principal consumers of these spirits. A much smaller quantity of burnt sugar than of treacle will be sufficient for colouring the same quantity of spirits: the taste is also very different; for instead of the sweetness imparted by the treacle, the spirit acquires from the burnt sugar an agreeable bitterness, and by that means recommends itself to nicer palates, which are offended with a luscious spirit. The burnt sugar is prepared by dissolving a proper quantity of sugar in a little water, and scorching it over the fire till it acquires a black colour. Either treacle or burnt sugar will nearly imitate the genuine colour of old French brandy; but neither of them will succeed when put to the test of the vitriolic solution.

“The spirit distilled from molasses or treacle is very clean or pure. It is made from common treacle dissolved in water, and fermented in the same manner as the wash for the common malt spirit. But if some particular art is not used in distilling this spirit, it will not prove so vinous as malt spirit, but more flat and less pungent and acid, though otherwise much cleaner tasted, as its essential oil is of a much less offensive flavour. Therefore, if good fresh wine lees, abounding in tartar, be added and duly fermented with the molasses, the spirit will acquire a much greater vinosity and briskness, and approach much nearer to the nature of foreign spirits. Where the molasses spirit is brought to the common proof strength, if it is found not to have a sufficient vinosity, it will be very proper to add some good dulcified spirit of nitre; and if the spirit be clean worked, it may, by this addition only, be made to pass on ordinary judges for French brandy. Great quantities of this spirit are used in adulterating foreign brandy, rum, and arrack. Much of it is also used alone in making cherry brandy and other drams by infusion; in all which many, and perhaps with justice, prefer it to foreign brandies. Molasses, like all other spirits, is entirely colourless when first extracted; but distillers always give it as nearly as possible the colour of foreign spirits.”

11
m, how
tated.

12
R ins the
b mate-
ri for pro-
c g pure
s t.

If these principles hold good, the imitation of foreign spirits of all kinds must be an easy matter. It will only cost the procuring of some of those substances from which the spirit is drawn; and distilling this with water, the essential oil will always give the flavour desired. Thus, to imitate Jamaica rum, it will only be necessary to procure some of the tops, or other useless parts, of the sugar-canes; from which an essential oil being drawn, and mixed with clean molasses spirit, will give it the true flavour. The principal difficulty must lie in procuring a spirit totally, or nearly free of all flavour of its own. The spirit drawn from the refuse of a sugar-house is by our author commended as superior to that drawn from molasses: though even this is not entirely devoid of some kind of flavour of its own; nor indeed is that drawn from the best refined sugar entirely flavourless. It is very probable, therefore, that to procure an absolutely flavourless spirit is impossible. The only method, therefore, of imitating foreign spirits is, by choosing such materials as will yield a spirit flavoured as much like them as possible. The materials most recommended by our author in this case, and probably the best that can be used, are raisins. Concerning these he gives the following directions: “In order to extract this spirit, the raisins must be infused in a proper quantity of water, and fermented in the manner already directed. When the fermentation is completed, the whole is to be thrown into the still, and the spirit extracted by a strong fire. The reason why we here direct a strong fire is, because by that means a greater quantity of the essential oil will come over the helm with the spirit, which will render it fitter for the distiller's purpose: for this spirit is commonly used to mix with common malt goods: and it is surprising how far it will go in this respect, ten gallons of it being often sufficient to give a determining flavour and agreeable vinosity to a whole piece of malt spirits. It is therefore well worth the distiller's while to endeavour at improving the common method of extracting spirits from raisins; and perhaps the following hint may merit attention. When the fermentation is completed, and the still charged with fermented liquor as above directed, let the whole be drawn off with as brisk a fire as possible; but, instead of the cask or can generally used by distillers for a receiver, let a large glass, called by chemists a *separating glass*, be placed under the nose of the worm, and a common receiver applied to the spout of the separating glass: by this means the essential oil will swim upon the top of the spirit, or rather low wine, in the separating glass, and may be easily preserved at the end of the operation.—The use of this limpid essential oil is well known to distillers; for in this resides the whole flavour, and consequently may be used to the greatest advantage in giving that distinguishing taste and true vinosity to the common malt spirits. After the oil is separated from the low wine, the liquor may be rectified in balneo mariæ into a pure and almost tasteless spirit, and therefore well adapted to make the finest compound cordials, or to imitate or mix with the finest French brandies, arracks, &c. In the same manner a spirit may be obtained from cyder. But as its particular flavour is not so desirable as that obtained from raisins, it should be distilled in a more gentle manner, and carefully rectified according to the directions we have already given.”

13
Directions for distilling compound spirits.

These directions may suffice for the distillation of any kind of simple spirits. The distillation of compound ones depends on the observation of the following general rules, which are very easy to be learned and practised.

1. The artist must always be careful to use a well cleansed spirit, or one freed from its own essential oil. For, as a compound water is nothing more than a spirit impregnated with the essential oil of the ingredients, it is necessary that the spirit should have deposited its own.

2. Let the time of previous digestion be proportioned to the tenacity of the ingredients, or the ponderosity of their oil.

3. Let the strength of the fire also be proportioned to the ponderosity of the oil intended to be raised with the spirit.

4. Let only a due proportion of the finest parts of the essential oil be united with the spirit; the grosser and less fragrant parts of the oil not giving the spirit so agreeable a flavour, and at the same time rendering it unsightly. This may in a great measure be effected by leaving out the faints, and making up to proof with fine soft water in their stead.

A careful observation of these four rules will render this part of distillation much more perfect than it is at present. Nor will there be any occasion for the use of burnt alum, white of eggs, isinglass, &c. to fine down cordial waters; for they will presently be fine, sweet, and pleasant tasted, without any further trouble. We shall now subjoin particular receipts for making some of of those compound waters, or spirits, that are most commonly to be met with, and are in the most general estimation.

14 Receipts for a number of compound spirits.

Strong Cinnamon Water. Take eight pounds of fine cinnamon bruised, 17 gallons of clean rectified spirit, and two gallons of water. Put them into your still, and digest them 24 hours with a gentle heat; after which draw off 16 gallons with a pretty strong heat.—A cheaper spirit, but of an inferior quality, may be obtained by using cassia lignea instead of cinnamon. If you would dulcify your cinnamon water, take double refined sugar in what quantity you please; the general proportion is about two pounds to a gallon; and dissolve it in the spirit, after you have made it up proof with clean water. One general caution is here necessary to be added; namely, that near the end of the operation, you carefully watch the spirit as it runs into the receiver, in order to prevent the faints from mixing with the goods. This you may discover by often catching some of it as it runs from the worm in a glass, and observing whether it is fine and transparent; for as soon as ever the faints begin to rise, the spirit will have an azure or bluish cast. As soon as this alteration in colour is perceived, the receiver must be immediately changed; for if the faints are suffered to mix themselves with the rest, the value of the goods will be greatly lessened. Here we may observe, that the distillers call such goods as are made up proof, *double goods;* and those below proof, *single.*

Clove water. Take of cloves bruised, four pounds; pimento, or all spice, half a pound; proof spirit, 16 gallons. Digest the mixture 12 hours in a gentle heat, and then draw off 15 gallons with a pretty brisk fire. The water may be coloured red, either by a strong tincture of cochineal, alkanet, or corn-poppy flowers. It may be dulcified at pleasure with double refined sugar.

Lemon water. Take of dried lemon peel, four pounds; clean proof spirit, 10 gallons and a half, and one gallon of water. Draw off ten gallons by a gentle fire, and dulcify with fine sugar.

Citron water. Take of dry yellow rinds of citrons, three pounds; of orange peel, two pounds; nutmegs, bruised, three quarters of a pound; clean proof spirit, ten gallons and a half; water, one gallon. Digest with a gentle heat; then draw off ten gallons in balneo mariæ, and dulcify with fine sugar.

Aniseed water. Take aniseed bruised, two pounds; proof spirit, 12 gallons and a half; water, one gallon. Draw off ten gallons with a moderate fire.—This water should never be reduced below proof; because the large quantity of oil with which it is impregnated, will render the goods milky and foul when brought down below proof. But if there is a necessity for doing this, their transparency may be restored by filtration.

Orange water. Take of the yellow part of fresh orange peel, five pounds; clean proof spirit, ten gallons and a half; water, two gallons. Draw off ten gallons with a gentle fire.

Cedrat water. The cedrat is a species of citron, and very highly esteemed in Italy, where it grows naturally. The fruit is difficult to be procured in this country; but as the essential oil is often imported from Italy, it may be made with it according to the following receipt.—Take of the finest loaf sugar reduced to powder, a quarter of a pound; put it into a glass mortar, with 120 drops of the essence of cedrat; rub them together with a glass pestle; and put them into a glass alembic, with a gallon of fine proof spirits and a quart of water. Place the alembic in balneo mariæ, and draw off one gallon, or till the faints begin to rise, and dulcify with fine sugar This is reckoned the finest cordial yet known; it will therefore be necessary to be particularly careful that the spirit is perfectly clean, and, as much as possible, freed from any flavour of its own.

Orange Cordial water, or *Eau de Bigarade.* Take the outer or yellow part of the peels of 14 bigarades, (a kind of orange); half an ounce of nutmegs, a quarter of an ounce of mace, a gallon of fine proof spirit, and two quarts of water. Digest all these together two days in a close vessel; after which draw off a gallon with a gentle fire, and dulcify with fine sugar. This cordial is greatly esteemed abroad, but is not so well known in this country.

Ros Solis. Take of the herb called *Ros Solis*, picked clean, four pounds; cinnamon, cloves, and nutmegs, of each three ounces and a half; marigold flowers, one pound; caraway seeds, ten ounces; proof spirit, ten gallons; water, three gallons. Distil with a pretty strong fire, till the faints begin to rise. Then take of liquorice root sliced, half a pound; raisins stoned, two pounds; red saunders, half a pound: digest these three days in two quarts of water; then strain out the clear liquor, in which dissolve three pounds of fine sugar, and mix it with the spirit drawn by distillation.

Usquebaugh. Take nutmegs, cloves, and cinnamon, of each two ounces; the seeds of anise, caraway, and coriander, of each four ounces; of liquorice root sliced, half a pound. Bruise the seeds and spices; and put them together with the liquorice, into the still with 11 gallons of proof spirits, and two gallons of water. Distil with a pretty brisk fire till the faints begin to rise. But, as soon as the still begins to work, fasten to the nose of the worm two ounces of English saffron tied up in a cloth, that the liquor may run through it, and extract all its tincture; and in order to this, you should frequently press the saffron with your fingers. When the operation is finished, dulcify your goods with fine sugar.

Ratafia—Is a liquor prepared from different kinds of fruits, and is of different colours according to the fruits made use of. Of red ratafia there are three kinds, the fine, the dry or sharp, and the common. The fruits most proper for making red ratafia, are the black heart cherry, the common red cherry, the black cherry, the mery or honey cherry, the strawberry, the raspberry, the red gooseberry, and the mulberry. These fruits should be gathered when in their greatest perfection, and the largest and most beautiful of them chosen for the purpose.—The following is a receipt for making red ratafia, fine and soft. Take of the black heart cherries, 24 pounds; black cherries, four pounds; raspberries and strawberries, of each three pounds. Pick the fruits from their stalks, and bruise them; in which state let them continue 12 hours: press out the juice; and to every pint of it add a quarter of a pound of sugar. When the sugar is dissolved, run the whole through the filtrating bag, and add to it three quarts of of clean proof spirits. Then take of cinnamon, four ounces; of mace, one ounce; and of cloves, two drachms. Bruise these spices; put them into an alembic with a gallon of clean proof spirits and two quarts of water, and draw off a gallon with a brisk fire. Add as much of this spicy spirit to your ratafia as will render it agreeable to your palate; about one-fourth is the usual proportion.

Ratafia made according to the above receipt will be of a very rich flavour and elegant colour. It may be rendered more or less of a spicy flavour, by adding or diminishing the quantity of spirit distilled from the spices. Some, in making ratafia, suffer the expressed juices of their fruits to ferment several days: by this means the vinosity of the ratafia is increased; but, at the same time, the elegant flavour of the fruits is greatly diminished. Therefore, if the ratafia is desired stronger or more vinous, it may be done by adding more spirits to the expressed juice; by which means the flavour of the fruits may be preserved, as well as the ratafia rendered stronger. It is also a method with some to tie the spices in a linen bag, and suspend them in the ratafia. But if this method is taken, it will be necessary to augment the quantity of spirit first added to the expressed juice. There is no great difference in the two methods of adding the spices, except that by suspending them in the ratafia the liquor is rendered less transparent.

Dry or *sharp Ratafia.* Take cherries and gooseberries, of each 30 pounds; mulberries, seven pounds; raspberries, ten pounds. Pick all these fruits clean from their stalks, &c. bruise them, and let them stand 12 hours; but do not suffer them to ferment. Press out the juice, and to every pint add three ounces of sugar. When the sugar is dissolved, run it through the filtrating bag, and to every five pints of liquor add four pints of clean proof spirit; together with the same proportion of spirit drawn from the spices in the foregoing composition.

Common Ratafia. Take of nutmegs, eight ounces; bitter almonds, ten pounds; Lisbon sugar, eight pounds; ambergrise, ten grains; infuse these ingredients three days in ten gallons of clean proof spirit, and filter through a flannel bag for use. The nutmegs and bitter almonds, must be bruised, and the ambergrise rubbed with the Lisbon sugar in a marble mortar, before they are infused in the spirit.

Gold Cordial. Take of the roots of angelica, four pounds; raisins stoned, two pounds; coriander seeds, half a pound; caraway seeds and cinnamon, of each half a pound; cloves, two ounces; figs and liquorice root, of each one pound; proof spirit, eleven gallons; water, two gallons. The angelica, liquorice, and figs, must be sliced before they are added. Digest two days; and draw off by a gentle heat till the faints begin to rise; hanging in a piece of linen, fastened to the mouth of the worm, an ounce of English saffron. Then dissolve eight pounds of sugar in three quarts of rose water, and add to it the distilled liquor.—This liquor derives its name of *gold cordial* from a quantity of leaf gold being formerly added to it; but this is now generally disused, as it cannot possibly add any virtue.

Cardamum or *All-fours.* Take of pimento, caraway, and coriander seeds, and lemon peel, each three pounds; of malt spirits, eleven gallons; water, three gallons. Draw off with a gentle fire, dulcify with common sugar, and make up to the strength desired with clear water. This is a dram greatly used by the poorer sort of people in some countries.

Geneva. There was formerly sold in the apothecaries shops a distilled spirituous water of juniper; but the vulgar being fond of it as a dram, the distillers supplanted the apothecaries, and sold it under the name of *Geneva.* The common kind, however, is not made from juniper berries, but from oil of turpentine; and indeed it is surprising that people should accustom themselves to drink such liquors for pleasure.—The receipt for making this kind of spirit, sold in the gin shops at London, is as follows: Take of the ordinary malt spirits, ten gallons; oil of turpentine, two ounces; bay salt, three handfuls. Draw off by a gentle fire till the faints begin to rise; and make up your goods to the strength required with clear water.

The best kind is made by the following recipe.—Take of juniper berries, three pounds; proof spirit, ten gallons; water, four gallons. Draw off by a gentle fire till the faints begin to rise, and make up your goods to the strength required with clean water.

There is a sort of this liquor called *Hollands Geneva*, from its being imported from Holland, which is greatly esteemed. The ingredients used by the Dutch are the same with those given in the last recipe; only, instead of malt spirits, they use French brandy. But from what has been already observed concerning the nature of these kinds of spirits, it is easy to see, that by the help of a well rectified spirit, geneva may be made in this country at least nearly equal to the Dutch, provided it is kept to a proper age; for all spirituous liquors contract a softness and mellowness by age, impossible to be imitated any other way.

DISTILLERY, the art of distilling brandy and other spirits. This art was first brought into Europe by the Moors of Spain, about the year 1150: they learned it of the African Moors, who had it from the Egyptians; and the Egyptians are said to have practised it in the reign of the emperor Dioclesian, though it was unknown to the ancient Greeks and Romans. See DISTILLATION and FERMENTATION.

DISTINCTOIN, in *Logic*, is an assemblage of two or more words, whereby disparate things, or their conceptions, are denoted.

DISTORTION, in *Medicine*, is when any part of the human body remarkably deviates from its natural shape or position. Distortions of different parts may arise either from a convulsion or palsy; though sometimes a terrible distortion in the shape of the whole body hath arisen merely from carelessness and ill habits. Mr Winslow, in the Memoirs of the Academy of Sciences at Paris, gives a very remarkable account of a lady of quality, whom he had known to be perfectly straight for several years; but who taking afterwards to a sedentary course of life, got a custom of dressing herself very carelessly, and of leaning as she sat, either forwards or to a side. It was not many months before she found it painful and troublesome to stand or sit upright; and soon afterwards she found an inequality in the lower part of the back bone. Alarmed at this, she consulted the gentleman who gave the account. To prevent the increase of the malady, he ordered her to wear a particular sort of jumps instead of stays, and had a pad of proper size applied: but this was soon neglected; and the consequence was, that in a little time the back bone became more and more crooked, and at length bent itself sidewise in two contrary directions, so as to represent the figure of the Roman S; and the lady, still refusing to take the proper measures, lost a fourth part of her height; and continued for the remainder of her life, not only crooked from right to left, and from left to right, but so oddly folded together, that the first of the false ribs on one side approached very near the crest of the os ilium on that side, and the viscera of the lower belly became strangely pushed out of their regular places to the opposite side; and the stomach itself was so strongly compressed, that whatever she swallowed seemed to her to fall into two separate cavities.

DISTRESS, in its ordinary acceptation, denotes calamity, misery, or painful suffering.

The Contemplation of DISTRESS, *a source of pleasure.* On this subject we have a very pleasing and ingenious essay by Dr Barnes, in the Memoirs of the Literary and Philosophical Society of Manchester*. It is introduced with the following motto.

Suave mari magno, turbantibus æquora ventis,
E terrâ alterius magnum spectare periclum.
Non quia vexari quenquam est jucunda voluptas;
Sed quibus ipse malis careas, quia cernere suave est.
LUCRETIUS.

"The pleasure here described by the poet, and of which he has mentioned so striking and apposite an instance, may perhaps at first seem of so singular and astonishing a nature, that some may be disposed to doubt of its existence. But that it does exist, in the case here referred to, and in many others of a similar kind, is an undoubted fact; and it may not appear an useless or disagreeable entertainment, to trace its source in the human breast, together with the final cause for which it was implanted there by our benevolent Creator.

"Shall I, it may be said, feel complacency in beholding a scene in which many of my fellow-creatures are agonizing with terror, whilst I can neither diminish their danger, nor, by my sympathy, divide their anguish? At the sight of another's woe, does not my bosom naturally feel pain? Do I not share in his sensations? And is not this strong and exquisite sensibility intended by my Maker to urge me on to active and immediate assistance! These sensations are indeed attended with a noble pleasure, when I can, by friendly attention, or by benevolent communication, soothe the sorrows of the poor mourner, snatch him from impending danger, or supply his pressing wants. But in general, where my sympathy is of no avail to the wretched sufferer, I fly from the spectacle of his misery, unable or unwilling to endure a pain which is not allayed by the sweet satisfaction of doing good."

It will be necessary, in answer to these objections, in the first place to prove the reality of the feeling, the cause of which, in the human constitution, we here attempt to explore.

Mr Addison, in his beautiful papers on the Pleasures of the Imagination, has observed, "that objects or scenes, which, when real, give disgust or pain, in description often become beautiful and agreeable. Thus, even a dunghill may, by the charms of poetic imagery, excite pleasure and entertainment. Scenes of this nature, dignified by apt and striking description, we regard with something of the same feelings with which we look upon a dead monster.

———————*Informe cadaver*
Protrahitur: nequeunt expleri corda tuendo
Terribiles oculos, vultum, villosaque setis
Pectora semiferi, atque extinctos faucibus ignes.
VIRGIL.

"This (he observes) is more particularly the case, where the description raises a ferment in the mind and works with violence upon the passions. One would wonder (adds he) how it comes to pass, that passions, which are very unpleasant at all other times, are very agreeable when excited by proper description; such as terror, dejection, grief, &c. This pleasure arises from the reflection we make upon ourselves, whilst reading it, that we are not in danger from them. When we read of wounds, death, &c. our pleasure does not rise so properly from the grief which these melancholy descriptions give us, as from the secret comparison we make of ourselves with those who suffer. We should not feel the same kind of pleasure, if we actually saw a person lying under the tortures that we meet with in a description."

And yet, upon the principle assigned by this amiable writer, we might feel the same, or even higher pleasure, from the actual view of distress, than from any description; because the comparison of ourselves with the sufferer would be more vivid, and consequently the feeling more intense. We would only observe that the cause which he assigns for this pleasure is the very same with that assigned by Lucretius in our motto. Mr Addison applies it to the description; the poet to the actual contemplation of affecting scenes. In both, the pleasure is supposed to originate in selfishness. But wherever the social passions are deeply interested, as they are here supposed to be, from the pathetic description, or the still more pathetic survey, of the sufferings of another, the sympathetic feelings will of themselves, at once, and previously to all reflection, become a source of agreeable and tender emotions. They will thus dignify and enhance the satisfaction, if any such be felt, arising merely from the consideration of our own personal security. And the more entirely we enter into the scene, by losing all ideas of its being either past or fabulous, the more perfectly we forget ourselves, and are absorbed in the feeling,—the more exquisite is the sensation.

But as our subsequent speculations will chiefly turn upon the pleasure derived from real scenes of calamity, and not from those which are imaginary, it may be expected that we produce instances in proof that such pleasure is felt by persons very different in their taste and mental cultivation.

We shall not mention the horrid joy with which the savage feasts his eyes upon the agonies and contortions of his expiring prisoner—expiring in all the pains which artificial cruelty can inflict! Nor will we recur to the almost equally savage sons of ancient Rome, when the majesty of the Roman people could rush, with eagerness and transport, to behold hundreds of gladiators contending

---

* Vol. i. p. 144, &c.

contending in fatal conflict, and probably more than half the number extended, weltering in blood and writhing in agony, upon the plain. Nor will we mention the Spanish bull feasts; nor the fervent acclamations of an English mob around their fellow creatures, when engaged in furious battle, in which it is possible that some of the combatants may receive a mortal blow, and be hurried in this awful state to the bar of his Judge. Let us survey the multitudes which in every part of the kingdom, always attend an execution. It may perhaps be said, that in all places the vulgar have little of the sensibility and tenderness of more polished bosoms. But, in the last mentioned instance, an execution, there is no exultation in the sufferings of the poor criminal. He is regarded by every eye with the most melting compassion. The whole assembly sympathize with him in his unhappy situation. An awful stillness prevails at the dreadful moment. Many are wrung with unutterable sensations: and prayer and silence declare, more loudly than any language could, the interest they feel in his distress. Should a reprieve come to rescue him from death, how great is the general triumph and congratulation! And probably in this multitude you will find not the mere vulgar herd alone, but the man of superior knowledge and of more refined sensibility; who, led by some strong principle, which we wish to explain, feels a pleasure greater than all the pain, great and exquisite as one should imagine it to be, from such a spectacle.

The man who condemns many of the scenes we have already mentioned as barbarous and shocking, would probably run with the greatest eagerness to some high cliff, overhanging the ocean, to see it swelled into a tempest, though a poor vessel, or even a fleet of vessels, were to appear as one part of the dreadful scenery, now lifted to the heavens on the foaming surge, now plunged deep into the fathomless abyss, and now dashed upon the rocks, where they are in a moment shivered into fragments, and, with all their mariners, entombed in the wave. Or, to vary the question a little; Who would not be forward to stand safe, on the top of some mountain or tower, adjoining to a field of battle, in which two armies meet in desperate conflict, though probably thousands may soon lie before him prostrate on the ground, and the whole field present the most horrid scenes of carnage and desolation?

That in all these cases pleasure predominates in the compounded feeling, is plain from hence, because you continue to survey the scene; whereas, when pain became the stronger sensation, you would certainly retire.

Cultivation may indeed have produced some minuter differences in the taste and feelings of different minds. Those whose sensibilities have not been refined by education or science, may feel the pleasure in a more gross and brutal form. But do not the most polished natures feel a similar, a kindred pleasure, in the deep wrought distresses of the well imagined scene? Here the endeavour is, to introduce whatever is dreadful or pathetic, whatever can harrow up the feelings, or extort the tear. And the deeper and more tragical the scene becomes, the more it agitates the several passions of terror, grief, or pity—the more intensely it delights, even the most polished minds. They seem to enjoy the various and vivid emotions of contending passions. They love to have the tear trembling in the eye, and to feel the whole soul wrapt in thrilling sensations. For that moment they seem to forget the fiction; and afterwards commend that exhibition most, in which they most entirely lost sight of the author, and of their own situation, and were alive to all the unutterable vibrations of strong or melting sensibility.

Taking it then for granted, that in the contemplation of many scenes of distress, both imaginary and real, a gratification is felt, let us endeavour to account for it, by mentioning some of those principles, woven in the web of human nature, by its benevolent Creator, on which that gratification depends.

Dr Akenside, with his accustomed strength and brilliancy of colouring, describes and accounts for it in the following manner:

——————— "Behold the ways
Of heaven's eternal destiny to man!
For ever just, benevolent, and wise!
That Virtue's awful steps, howe'er pursued
By vexing fortune, and intrusive pain,
Should never be divided from her chaste,
Her fair attendant, Pleasure. Need I urge
Thy tardy thought through all the various round
Of this existence, that thy softening soul
At length may learn, what energy the hand
Of Virtue mingles in the bitter tide
Of Passion, swelling with distress and pain,
To mitigate the sharp, with gracious drops
Of cordial Pleasure. Ask the faithful youth
Why the cold urn of her, whom long he lov'd,
So often fills his arm? so often draws
His lonely footsteps, at the silent hour,
To pay the mournful tribute of his tears?
O! he will tell thee, that the wealth of worlds
Should ne'er seduce his bosom to forego
That sacred hour, when stealing from the noise
Of care and envy, sweet remembrance soothes,
With Virtue's kindest look, his aching breast,
And turns his tears to rapture. Ask the crowd,
Which flies impatient from the village-walk
To climb the neighb'ring cliffs, when far below
The cruel winds have hurl'd upon the coast
Some helpless bark: whilst sacred Pity melts
The general eye, or Terror's icy hand
Smites their distorted limbs, or horrent hair;
Whilst every mother closer to her breast
Catches her child; and, pointing where the waves
Foam through the shattered vessel, shrieks aloud,
As one poor wretch, that spreads his piteous arms
For succour, swallowed by the roaring surge,
As now another, dash'd against the rock,
Drops lifeless down. O deemest thou indeed
No kind endearment here, by nature given,
To mutual terror, and compassion's tears?
No sweetly melting softness, which attracts
O'er all that edge of pain, the social powers,
To this their proper action and their end?"

The poet pursues the sentiment in the same animated imagery, describing the strong, but pleasurable, sensations which the soul feels in reading the sufferings of heroes who nobly died in the cause of liberty and their country.

——————"When

———— “When the pious band
Of youths, who fought for freedom, and their sires,
Lie side by side in gore.”

Or, in the strong movements of indignation and revenge against the tyrant, who invades their liberty, and enslaves their country.

———— “When the patriot's tear
Starts from thine eye, and thy extended arm
In fancy hurls the thunderbolt of Jove,
To fire the impious wreath on Philip's brow,
Or dash Octavius from his trophied car;
Say—Does the sacred soul repine to taste
Thy big distress? Or, would'st thou then exchange
Those heart-ennobling sorrows for the lot
Of him, who sits amid the gaudy herd
Of mute barbarians, bending to his nod,
And bears aloft his gold-invested front,
And says within himself, “I am a king,
And wherefore should the clamorous voice of woe
Intrude upon mine ear?”

The sentiment of this charming and moral poet is, that sympathetic feelings are virtuous, and therefore pleasant. And from the whole, he deduces this important conclusion; that every virtuous emotion must be agreeable, and that this is the sanction and the reward of virtue. The thought is amiable; the conclusion noble: but still the solution appears to us to be imperfect.

We have already said, that the pleasure arising from the contemplation of distressful scenes is a compounded feeling, arising from several distinct sources in the human breast. The kind and degree of the sensation must depend upon the various blendings of the several ingredients which enter into the composition. The cause assigned by Mr Addison, the sense of our own security, may be supposed so have some share in the mass of feelings. That of Dr Akenside may be allowed to have a still larger proportion. Let us attempt to trace some of the rest.

There are few principles in human nature of more general and important influence than that of sympathy. A late ingenious writer, led by the fashionable idea of simplifying all the springs of human nature into one source, has in his beautiful theory of Moral Sentiments, endeavoured to analyze a very large number of the feelings of the heart into sympathetic vibration. Though it appears to us most probable, that the human mind, like the human body, possesses various and distinct springs of action and of happiness, yet he has shown, in an amazing diversity of instances, the operation and importance of this principle of human nature. Let us apply it to our present subject.

We naturally sympathize with the passions of others. But if the passions they appear to feel be not those of mere distress alone; if, amidst the scenes of calamity, they display fortitude, generosity, and forgiveness; if, “rising superior to the cloud of ills which covers them,” they nobly stand firm, collected, and patient; here a still higher source of pleasure opens upon us, from complacence, admiration, and that unutterable sympathy which the heart feels with virtuous and heroic minds. By the operation of this principle, we place ourselves in their situation; we feel, as it were, some share of that conscious integrity and peace which they must enjoy. Hence, as before observed, the pleasure will vary, both as to its nature and degree, according to the scene and characters before us. The shock of contending armies in the field,—the ocean wrought to tempest, and covered with the wreck of shattered vessels,—and a worthy family silently, yet nobly, bearing up against a multitude of surrounding sorrows, will excite very different emotions, because the component parts of the pleasurable sensation consist of very different materials. They all excite admiration; but admiration, how diversified, both as to its degree and its cause! These several ingredients may doubtless be so blended together, that the pleasure shall make but a very small part of the mixed sensation. The more agreeable teints may bear little proportion to the terrifying red or the gloomy black.

In many of the instances which have been mentioned, the pleasure must arise chiefly, if not solely, from the circumstances or accompanyments of the scene. The sublime feelings excited by the view of an agitated ocean, relieve and soften those occasioned by the shipwreck. And the awe excited by the presence of thousands of men, acting as if with one soul, and displaying magnanimity and firmness in the most solemn trial, tempers those sensations of horror and of pain which would arise from the field of battle.

The gratification we are attempting to account for depends also, in a very considerable degree, upon a principle of human nature, implanted in it for the wisest ends; the exercise which it gives to the mind, by rousing it to energy and feeling. Nothing is so insupportable, as that languor and ennui, for the full expression of which our language does not afford a term. How agreeable is it to have the soul called forth to exertion and sensibility, let the gamester witness, who, unable to endure the lassitude and sameness of unanimated luxury, runs with eagerness to the place where probably await him all the irritation and agony of tumultuous passions.

Again; it is a law of our nature, that opposite passions, when felt in succession, and above all, when felt at the same moment, heighten and increase each other. Ease succeeding pain, certainly after suspense, friendship after aversion, are unspeakably stronger than if they had not been thus contrasted. In this conflict of feelings, the mind rises from passive to active energy. It is roused to intense sensation; and it enjoys that peculiar, exquisite, and complex feeling, in which, as in many articles of our table, the acid and the sweet, the pleasurable and painful, pungencies are so happily mixed together, as to render the united sensation amazingly more strong and delightful.

We have not yet mentioned the principle of curiosity, that busy and active power, which appears so early, continues almost unimpaired so long, and to which, for the wisest ends, is annexed so great a sense of enjoyment. To this principle, rather than to a love of cruelty, would we ascribe that pleasure which children sometimes seem to feel from torturing flies and lesser animals. They have not yet formed an idea of the pain they inflict. It is, indeed, of unspeakable consequence, that this practice be checked as soon and as effectually as possible, because it is so important, that they learn to connect the ideas of pleasure and pain

pain with the motions and actions of the animal creation. And to this principle may we also refer no small share of that pleasure in the contemplation of distressful scenes, the springs of which, in the human heart, we are now endeavouring to open.

To curiosity, then—to sympathy—to mental exertion—to the idea of our own security—and to the strong feelings occasioned by viewing the actions and passions of mankind in interesting situations, do we ascribe the gratification which the mind feels from the survey of many scenes of sorrow. We have called it a *pleasure;* but it will approach towards, or recede from, pleasure, according to the nature and proportion of the ingredients of which the sensation is composed. In some cases, pain will predominate. In others, there will be exquisite enjoyment.

The final cause of this constitution of the human mind is probably, that by means of this strong sensation, the soul may be preserved in continual and vigorous motion—that its feelings may be kept lively and tender—that it may learn to practise the virtues it admires—and to assist those to whom its sympathy can reach—and that it may thus be led, by these social exercises of the heart, to soften with compassion—to expand with benevolence—and generously to assist in every case in which assistance can be given. An end this sufficient,

——— "To assert eternal Providence,
And justify the ways of God to man."

Distress, in *Law*, the seizing or distraining any thing for rent in arrear, or other duty unperformed.

The effect of this distress is to compel the party either to replevy the things distrained, and contest the taking, in an action of trespass against the distrainer; or rather to oblige him to compound and pay the debt or duty for which he was so distrained.

There are likewise compulsory distresses in actions to cause a person appear in court; of which kind there is a distress personal of one's moveable goods, and the profits of his lands, for contempt in not appearing after summons: there is likewise distress real, of a person's immoveable goods. In these cases none shall be distrained to answer for any thing touching their freeholds, but by the king's writ.

Distress may be either finite or infinite. Finite distress is that which is limited by law, in regard to the number of times it shall be made, in order to bring the party to a trial of the action. Infinite distress is that which is without any limitation, being made till the person appear: it is farther applied to jurors that do not appear; as, upon a certificate of assize, the process is *venire facias*, *habeas corpora*, and distress infinite.

It is also divided into grand distress and ordinary distress; of these the former extends to all the goods and chattels that the party has within the county. A person, of common right, may distrain for rents and all manner of services; and where a rent is reserved on a gift in tail, lease for life, or years, &c. though there be no clause of distress in the grant or lease, so as that he has the reversion; but on a feoffment made in fee, a distress may not be taken, unless it be expressly reserved in the deed.

DISTRIBUTION, in a general sense, the act of dividing a thing into several parts, in order to the disposing each in its proper place.

Distribution, in *Architecture*, the dividing and disposing the several parts and pieces which compose a building, as the plan directs. See Architecture.

Distribution, in *Rhetoric*, a kind of description, whereby an orderly division and enumeration is made of the principal qualities of the subject. David supplies us with an example of this kind, when in the heat of his indignation against sinners, he gives a description of their iniquity: "Their throat is an open sepulchre; they flatter with their tongues; the poison of asps is under their lips; their mouth is full of cursing and lies; and their feet are swift to shed blood."

Distribution, in *Printing*, the taking a form asunder, separating the letters, and disposing them in the cases again, each in its proper cell. See Printing.

DISTRICT, in *Geography*, a part of a province, distinguished by peculiar magistrates, or certain privileges; in which sense it is synonymous with hundred. See Hundred.

DISTRINGAS, in *Law*, a writ commanding the sheriff, or other officer, that he distrain a person for debt to the king, &c. or for his appearance at a certain day.

Distringas Juratores, a writ directed to the sheriff, whereby he is commanded to distrain upon a jury to appear and to return issues on their lands, &c. for nonappearance. This writ of distringas juratores issues for the sheriff to have their bodies in court, &c. at the return of the writ.

DITCH, a common fence or enclosure in marshes, or other wet land where there are no hedges. They allow these ditches six feet wide against highways that are broad; and against commons, five feet. But the common ditches about enclosures, dug at the bottom of the bank on which the quick is raised, are three feet wide at the top, one at the bottom, and two feet deep. By this means each side has a slope, which is of great advantage; for where this is neglected, and the ditches dug perpendicular, the sides are always washing down: besides, in a narrow-bottomed ditch, if cattle get down into it, they cannot stand to turn themselves to crop the quick: but where the ditch is four feet wide, it should be two and a half deep: and where it is five wide, it should be three deep; and so in proportion.

Ditch-Water is often used as an object for the microscope, and seldom fails to afford a great variety of animalcules. This water very often appears of a yellowish, greenish, or reddish colour; and this is wholly owing to the multitudes of animals of those colours which inhabit it. These animals are usually of the shrimp kind: and Swammerdam, who very acurately examined them, has called them, from the figure of their horns, *pulex aquaticus arborescens*. They copulate in May or June; and are often so numerous at that season, that the whole body of the water they are found in, is seen to be of a red, green, or yellowish colour, according to the colours of their bodies. The green thin scum also, so frequently seen on the surface of standing waters in summer, is no other than a multitude of small animalcules of this or some of the other kinds. Dunghill water is not less full of animals than that of ditches; and is often found so thronged with animalcules, that it seems altogether alive: it is then so very much crowded with these creatures, that it must be diluted with clear water before they can be distinctly viewed. There are usually in this fluid a sort of eels which are extremely active; and besides these and many other of the common inhabitants of fluids, there is one species found in this which seems peculiar to it: the middle part of them is dark and beset with hairs, but the ends are transparent; their tails are tapering, with a long sprig at the extremity, and their motion is slow and waddling. See ANIMALCULE.

DITCH, in *Fortification*, called also *foss* and *moat*, a trench dug round the rampart or wall of a fortified place, between the scarp and counterscarp. See FORTIFICATION.

DITHYRAMBUS, in ancient poetry, a hymn in honour of Bacchus, full of transport and poetical rage.

This poetry owes its birth to Greece, and to the transports of wine; and yet art is not quite exploded, but delicately applied to guide and restrain the dithyrambic impetuosity, which is indulged only in pleasing flights. Horace and Aristotle tell us, that the ancients gave the name of dithyrambus to those verses wherein none of the common rules or measures were observed. As we have now no remains of the dithyrambus of the ancients, we cannot say exactly what their measure was.

DITONE, in *Music*, an interval comprehending two tones. The proportion of the sounds that form the ditone is 4 : 5, and that of the semitone is 5 : 6.

DITRIHEDRIA, in *Mineralogy*, an old term expressive of crystals with twice three sides, or six planes; being formed of two trigonal pyramids joined base to base, without any intermediate prism.

The species of ditrihedria are distinguished by the different figures of these pyramids.

DITTANDER. See LEPIDIUM, BOTANY *Index*.

DITTANY. See DICTAMNUS, BOTANY *Index*.

DITTO, in books of accounts, usually written D°, signifies the afore-mentioned. The word is corrupted from the Italian *detto*, "the said: as in our law-phrase, "the said premises," meaning the same as were aforementioned.

DITTON, HUMPHRY, an eminent mathematician, was born at Salisbury, May 29. 1675. Being an only son, and his father observing in him an extraordinary good capacity, determined to cultivate it with a good education. For this purpose he placed him in a reputable private academy; upon quitting of which he at the desire of his father, though against his own inclination, engaged in the profession of divinity, and began to exercise his function at Tunbridge in the county of Kent, where he continued to preach some years; during which time he married a lady of that place.

But a weak constitution and the death of his father, induced Mr Ditton to quit that profession. And at the persuasion of Dr Harris and Mr Whiston, both eminent mathematicians, he engaged in the study of mathematics; a science to which he had always a strong inclination. In the prosecution of this science, he was much encouraged by the success and applause he received: being greatly esteemed by the chief professors of it, and particularly by Sir Isaac Newton, by whose interest and recommendation he was elected master of the new mathematical school in Christ's Hospital; where he continued till his death, which happened in 1715, in the 40th year of his age, much regretted by the philosophical world, who expected many useful and ingenious discoveries from his assiduity, learning, and penetrating genius.

Mr Ditton published several mathematical and other tracts, as below.—1. Of the Tangents of Curves, &c. *Phil. Trans.* vol. xxiii.

2. A Treatise on Spherical Catoptrics, published in the Philos. Trans. for 1705; from whence it was copied and reprinted in the *Acta Eruditorum* 1707, and also in the Memoirs of the Academy of Sciences at Paris.

3. General Laws of Nature and Motion; 8vo, 1705. Wolfius mentions this work, and says that it illustrates and renders easy the writings of Galileo, Huygens, and the Principia of Newton. It is also noticed by La Roche, in the *Memoires de Literature*, vol. viii. page 46.

4. An Institution of Fluxions, containing the first Principles, Operations, and Applications, of that admirable method, as invented by Sir Isaac Newton, 8vo, 1706. This work, with additions and alterations, was again published by Mr John Clarke, in the year 1726.

5. In 1709 he published the *Synopsis Algebraica* of John Alexander, with many additions and corrections.

6. His Treatise on Perspective was published in 1712. In this work he explained the principles of that art mathematically; and besides teaching the methods then generally practised, gave the first hints of the new method afterwards enlarged upon and improved by Dr Brook Taylor; and which was published in the year 1715.

7. In 1714, Mr Ditton published several pieces both theological and mathematical; particularly his Discourse on the Resurrection of Jesus Christ; and The New Law of Fluids, or a Discourse concerning the Ascent of Liquids, in exact Geometrical Figures, between two nearly contiguous Surfaces. To this was annexed a tract, to demonstrate the impossibility of thinking or perception being the result of any combination of the parts of matter and motion: a subject much agitated about that time. To this work also was added an advertisement from him and Mr Whiston, concerning a method for discovering the longitude, which it seems they had published about half a year before. This attempt probably cost our author his life; for although it was approved and countenanced by Sir Isaac Newton, before it was presented to the Board of Longitude, and the method has been successfully put in practice, in finding the longitude between Paris and Vienna; yet that board then determined against it; so that the disappointment, together with some public ridicule (particularly in a poem written by Dean Swift), affected his health so that he died the ensuing year, 1715.

In an account of Mr Ditton, prefixed to the German translation of his Discourse on the Resurrection, it is said that he had published, in his own name only, another method for finding the longitude; but which Mr Whiston denied. However, Raphael Levi, a learned Jew, who had studied under Leibnitz, informed the German editor, that he well knew that Ditton and Leibnitz had corresponded upon the subject; and that

Ditton had sent to Leibnitz a delineation of a machine he had invented for that purpose; which was a piece of mechanism constructed with many wheels like a clock, and which Leibnitz highly approved of for land use; but doubted whether it would answer on ship board, on account of the motion of the ship.

DIVAL, in *Heraldry*, the herb nightshade, used by such as blazon by flowers and herbs instead of colours and metals, for sable or black.

DIVALIA, in antiquity, a feast held among the ancient Romans, on the 21st day of December, in honour of the goddess Angerona; whence it is also called *Angeronalia*.—On the day of this feast, the pontifices performed sacrifice in the temple of Voluptia, or the goddess of joy and pleasure; who, some say, was the same with Angerona, and supposed to drive away all the sorrows and chagrins of life.

DIVAN, a council chamber or court of justice among the eastern nations, particularly the Turks.—The word is Arabic, and signifies the same with SOFA in the Turkish dialect.

There are two sorts of divans; that of the grand signior, called *the council of state*, which consists of seven of the principal officers of the empire; and that of the grand vizir, composed of six other vizirs or counsellors of state, the chancellor, and secretaries of state, for the distribution of justice.

The word is also used for a hall in the private houses of the orientals. The custom of China does not allow the receiving of visits in the inner parts of the house, but only at the entry, in a divan contrived on purpose for ceremonies.

Travellers relate wonders of the silence and expedition of the divans of the east.

DIVAN-Beghi, the superintendant of justice in Persia, whose place is the last of the six ministers of the second rank, who are all under the athemadauler or first minister. To this tribunal of the divan-beghi lie appeals from sentences passed by the governors. He has a fixed stipend of 50,000 crowns for administering justice. All the serjeants, ushers, &c. of the court are in his service. He takes cognizance of the criminal causes of the chans, governors, and other great lords of Persia, when accused of any fault. There are divan-beghis not only at court and in the capital, but also in the provinces and other cities of the empire. The Alcoran is the sole rule of his administration of justice, which also he interprets at pleasure. He takes no cognizance of civil causes; but all differences arising between the officers of the king's household and between foreign ministers are determined by him.

DIVANDUROW, the name of seven islands which lie a league north of the Maldives, and 24 from the coast of Malabar, almost opposite to Cananor.

DIVER. See COLYMBUS, ORNITHOLOGY *Index*.

DIVERGENT or DIVERGING LINES, in *Geometry*, are those which constantly recede from each other.

DIVERGENT Rays, in *Optics*, are those which, going from a point of the visible object, are dispersed, and continually depart one from another in proportion as they are removed from the object: in which sense it is opposed to convergent. See OPTICS.

DIVERSIFYING, in *Rhetoric*, is of infinite service to the orator; it is an accomplishment essential to his character, and may fitly be called the subject of all his tropes and figures. Vossius lays down six ways of diversifying a subject. 1. By enlarging on what was briefly mentioned before. 2. By a concise enumeration of what had been insisted on at length. 3. By adding something new to what is repeated. 4. By repeating only the principal heads of what had been said. 5. By transposing the words and periods. 6. By imitating them.

DIVERSION, in military affairs, is when an enemy is attacked in one place where they are weak and unprovided, in order to draw off their forces from another place where they have made or intend to make an irruption. Thus the Romans had no other way in their power of driving Hannibal out of Italy, but by making a diversion in attacking Carthage.

DIVESTING, properly signifies undressing or stripping off one's garment; in contradistinction from investing.

In law, it is used for the act of surrendering or relinquishing one's effects. By a contract of donation or sale, the donor or seller is said to be disseised and divested of his property in such a commodity, and the donee or purchaser becomes invested therewith. See INVESTITURE.

A demise is a general divestiture which the fathers and mothers make of all their effects in favour of their children.

DIVIDEND, in *Arithmetic*, the number proposed to be divided into equal parts. See ARITHMETIC, N° 14.

DIVIDEND of Stocks is a share or proportion of the interest of stocks erected on the public funds, as the South sea, &c. divided among and paid to the adventurers half yearly.

DIVINATION, the knowledge of things obscure or future, which cannot be attained by any natural means.

It was a received opinion among the heathens, that the gods were wont to converse familiarly with some men, whom they endowed with extraordinary powers, and admitted to the knowledge of their councils and designs. Plato, Aristotle, Plutarch, Cicero, and others, divide divination into two sorts or species, viz. natural and artificial.

The former was so called, because not attained by any rules or precepts of art, but infused or inspired into the diviner, without his taking any further care about it than to purify and prepare himself for the reception of the divine afflatus. Of this kind were all those who delivered oracles, and foretold future events by inspiration, without observing external signs or accidents.

The second species of divination was called *artificial*, because it was not obtained by immediate inspiration, but proceeded upon certain experiments and observations arbitrarily instituted, and mostly superstitious. Of this sort there were various kinds, as by sacrifices, entrails, flame, cakes, flour, wine, water, birds, lots, verses, omens, &c.

In holy Scripture we find mention made of nine different kinds of divination. The first performed by the inspection of planets, stars, and clouds: it is supposed to be the practisers of this whom Moses calls מערנן *meonen*, of אנן *anan*, "cloud," Deuter. chap. xviii. ver. 10. 2. Those whom the prophet calls in the same place

Divination.

מנחש *menacheseh*, which the Vulgate and generality of interpreters render *augur*. 3. Those who in the same place are called מכשף *mecascheph*, which the Septuagint and Vulgate translate "a man given to ill practices." 4. Such others whom Moses in the same chapter, ver. 11. calls חובר *hhober*. 5. Those who consult the spirits called *Python;* or, as Moses expresses it in the same book, אוב אשל "those who ask questions of Python." 6. Witches or magicians, whom Moses calls ידעני *judeoni*. 7. Those who consult the dead, *necromancers*. 8. The prophet Hosea, chap. iv. ver. 12. mentions such as consult staves, שאל מקלי; which kind of divination may be called *rhabdomancy*. 9. The last kind of divination mentioned in Scripture is *hepatascopy*, or the consideration of the liver.

Divination of all kinds was necessarily made an occult science, which naturally remained in the hands of the priests and priestesses, the magi, the soothsayers, the augurs, the visionaries, the priests of the oracles, the false prophets, and other like professors, till the time of the coming of Jesus Christ. The light of the gospel, it is true, has dissipated much of this darkness; but it is more difficult than is commonly conceived, to eradicate from the human mind, a deep-rooted superstition, even though the truth be set in the strongest light, especially when the error has been believed almost from the origin of the world; so we still find existing among us the remains of this Pagan superstition, in the following chimeras, which enthusiastic and designing men have formed into arts and sciences; though it must be owned, to the honour of the 18th century, that the pure doctrines of Christianity, and the spirit of philosophy, which become every day more diffused, equally concur in banishing these visionary opinions. The vogue for these pretended sciences and arts, moreover, is past, and they can no longer be named without exciting ridicule in all sensible people. By relating them here, therefore, and drawing them from their obscurity, we only mean to show their futility, and to mark those rocks against which the human mind, without the assistance of a pilot, might easily run.

For the attaining of these supernatural qualifications, there are still existing in the world the remains of,

1. *Astrology:* a conjectural science which teaches to judge of the effects and influences of the stars; and to predict future events by the situation of the planets and their different aspects. It is divided into *natural astrology*, or *meteorology;* which is confined to the foretelling of natural effects, as the winds, rain, hail, and snow, frosts and tempests. In this consists one branch of the art of almanack-makers; and by merely confronting these predictions in the kalendar, with the weather each day produces, every man of sense will see what regard is to be paid to this part of astrology. The other part, which is called *judicial astrology*, is still far more illusive and rash than the former: and having been at first the wonderful art of visionaries, it afterwards became that of impostors; a very common fate with all those chimerical sciences, of which we shall here speak. This art pretends to teach the method of predicting all sorts of events that shall happen upon the earth, as well such as relate to the public as to private persons; and that by the same inspection of the stars and planets and their different constellations. The *cabala* signifies, in like manner, the knowledge of things that are above the moon, as the celestial bodies and their influences; and in this sense it is the same with judicial astrology, or makes a part of it.

2. *Horoscopy*, which may also be considered as a part of astrology, is the art by which they draw a figure, or celestial scheme, containing the 12 houses, wherein they mark the disposition of the heavens at a certain moment; for example, that at which a man is born, in order to foretel his fortune, or the incidents of his life. In a word, it is the disposition of the stars and planets at the moment of any person's birth. But as there cannot be any probable or possible relation between the constellations and the human race, all the principles they lay down, and the prophecies they draw from them, are chimerical, false, absurd, and a criminal imposition on mankind.

3. The art of *augury* consisted, among the ancient Romans, in observing the flight, the singing and eating of birds, especially such as were held sacred. See AUGURY.

4. The equally deceitful art of *haruspicy* consisted, on the contrary, in the inspection of the bowels of animals, but principally of victims; and from thence predicting grand incidents relative to the republic, and the good or bad events of its enterprises.

5. *Aeromancy* was the art of divining by the air. This vain science has also come to us from the Pagans; but is rejected by reason as well as Christianity, as false and absurd.

6. *Pyromancy* is a divination made by the inspection of a flame, either by observing to which side it turns, or by throwing into it some combustible matter, or a bladder filled with wine, or any thing else from which they imagined they were able to predict.

7. *Hydromancy* is the supposed art of divining by water. The Persians, according to Varro, invented it. Pythagoras and Numa Pompilius made use of it; and we still admire the like wonderful prognosticators.

8. *Geomancy* was a divination made by observing of cracks or clefts in the earth. It was also performed by points made on paper, or any other substance, at a venture; and they judged of future events from the figures that resulted from thence. This was certainly very ridiculous; but it is nothing less so to pretend to predict future events by the inspection of the grounds of a dish of tea or coffee, or by cards, and many other like matters.—Thus have designing men made use of the four elements to deceive their credulous brethren.

9. *Chiromancy* is the art which teaches to know, by inspecting the hand, not only the inclinations of a man, but his future destiny also. The fools or impostors who practise this art pretend that the different parts or the lines of the hand have a relation to the internal parts of the body, as some to the heart, others to the liver, spleen, &c. On this false supposition, and on many others equally extravagant, the principles of chiromancy are founded: and on which, however, several authors, as Robert Flud an Englishman, Artemidorus, M. de la Chambre, John of Indagina, and many others, have written large treatises.

10. *Physiognomy*, or *physiognomancy*, is a science that pretends to teach the nature, the temperament, the understanding,

understanding, and the inclinations of men, by the inspection of their countenances, and is therefore very little less frivolous than chiromancy; though Aristotle, and a number of learned men after him, have written express treatises concerning it.

DIVINE, something relating to God. The word is also used, figuratively, for any thing that is excellent, extraordinary, and that seems to go beyond the power of nature and the capacity of mankind. In which sense, the compass, telescope, clocks, &c. are said to be *divine inventions:* Plato is called the *divine author*, the *divine Plato;* and the same appellation is given to Seneca: Hippocrates is called, "the divine old man," *divinus senex*, &c.

DIVING, the art or act of descending under water to considerable depths, and abiding there a competent time.

The uses of diving are very considerable, particularly in the fishing for pearls, corals, sponges, &c. See *Pearl-Fishing*, &c.

There have been various methods proposed, and machines contrived, to render the business of diving more safe and easy. The great point is to furnish the diver with fresh air; without which, he must either make a short stay or perish.

Those who dive for sponges in the Mediterranean, help themselves by carrying down sponges dipt in oil in their mouths. But considering the small quantity of air that can be contained in the pores of a sponge, and how much that little will be contracted by the pressure of the incumbent water, such a supply cannot long subsist the diver. For it is found by experiment, that a gallon of air included in a bladder, and by a pipe reciprocally inspired and expired by the lungs, becomes unfit for respiration in little more than one minute of time. For though its elasticity be but little altered in passing the lungs, yet it loses its vivifying spirit, and is rendered effete.

In effect, a naked diver, Dr Halley assures us, without a sponge, cannot remain above a couple of minutes enclosed in water, nor much longer with one, without suffocating; nor, without long practice, near so long; ordinary persons beginning to stifle in about half a minute. Besides, if the depth be considerable, the pressure of the water on the vessels makes the eyes blood-shotten, and frequently occasions a spitting of blood.

Hence, where there has been occasion to continue long at the bottom, some have contrived double flexible pipes, to circulate air down into a cavity, enclosing the diver as with armour, both to furnish air and to bear off the pressure of the water, and give leave to his breast to dilate upon inspiration; the fresh air being forced down one of the pipes with bellows, and returning by the other of them, not unlike to an artery and vein.

But this method is impracticable when the depth surpasses three fathoms; the water embracing the bare limbs so closely as to obstruct the circulation of the blood in them; and withal pressing so strongly on all the junctures where the armour is made tight with leather, that, if there be the least defect in any of them, the water rushes in, and instantly fills the whole engine, to the great danger of the diver's life.

It is certain, however, that people, by being accustomed to the water from their infancy, will at length be enabled, not only to stay much longer under water than the time above mentioned, but put on a kind of amphibious nature, so that they seem to have the use of all their faculties as well when their bodies are immersed in water as when they are on dry land. Most savage nations are remarkable for this. According to the accounts of our late voyagers, the inhabitants of the South sea islands are such expert divers, that when a nail or any piece of iron was thrown overboard, they would instantly jump into the sea after it, and never failed to recover it, notwithstanding the quick descent of the metal. Even among civilized nations, many persons have been found capable of continuing an incredible length of time below water. The most remarkable instance of this kind is the famous Sicilian diver Nicolo Pesce. The authenticity of the account, indeed, depends entirely on the authority of F. Kircher. He assures us that he had it from the archives of the kings of Sicily: but, notwithstanding this assertion, the whole hath so much of the marvellous in it, that we believe there are few who will not look upon it to have been exaggerated. "In the times of Frederic king of Sicily (says Kircher), there lived a celebrated diver, whose name was *Nicolas*, and who, from his amazing skill in swimming, and his perseverance under water, was surnamed the *fish*. This man had from his infancy been used to the sea; and earned his scanty subsistence by diving for corals and oysters, which he sold to the villagers on shore. His long acquaintance with the sea, at last, brought it to be almost his natural element. He was frequently known to spend five days in the midst of the waves, without any other provisions than the fish which he caught there, and ate raw. He often swam over from Sicily into Calabria, a tempestuous and dangerous passage, carrying letters from the king. He was frequently known to swim among the gulfs of the Lipari islands, noway apprehensive of danger.

"Some mariners out at sea, one day observed something at some distance from them, which they regarded as a sea monster; but upon its approach it was known to be Nicholas, whom they took into their ship. When they asked him whither he was going in so stormy and rough a sea, and at such a distance from land, he showed them a packet of letters, which he was carrying to one of the towns of Italy, exactly done up in a leather bag, in such a manner as that they could not be wetted by the sea. He kept them thus company for some time in their voyage, conversing, and asking questions; and after eating a hearty meal with them, he took his leave, and, jumping into the sea, pursued his voyage alone.

"In order to aid these powers of enduring in the deep, nature seemed to have assisted him in a very extraordinary manner: for the spaces between his fingers and toes were webbed, as in a goose; and his chest became so very capacious, that he could take in, at one inspiration, as much breath as would serve him for a whole day.

"The account of so extraordinary a person did not fail to reach the king himself; who commanded Nicholas to be brought before him. It was no easy matter to find Nicholas, who generally spent his time in the solitudes of the deep; but, at last, after much searching,

searching, he was found, and brought before his majesty. The curiosity of this monarch had been long excited by the accounts he had heard of the bottom of the gulf of Charybdis; he now therefore conceived, that it would be a proper opportunity to have more certain information. He therefore commanded our poor diver to examine the bottom of this dreadful whirlpool; and as an incitement to his obedience, he ordered a golden cup to be flung into it. Nicholas was not insensible of the danger to which he was exposed; dangers best known only to himself; and therefore he presumed to remonstrate: but the hopes of the reward, the desire of pleasing the king, and the pleasure of showing his skill, at last prevailed. He instantly jumped into the gulf, and was as instantly swallowed up in its bosom. He continued for three quarters of an hour below; during which time the king and his attendants remained on shore, anxious for his fate; but he at last appeared, holding the cup in triumph in one hand, and making his way good among the waves with the other. It may be supposed he was received with applause when he came on shore: the cup was made the reward of his adventure; the king ordered him to be taken proper care of; and, as he was somewhat fatigued and debilitated by his labour, after a hearty meal he was put to bed, and permitted to refresh himself by sleeping.

" When his spirits were thus restored, he was again brought to satisfy the king's curiosity with a narrative of the wonders he had seen; and his account was to the following effect. He would never, he said, have obeyed the king's commands, had he been apprised of half the dangers that were before him. There were four things, he said, which rendered the gulf dreadful, not only to men, but to fishes themselves. 1. The force of the water bursting up from the bottom, which required great strength to resist. 2. The abruptness of the rocks that on every side threatened destruction. 3. The force of the whirlpool dashing against those rocks. And, 4. The number and magnitude of the polypous fish, some of which appeared as large as a man; and which everywhere sticking against the rocks, projected their fibrous arms to entangle him. Being asked how he was able so readily to find the cup that had been thrown in, he replied, that it happened to be flung by the waves into the cavity of a rock against which he himself was urged in his descent. This account, however, did not satisfy the king's curiosity. Being requested to venture once more into the gulf for further discoveries, he at first refused: but the king, desirous of having the most exact information possible of all things to be found in the gulf, repeated his solicitations; and, to give them still greater weight, produced a larger cup than the former, and added also a purse of gold. Upon these considerations the unfortunate diver once again plunged into the whirlpool, and was never heard of more."

To obviate the inconveniencies of diving to those who have not the extraordinary powers of the diver above mentioned, different instruments have been contrived. The chief of these is the diving-bell; which is most conveniently made in form of a truncated cone, the smaller base being closed, and the larger open. It is to be poised with lead; and so suspended, that the vessel may sink full of air, with its open basis downward, and as near as may be in a situation parallel to the horizon, so as to close with the surface of the water all at once.

Under this covercle the diver sitting, sinks down with the included air to the depth desired: and if the cavity of the vessel contain a tun of water, a single man may remain a full hour, without much inconvenience, at five or six fathoms deep. But the lower you go, still the included air contracts itself according to the weight of the water which compresses it: so that at 33 feet deep the bell becomes half full of water, the pressure of the incumbent water being then equal to that of the atmosphere; and at all other depths the space occupied by the compressed air in the upper part of the bell will be to the under part of its capacity filled with water, as 33 feet to the surface of the water in the bell below the common surface thereof. And this condensed air being taken in with the breath soon insinuates itself into all the cavities of the body, and has no ill effect, provided the bell be permitted to descend so slowly as to allow time for that purpose. One inconvenience that attends it, is found in the ears, within which there are cavities which open only outwards, and that by pores so small as not to give admission even to the air itself, unless they be dilated and distended by a considerable force. Hence, on the first descent of the bell, a pressure begins to be felt on the ear; which, by degrees, grows painful, till the force overcoming the obstacle, what constringes these pores yields to the pressure, and letting some condensed air slip in, presently ease ensues. The bell descending lower, the pain is renewed, and again eased in the same manner. But the greatest inconvenience of this engine is, that the water entering it, contracts the bulk of air into a small compass, it soon heats and becomes unfit for respiration; so that there is a necessity for its being drawn up and renewed.

Hist. of Invent.

" The invention of this bell, (says Professor Beckmann), is generally assigned to the 16th century; and I am of opinion that it was little known before that period. We read, however, that in the time of Aristotle divers used a kind of kettle, to enable them to continue longer under the water; but the manner in which it was employed is not clearly described. The oldest information which we have of the use of the diving-bell in Europe, is that of John Taisnier, who was born in Hainault in 1509, and had a place at court under Charles V. whom he attended on his voyage to Africa. He relates in what manner he saw at Toledo, in the presence of the emperor and several thousand spectators, two Greeks let themselves down under water, in a large inverted kettle, with a burning light, and rise up again without being wet. It appears that this art was then new to the emperor and the Spaniards, and that the Greeks were caused to make the experiment in order to prove the possibility of it."

" When the English in 1588, dispersed the Spanish fleet, called the Invincible Armada, part of the ships went to the bottom, near the Isle of Mull, on the western coast of Scotland; and some of these, according to the account of the Spanish prisoners, contained great riches. This information excited, from time to time, the avarice of speculators, and gave rise to several attempts

tempts to procure part of the lost treasure. In the year 1665, a person was so fortunate as to bring up some cannon, which, however, were not sufficient to defray the expenses. Of these attempts, and the kind of diving-bell used in them, the reader will find an account in a work printed at Rotterdam in 1669, and entitled *G. Sinclari Ars nova et magna gravitatis et levitatis.* In the year 1680. William Phipps, a native of America, formed a project for searching and unloading a rich Spanish ship sunk on the coast of Hispaniola; and represented his plan in such a plausible manner, that King Charles II. gave him a ship, and furnished him with every thing necessary for the undertaking. He set sail in the year 1683; but being unsuccessful, returned again in great poverty, though with a firm conviction of the possibility of his scheme. By a subscriptions promoted chiefly by the duke of Albemarle, the son of the celebrated Monk, Phipps was enabled, in 1687, to try his fortune once more, having previously engaged to divide the profit according to the twenty shares of which the subscription consisted. At first all his labour proved fruitless; but at last, when his patience was almost entirely exhausted, he was so lucky as to bring up, from the depth of six or seven fathoms, so much treasure, that he returned to England with the value of two hundred thousand pounds sterling. Of this sum he himself got about sixteen, others say twenty thousand, and the duke ninety thousand pounds. After he came back, some persons endeavoured to persuade the king to seize both the ship and the cargo, under a pretence, that Phipps, when he solicited for his majesty's permission, had not given accurate information respecting the business. But the king answered, with much greatness of mind, that he knew Phipps to be an honest man, and that he and his friends should share the whole among them had he returned with double the value. His majesty even conferred upon him the honour of knighthood, to show how much he was satisfied with his conduct. We know not the construction of Phipps's apparatus: but of the old figures of a diving-machine, that which approaches nearest to the diving-bell is in a book on fortification by Lorini; who describes a square box bound round with iron, which is furnished with windows, and has a stool affixed to it for the diver. This ingenious contrivance appears, however, to be older than that Italian; at least he does not pretend to be the inventor of it.

"In the year 1617, Francis Kessler gave a description of his water-armour, intended also for diving, but which cannot really be used for that purpose. In the year 1671, Witsen taught, in a better manner than any of his predecessors, the construction and use of the diving-bell; but he is much mistaken when he says that it was invented at Amsterdam. In 1679 appeared, for the first time, Borelli's well known work *de motu animalium;* in which he not only described the diving-bell, but also proposed another, the impracticability of which was shewn by James Bernoulli. When Sturm published his *Collegium curiosum* in 1678, he proposed some hints for the improvement of this machine, on which remarks were made in the *Journal des Sçavans.*"

To obviate the difficulties of the diving-bell, Dr Halley contrived some further apparatus, whereby not only to recruit and refresh the air from time to time, but also to keep the water wholly out of it at any depth. The manner in which this was effected, he relates in the following words:

"The bell I made use of was of wood, containing about 60 cubic feet in its concavity; and was of the form of a truncated cone, whose diameter at the top was three feet, and at the bottom five. This I coated with lead so heavy that it would sink empty; and I distributed the weight so about its bottom, that it would go down in a perpendicular direction, and no other. In the top I fixed a strong but clear glass, as a window, to let in the light from above; and likewise a cock to let out the hot air that had been breathed; and below, about a yard under the bell, I placed a stage which hung by three ropes, each of which was charged with about one hundred weight to keep it steady. This machine I suspended from the mast of a ship by a sprit, which was sufficiently secured by stays to the mast head, and was directed by braces to carry it overboard clear of the ship's side, and to bring it again within board as occasion required.

"To supply air to this bell when under water, I caused a couple of barrels of about 36 gallons each to be cased with lead, so as to sink empty; each of them having a bung-hole in its lowest parts to let in the water, as the air in them condensed on their descent; and to let it out again when they were drawn up full from below. And to a hole in the uppermost part of these barrels, I fixed a leathern trunk or hose well liquored with bees wax and oil, and long enough to fall below the bung-hole, being kept down by a weight appended: so that the air in the upper part of the barrels could not escape, unless the lower ends of these hose were first lifted up.

"The air-barrels being thus prepared, I fitted them with tackle proper to make them rise and fall alternately, after the manner of two buckets in a well; which was done with so much ease, that two men, with less than half their strength, could perform all the labour required; and in their descent they were directed by lines fastened to the under edge of the bell, the which passed through rings on both sides the leathern hose in each barrel; so that, sliding down by these lines, they came readily to the hand of a man who stood on the stage on purpose to receive them, and to take up the ends of the hose into the bell. Through these hose, as soon as their ends came above the surface of the water in the barrels, all the air that was included in the upper parts of them was blown with great force into the bell, whilst the water entered at the bung holes below, and filled them; and as soon as the air of one barrel had been thus received, upon a signal given, that was drawn up, and at the same time the other descended; and by an alternate succession, furnished air so quick, and in so great plenty, that I myself have been one of five who have been together at the bottom in nine or ten fathom water, for above an hour and a half at a time. without any sort of ill consequence; and I might have continued there as long as I pleased, for any thing that appeared to the contrary. Besides, the whole cavity of the bell was kept entirely free from water, so that I sat on a bench which was diametrically placed near the bottom, wholly dressed, with all my clothes on. I only observed, that it was necessary to be let down gradually at first, as about 12 feet at a time; and then

then to stop and drive out the air that entered, by receiving three or four barrels of fresh air before I descended further. But, being arrived at the depth designed, I then let out as much of the hot air that had been breathed, as each barrel would replenish with cool, by means of the cock at the top of the bell; through whose aperture, though very small, the air would rush with so much violence, as to make the surface of the sea boil, and to cover it with a white foam, notwithstanding the weight of the water over us.

"Thus I found that I could do any thing that required to be done just under us; and that, by taking off the stage, I could, for a space as wide as the circuit of the bell lay the bottom of the sea so far dry, as not to be overshoes thereon. And, by the glass window, so much light was transmitted, that when the sea was clear, and especially when the sun shone, I could see perfectly well to write or read; much more to fasten or lay hold on any thing under us that was to be taken up. And, by the return of the air-barrels, I often sent up orders written with an iron pen, on small plates of lead, directing how to move us from place to place as occasion required. At other times, when the water was troubled and thick, it would be as dark as night below; but in such cases I have been able to keep a candle burning in the bell as long as I pleased, notwithstanding the great expence of air necessary to maintain flame.—By an additional contrivance, I have found it not impracticable, for a diver to go out of an engine to a good distance from it, the air being conveyed to him with a continued stream, by small flexible pipes; which pipes may serve as a clue, to direct him back again when he would return to the bell."

Plate CLXXVI. fig. 1. shows Dr Halley's diving-bell, with the divers at work. DBLKRIMP represents the body of the bell. D, the glass which serves as a window. B, the cock for letting out the air which has been breathed. LM the seats. C, one of the air-barrels. P, H, two of the divers. F, another diver at a distance from the bell, and breathing through the flexible tube K.—This diver is supposed to have a head-piece of lead, made to fit quite close about his shoulders; this head-piece was capable of containing as much air as would supply him for a minute or two. When he had occasion for more air, he turned a cock at F, by which means a communication was opened with the air in the bell, and thus he could receive a new supply at pleasure.

Since the invention of this diving machine, there has been one contrived by Mr Triewald, F. R. S. and military architect to the king of Sweden, which for a single person, is in some respects thought to be more eligible than Dr Halley's, and is constructed as follows: AB is the bell, which is sunk by lead weights DD hung to its bottom. This bell is of copper, and tinned all over in the inside, which is illuminated by three strong convex lenses, G, G, G, with copper lids H, H, H, to defend them. The iron ring or plate E serves the diver to stand on when he is at work; and is suspended at such a distance from the bottom of the bell by the chains F, F, F, that when the diver stands upright, his head is just above the water in the bell, where the air is much better than higher up, because it is colder, and consequently more fit for respiration. But as the diver must always be within the bell, and his head of course in the upper part, the inventor has contrived, that even there, when he has breathed the hot air as well as he can, he may, by means of a spiral copper tube, *b c*, placed close to the inside of the bell, draw the cooler and fresher air from the lowermost parts; for which purpose, a flexible leather tube, about two feet long, is fixed to the upper end of the copper tube at *b*; and to the other end of this tube is fixed an ivory mouth-piece, by which the diver draws in the air.

The greatest improvement, however, which the diving-bell ever received, or probably can receive, was from the late Mr Spalding of Edinburgh. A section of his improved diving bell is represented in fig. 3. This construction is designed to remedy some inconveniencies of Dr Halley's, which are very evident, and of very dangerous tendency. These are, 1. By Dr Halley's construction, the sinking or rising of the bell depends entirely on the people who are at the surface of the water; and as the bell even when in the water has a very considerable weight, the raising it not only requires a great deal of labour, but there is a possibility of the rope breaking by which it is raised, and thus every person in the bell would inevitably perish. 2. As there are, in many places of the sea, rocks which lie at a considerable depth, the figure of which cannot possibly be perceived from above, there is danger that some of their ragged prominences may catch hold of one of the edges of the bell in its descent, and thus overset it before any signal can be given to those above, which would infallibly be attended with the destruction of the people in the bell; and as it must always be unknown, before trial, what kind of a bottom the sea has in any place, it is plain, that without some contrivance to obviate this last danger, the descent in Dr Halley's diving-bell is not at all eligible.

How these inconveniences are remedied by Mr Spalding's new construction will be easily understood from the following description.—ABCD represents a section of the bell, which is made of wood; *e*, *e*, are iron hooks, by means of which it is suspended by ropes Q B F *e*, and Q A E R *e*, and Q S, as expressed in the figure; *c*, *c*, are iron hooks, to which are appended lead weights, that keep the mouth of the bell always parallel to the surface of the water, whether the machine taken altogether is lighter or heavier than an equal bulk of water. By these weights alone, however, the bell would not sink; another is therefore added, represented at L; and which can be raised or lowered at pleasure, by means of a rope passing over the pulley *a*, and fastened to one of the sides of the bell at M. As the bell descends, this weight, called by Mr Spalding the *balance-weight*, hangs down a considerable way below the mouth of the bell. In case the edge of the bell is catched by any obstacle, the balance-weight is immediately lowered down so that it may rest upon the bottom. By this means the bell is lightened, so that all danger of oversetting is removed; for being lighter without the balance-weight, than an equal bulk of water, it is evident that the bell will rise, as well as the length of the rope affixed to the balance weight will allow it. This weight, therefore, will serve as a

PLATE CLXXVI.

Fig. 1.
Halley's DIVING BELL

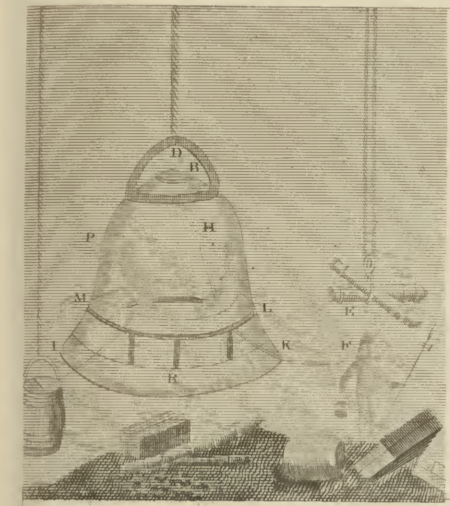


Fig. 2.
Triewalds

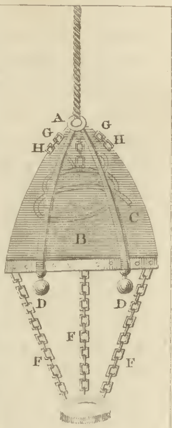


Fig. 3.
Spaldings

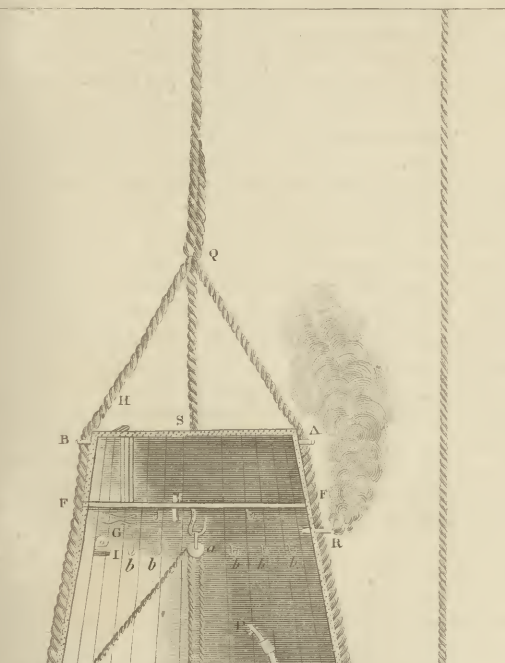
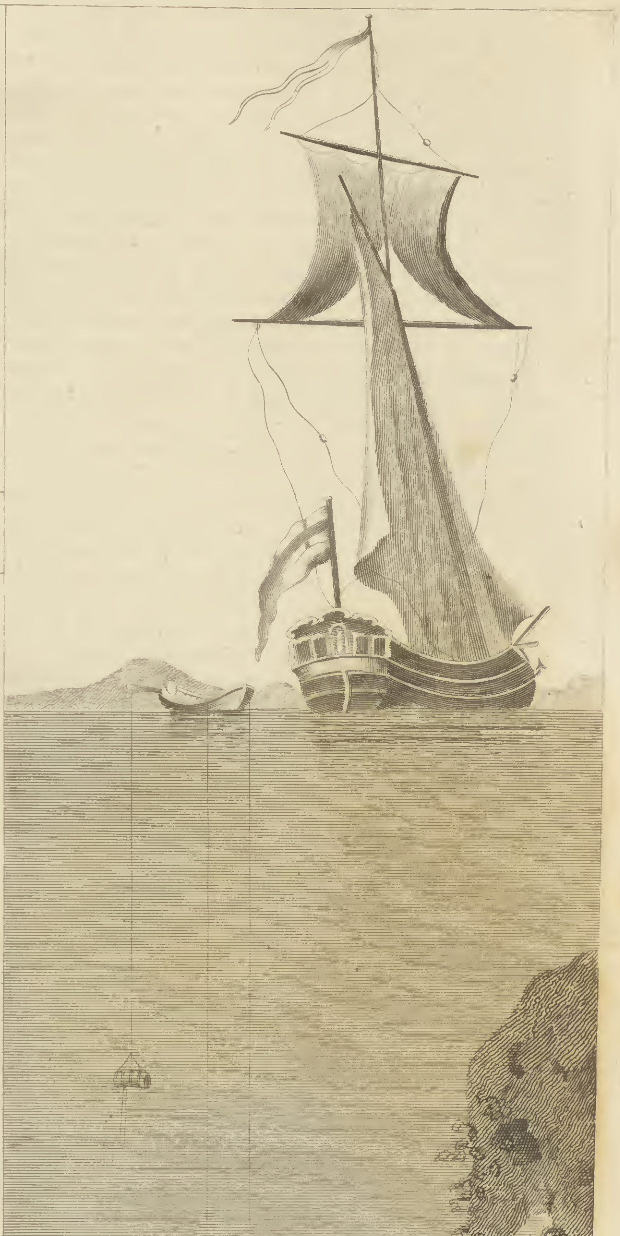


Fig. 4.



E. Mitchell sculpt.

kind of anchor to keep the bell at any particular depth which the divers may think necessary; or by pulling it quite up, the descent may be continued to the very bottom.

By another very ingenious contrivance, Mr Spalding rendered it possible for the divers to raise the bell, with all the weights appended to it, even to the surface, or to stop at any particular depth, as they think proper; and thus they could still be safe, even though the rope designed for pulling up the bell was broke. For this purpose the bell is divided into two cavities, both of which are made as tight as possible. Just above the second bottom EF, are small slits in the sides of the bell; through which the water entering as the bell descends, displaces the air originally contained in this cavity, which flies out at the upper orifice of the cock GH. When this is done, the divers turn the handle G, which stops the cock; so that if any more air was to get into the cavity AEFD, it could not longer be discharged through the orifice H as before. When this cavity is full of water, the bell sinks; but, when a considerable quantity of air is admitted, it rises. If, therefore, the divers have a mind to raise themselves, they turn the small cock *g*, by which a communication is made between the upper and under cavities of the bell. The consequence of this is, that a quantity of air immediately enters the upper cavity, forces out a quantity of the water contained in it, and thus renders the bell lighter by the whole weight of the water which is displaced. Thus, if a certain quantity of air is admitted into the upper cavity, the bell will descend very slowly; if a greater quantity, it will neither ascend nor descend, but remain stationary; and if a larger quantity of air is still admitted, it will arise to the top. It is to be observed, however, that the air which is thus let out into the upper cavity must be immediately replaced from the air-barrel; and the air is to be let out very slowly, or the bell will rise to the top with so great velocity that the divers will be in danger of being shaken out of their seats. But, by following these directions, every possible accident may be prevented, and people may descend to great depths without the least apprehension of danger. The bell also becomes so easily manageable in the water, that it may be conducted from one place to another by a small boat with the greatest ease, and with perfect safety to those who are in it.

Instead of wooden seats used by Dr Halley, Mr Spalding made use of ropes suspended by hooks *b b b*; and on these ropes the divers may sit without any inconvenience. I and K are two windows made of thick strong glass, for admitting light to the divers. N represents an air-cask with its tackle, and OCP the flexible pipe through which the air is admitted to the bell. In the ascent and descent of this cask the pipe is kept down by a small weight appended, as in Dr Halley's machine. R is a small cock by which the hot air is discharged as often as it becomes troublesome. Fig. 4. is a representation of the whole diving apparatus, which it is hoped will be readily understood without any further explanation. Two air-barrels are represented in this figure; but Mr Spalding was of opinion, that one capable of containing 30 gallons is sufficient for an ordinary machine.

We are told of another method put in practice by a gentleman of Devonshire. He has contrived a large case of strong leather, perfectly water-proof, which may hold about half a hogshead of air. This is so contrived, that, when he shuts himself up in this case, he may walk at the bottom of the sea, and go into any part of a wrecked vessel, and deliver out the goods.—This method, we are told, he has practised for many years and has thus acquired a large fortune. It would be a considerable improvement on this machine to condense the air in it as much as possible before the diver descended; as he would thus be furnished with an atmosphere endued with elasticity sufficient to resist the weight of the water, which otherwise would squeeze his case into much less room than it originally took up. The condensed air also would serve for respiration a much longer time than that which is in its ordinary state. See the article Diving, in the Supplement.

Diving-Bladder, a machine invented by Borelli, and by him preferred, though without any good reason, to the diving-bell. It is a globular vessel of brass or copper, about two feet in diameter, which contains the diver's head. It is fixed to a goat's skin habit exactly fitted to his person. Within the vessel are pipes; by means of which a circulation of air is contrived; and the person carries an air-pump by his side by which he can make himself heavier or lighter, as fishes do by contracting or dilating their air-bladder. By this means he thought all the objections to which other diving machines are liable were entirely obviated, and particularly that of want of air; the air which had been breathed, being, as he imagined, deprived of its noxious qualities by circulating through the pipes. These advantages, however, it is evident, are only imaginary. The diver's limbs, being defended from the pressure of the water only by a goat's skin, would infallibly be crushed, if he descended to any considerable depth; and from the discoveries now made by Dr Priestley and others, it is abundantly evident, that air, which is once rendered foul by breathing, cannot in any degree be restored by circulation through pipes. Concerning the use of copper machines in general, Mr Spalding favoured us with the following curious observation, namely, That when a person has breathed in them a few minutes, he feels in his mouth a very disagreeable brassy taste, which continues all the time he remains in the vessel; so that, on this account, copper seems by no means an eligible material. This taste most probably arises from the action of the alkalescent effluvia of the body upon the copper; for volatile alkali is a strong dissolvent of this metal; but how these effluvia volatilize the copper in such a manner as to make the taste of it sensible in the mouth, it is not easy to say.

DIVINITY, properly signifies the nature, quality, and essence of God.

Divinity is also used in the same sense with theology.

DIVISIBILITY, that property by which the particles of matter in all bodies are capable of a separation or disunion from each other.

The Peripatetics and Cartesians hold divisibility to be an affection of all matter. The Epicureans, again, allow it to agree to every physical continuum; but they

they deny that this affection agrees to all bodies, for the primary corpuscles or atoms they maintain to be perfectly insecable and indivisible.

As it is evident that body is extended, so it is no less evident that it is divisible; for since no two particles of matter can exist in the same place, it follows, that they are really distinct from each other; which is all that is meant by being divisible. In this sense the least conceivable particle must still be divisible, since it will consist of parts which will be really distinct. To illustrate this by a familiar instance. Let the least imaginable piece of matter be conceived lying on a smooth plain surface, it is evident the surface will not touch it everywhere; those parts, therefore, which it does not touch may be supposed separable from the others, and so on as far as we please; and this is all that is meant when we say matter is infinitely divisible.

Plate CLXXV.

The infinite divisibility of mathematical quantity is demonstrated thus geometrically. Suppose the line AC perpendicular to BF; and another, as GH, at a small distance from it, also perpendicular to the same line; with the centres CCC, &c. describe circles cutting the line GH in the points *e e e*, &c. Now the greater the radius AC is, the less is the part *e* H. But the radius may be augmented in infinitum; so long, therefore, the part *e* H may be divided into still less portions; consequently it may be divided in infinitum.

All that is supposed in strict geometry (says Mr Maclaurin) concerning the divisibility of magnitude, amounts to no more than that a given magnitude may be conceived to be divided into a number of parts equal to any given or proposed number. It is true, that the number of parts into which a given magnitude may be conceived to be divided, is not to be fixed or limited, because no given number is so great but a greater may be conceived and assigned; but there is not, therefore, any necessity of supposing the number of parts actually infinite; and if some have drawn very abstruse consequences from such a supposition, yet geometry ought not to be loaded with them.

How far matter may actually be divided, may in some measure be conceived from hence, that a piece of wire gilt with so small a quantity as eight grains of gold, may be drawn out to a length of 13,000 feet, the whole surface of it still remaining covered with gold. We have also a surprising instance of the minuteness of some parts of matter from the nature of light and vision. Let a candle be lighted, and placed in an open plain, it will then be visible two miles round; and consequently, was it placed two miles above the surface of the earth, it would fill with luminous particles a sphere whose diameter was four miles, and that before it had lost any sensible part of its weight. A quantity of vitriol being dissolved, and mixed with 9000 times as much water, will tinge the whole; consequently will be divided into as many parts as there are visible portions of matter in that quantity of water. There are perfumes, which, without a sensible diminution of their quantity, shall fill a very large space with their odoriferous particles; which must therefore be of an inconceivable smallness, since there will be a sufficient number in every part of that space sensibly to affect the organ of smelling. Dr Keill demonstrates, that any particle of matter, how small soever, and any finite space, how large soever, being given, it is possible for that small particle of matter to be diffused through all that space, and to fill it in such a manner, as that there shall be no pore in it whose diameter shall exceed any given line.

The chief objections against the divisibility of matter in infinitum are, That an infinite cannot be contained by a finite; and that it follows from a divisibility in infinitum, either that all bodies are equal, or that one infinite is greater than another. But the answer to these is easy; for the properties of a determined quantity are not to be attributed to an infinite considered in a general sense; and who has ever proved that there could not be an infinite number of infinitely small parts in a finite quantity, or that all infinites are equal? The contrary is demonstrated by mathematicians in innumerable instances. See the article INFINITY, and *'S Gravesande Elem. Mathem.* l. i. c. 4.

DIVISION, in general, is the separating a thing into two or more parts.

Mechanical DIVISION, signifies that separation which is occasioned in the parts of a body by help of mechanical instruments.—The mechanical division of bodies does indeed separate them into smaller, homogeneous, similar parts; but this separation cannot extend to the primary integrant molecules of any body; and consequently is incapable of breaking what is properly called their *aggregation;* also, no union is formed betwixt the divided and dividing bodies, in which respect division essentially differs from dissolution.

Division is not properly a chemical operation. It is only employed preparatorily to facilitate other operations, and particularly solution. For this purpose it is very useful, as it increases the quantity of surface, and consequently the points of contact of any body.—Different methods are used to divide bodies according to their nature. Those which are tenacious and elastic, as horns and gums, require to be cut, rasped, or filed. Metals, because of their ductility, require the same treatment: but as they are also fusible, they may be quickly and conveniently reduced into grains small enough for most operations, by pouring them, when melted, into water. All brittle bodies may be reduced conveniently into fine parts by being bruised in a mortar with a pestle. Very hard bodies, such as glass, crystals, stones, particularly those of the vitrifiable kind, before they are pounded, ought to be plunged when red hot into water, by which they are split and cracked, and rendered more easily pulverable. Bodies of this kind may also be bruised or ground by means of a hard and flat stone, upon which the matter is to be put, and bruised by another hard stone so small as to be held and moved upon the larger stone with the hand. The larger stone is called a *porphyry*, from its being generally of that kind of stone; and the operation is called *porphyrization.* Instead of porphyrization, a mill may be used, composed of a hard grit millstone, moving round upon another stone of the same kind, which must be fixed: in the upper stone is a groove or channel, through which the matter to be ground passes. By this method a substance may be more quickly reduced to a fine powder than by porphyrization. But these mills can be only employed for considerable quantities of matter.

These methods of mechanically dividing bodies are attended

attended with some practical inconveniences; the most considerable of which is, that some parts of the dividing instruments are always struck off, and mixed with the matter to be divided. This may greatly affect the operations. For instance, instruments of iron and copper furnish metallic colouring particles, and copper is very prejudicial to health. Porphyry is coloured by a reddish brown matter, which injures the colour of crystal glasses, enamels, and porcelains made with matters ground upon this stone. These matters therefore must be cleansed after their porphyrization, or else no instruments capable of injuring the intended operations ought to be employed. Thus, for the preparation of all medicines to be taken internally, no copper instruments, as mortars, pestles, &c. ought to be used; those made of iron are preferable: and, instead of porphyries, mortars, grinding stones and millstones made of hard and white stones, ought to be employed for substances which are to enter into the composition of enamels, crystal glass, and porcelain, the whiteness of which is a most necessary quality.

Division, in *Algebra*, See Algebra.

Division, in *Arithmetic*. See Arithmetic, N° 11.

Divisions of an Army, in the military art, the several brigades and squadrons into which it is cantoned.

Divisions of a Battalion, are the several platoons into which it is divided in marching or firing, each of which is commanded by an officer.

Division, in sea affairs, a select number of ships in a fleet or squadron of men of war, distinguished by a particular flag or pendant, and usually commanded by a general officer. A squadron is commonly ranged into three divisions, the commanding officer of which is always stationed in the centre.

When a fleet consists of 60 sail of the line, that is, of ships having at least 60 cannon each, the admiral divides it into three squadrons, each of which has its divisions and commanding officers. Each squadron has its proper colours, according to the rank of the admiral who commands it, and every division its proper mast. Thus the white flag denotes the first division of France; the white and blue the second; and the third is characterized by the blue. In Britain, the first admiral, or the admiral of the fleet, displays the union flag at the main-top-mast head; next follows the white flag with St George's cross; and afterwards the blue.

The private ships carry pendants of the same colour with their respective squadrons at the mast of their particular divisions; so that the last ship in the division of the blue squadron carries a blue pendant at her mizen-top-mast head.

DIVISOR, in *Arithmetic*. See Arithmetic, N° 11.

DIUM, in *Ancient Geography*, a town of Chalcidice in Macedonia, near Mount Athos. Also a promontory of Crete, on the north side of the island.—A third *Dium*, a promontory of Eubœa; or a town of that name in Eubœa, near the promontory Cnæum, on the north-west side of the island, called also *Dia*.—A fourth *Dium* in Pieria of Macedonia, on the west side of the Sinus Thermaicus. Strabo and Livy place it on the borders of Pieria to the south, at the foot of Mount Olympus towards Thessaly. That it was a splendid city, appears from Polybius; who relates, that its gymnasium and wall were overthrown by the Ætolians. From which overthrow, however, it again recovered, Alexander adding new splendour to it, by the brass statues cast by Lysippus, and erected there in in memory of the slain at the Granicus: an ornament which was continued down to the time of the Romans; who made it a colony, called *Diensis*.—A fifth *Dium* beyond Jordan, near Pella in the Piræa.

DIVODURUM, in *Ancient Geography*, a town of the Mediomatrici, in Gallia Belgica; situated on the Moselle, on the spot where now Metz stands; now a city of Lorrain. E. Long. 6. 0. N. Lat. 49. 16.

DIVORCE, a breach or dissolution of the bond of marriage. See Marriage, and Law *Index*.

Divorce is of two kinds: the one *à vinculo matrimonii*, which alone is properly *divorce*; the other, *à mensa et thoro*, "a separation from bed and board."

The woman divorced *à vinculo matrimonii* receives all again that she brought with her: the other has a suitable separate maintenance allowed her out of her husband's effects. The first only happens through some essential impediment, as consanguinity or affinity within the degrees forbidden, pre-contract, impotency, adultery, &c. of which impediments the canon law allows 14, comprehended in these verses:

> *Error, conditio, votum, cognatio, crimen,*
> *Cultus, disparitas, vis, ordo, ligamen, honestas,*
> *Si sis affinis, si forte coire nequibis,*
> *Si parochi et duplicis desit præsentia testis,*
> *Raptave sit mulier, nec parti reddita tuta.*

Divorce is a spiritual judgment, and therefore is passed in the spiritual court. Under the old law, the woman divorced was to have of her husband a writing, as St Jerome and Josephus testify, to this effect: *I promise, that hereafter I will lay no claim to thee*; which was called a *bill of divorce*.

Divorce was allowed of in great latitude both among the Pagans and Jews. At Rome, barrenness, age, disease, madness, and banishment, were the ordinary causes of divorce. Spurius Carvilius, between 500 and 600 years after the building of Rome, under the consulship of M. Attilius and P. Valerius, was the first who put away his wife because she was barren; though Plutarch, in his Roman Questions, maintains, that Domitian was the first who permitted divorce. Justinian afterwards added impotence, a vow of chastity, and the profession of a monastic life, as valid reasons of divorce.

The Roman lawyers distinguish between *repudium* and *divortium*; making the former to be the breaking of a contract or espousal, and the latter separation after matrimony. Romulus enacted a severe law, which suffered not a wife to leave her husband, but gave the man the liberty of turning off his wife, either upon poisoning her children, counterfeiting his private keys, or for the crime of adultery; but if the husband on any other occasion put her away, he ordered one moiety of his estate for the wife, and the other to the goddess Ceres: besides an atonement to the gods of the earth. However, in later times, the women as well as the men might sue a divorce. The common way of divorcing was by sending a bill to the woman, containing the reasons of separation, and the tender of all her goods which she brought with her: and this was called *repudium mittere;* or else it was performed in her presence, and before seven witnesses, and accompanied with the formalities of tearing the writings, refunding the portion, taking away the keys, and turning the woman out of doors.

The Grecian laws concerning divorces were different: The Cretans allowed divorce to any man that was afraid of having too many children. The Spartans seldom divorced their wives; and it was extremely scandalous for a woman to depart from her husband. The Athenians allowed divorce on very small grounds, by a bill, containing the reason of the divorce, and approved, if the party appealed, by the chief magistrate; and women also were allowed to leave their husbands on just occasions. Persons divorcing their wives were obliged to return their portions; otherwise, the Athenian laws obliged them to pay nine oboli a month for alimony. The terms expressing the separation of men and women from each other were different; the men were said αποπεμπειν or απολευειν, *to dismiss their wives;* but wives, απολειπειν, *to leave their husbands.*

Paley's Moral and Political Philosophy, p. 273.

"The law of Moses (Mr Paley observes), for reasons of local expediency, permitted the Jewish husband to put away his wife; but whether for every cause, or for what cause, appears to have been controverted amongst the interpreters of those times. Christ, the precepts of whose religion were calculated for more general use and observation, revokes this permission, as given to the Jews 'for their hardness of heart,' and promulgates a law which was thenceforward to confine divorces to the single cause of adultery in the wife: 'Whosoever shall put away his wife, except it be for fornication, and shall marry another, committeth adultery; and whoso marrieth her which is put away, doth commit adultery,' Mat. xix. 9.

"Inferior causes may justify the separation of husband and wife, although they will not authorize such a dissolution of the marriage contract as would leave either at liberty to marry again: for it is that liberty in which the danger and mischief of divorces generally consist. The law of this country, in conformity to our Saviour's injunction, confines the dissolution of the marriage contract to the single case of adultery in the wife; and a divorce even in that case can only be brought about by the operation of an act of parliament, founded upon a previous sentence in the spiritual court, and a verdict against the adulterer at common law: which proceedings taken together compose as complete an investigation of the complaint as a cause can receive. It has lately been proposed to the legislature to annex a clause to these acts, restraining the offending party from marrying with the companion of her crime, who by the course of proceeding is always known and convicted; for there is reason to fear, that adulterous connections are often formed with the prospect of bringing them to this conclusion; at least, when the seducer has once captivated the affection of a married woman, he may avail himself of this tempting argument to subdue her scruples, and complete his victory; and the legislature, as the business is managed at present, assists by its interposition the criminal design of the offenders, and confers a privilege where it ought to inflict a punishment. The proposal deserved an experiment; but something more penal, it is apprehended, will be found necessary to check the progress of this alarming depravity. Whether a law might not be framed, directing *the fortune of the adultress to descend as in case of her natural death;* reserving, however, a certain proportion of the produce of it, by way of annuity, for her subsistence (such annuity in no case to exceed a certain sum); and also so far suspending the estate in the hands of the heir, as to preserve the inheritance to any children she might bear to a second marriage, in case there was none to succeed in the place of their mother by the first: whether such a law would not render female virtue in higher life less vincible, as well as the seducers of that virtue less urgent in their suit, I would recommend to the deliberation of those who are willing to attempt the reformation of this important but most incorrigible class of the community. A passion for splendour, for expensive amusements and distinctions, is commonly found in that description of women who would become the subject of such a law, not less inordinate than their other appetites. A severity of the kind proposed applies immediately to that passion. And there is no room for any complaint of injustice, since the provisions above stated, with others which might be contrived, confine the punishment, so far as it is possible, to the person of the offender; suffering the estate to remain to the heir, or within the family of the ancestor from whom it came, or to attend the appointments of his will.

"Sentences of the ecclesiastical courts, which release the parties *à vinculo matrimonii*, by reason of impuberty, frigidity, consanguinity within the prohibited degrees, prior marriage, or want of the requisite consent of parents or guardians, are not dissolutions of the marriage contract, but judicial declarations that there never was any marriage; such impediment subsisting at the time as rendered the celebration of the marriage rite a mere nullity. And the rite itself contains an exception of these impediments. The man and woman to be married are charged, "if they know any impediment why they may not be lawfully joined together, to confess it:" and assured, "that so many as are coupled together, otherwise than God's word doth allow, are not joined together by God, neither is their matrimony lawful:" all which is intended by way of solemn notice to the parties, that the vow they are about to make will bind their consciences and authorize their cohabitation only upon the supposition that no legal impediment exist."

DIURETICS (from δια, *by*, and ουρον, *urine*,) medicines which provoke a discharge by urine.

Such is water drank plentifully; white wine drank in a morning; alkaline salts of all kinds; sea salt, sal gemmæ, nitre, borax, alum, tartar, sal ammoniac, whey, sour milk, lemon juice, &c. Aqueous liquors are generally diuretic, especially if mixed with salt, and drank cold. Fermented liquors are the least diuretic of all; and the less so, as they are the fatter. Sharp thin sour wines, Rhenish, &c. as also acid spirits of vinegar, salt, sulphur, alum, vitriol, &c. asparagus, bitter almonds, smallage, eryngium, eupatorium, sassafras, &c. are all diuretics.

DIURNAL, in *Astronomy*, something relating to day; in opposition to *nocturnal*, which regards the night.

DIVUS, Diva, in antiquity, appellations given to men

men and women who had been deified, or placed in the number of the gods. See DEIFICATION, &c.

Hence it is, that on medals struck for the consecration of an emperor or empress, they give them the title of *divus* or *diva*: for example, DIVUS JULIUS. DIVO ANTONINO PIO. DIVO PIO. DIVO CLAUDIO. DIVA FAUSTINA AUG. &c.

DIZZINESS, in *Medicine*. See VERTIGO.

DO, in *Music*, a note of the Italian scale, corresponding to *ut* of the common gammut. See MUSIC.

DOBSON, WILLIAM, an eminent English portrait and history painter, born at London in 1610. He served an apprenticeship with one Peck a stationer and picture-dealer; and owed his improvement to the copying some pictures of Titian and Van Dyck, whose manner he always retained. He had farther obligations to the latter of these artists; for it is said, that a picture of his painting being exposed at a shop on Snow-hill, Van Dyck passing by was struck with it exceedingly; and inquiring after the author, found him at work in a poor garret. Van Dyck had the generosity to equip him in a manner suitable to his merit. He presented him to King Charles I. who took him under his protection, kept him with him at Oxford all the time his majesty continued in that city, and not only sat to him several times for his picture, but caused the prince of Wales, Prince Rupert, and most of the lords of his court to do so too. Mr Dobson, however, being somewhat loose and irregular in his way of life, was far from improving the many opportunities he had of making his fortune; and died very poor in 1647, at his house in St Martin's Lane.

DOBUNI, or BODUNI; an ancient people of Britain, who possessed the territory which now forms the counties of Oxford and Gloucester. Both the names of this British nation seem to have been derived from the low situation of a great part of the country which they inhabited: for both *Duvn* and *Bodun* signify "profound" or "low," in the ancient language of Gaul and Britain. The Dobuni are not mentioned among the British nations who resisted the Romans under Julius Cæsar, which was probably owing to the distance of their country from the scene of action; and before the next invasion under Claudius, they had been so much oppressed by their ambitious neighbours the Cattivellauni, that they submitted with pleasure to the Romans, in order to be delivered from that oppression. Cogidunus, who was at that time (as his name imports) prince of the Dobuni, recommended himself so effectually to the favour of the emperor Claudius, by his ready submission, and other means, that he was not only continued in the government of his own territories, but had some other states put under his authority. This prince lived so long, and remained so steadily a friend and ally to the Romans, that his subjects, being habituated to their obedience in his time, never revolted, nor stood in need of many forts or forces to keep them in subjection. This is certainly the reason that we meet with so few Roman towns and stations in the country anciently inhabited by the Dobuni. The Durocornovium of Antoninus, and the Corinium of Ptolemy, are believed by antiquaries to have been the same place, the capital of the Dobuni, and situated at Cirencester in Gloucestershire, where there are many marks of a Roman station. Clevum or Glevum, in the thirteenth iter of Antoninus, stood where the city of Gloucester now stands; and Abone, in the fourteenth iter, was probably situated at Avinton on the Severn. The country of the Dobuni was comprehended in the Roman province Britannia Prima.

DOCETÆ (from δοκειν, *to appear*), in ecclesiastical history, the followers of Julius Cassianus, one of the Valentinian sect, towards the close of the second century, who revived a notion that had been adopted by a branch of the Gnostics, against whom St John, Ignatius, and Polycarp, had asserted the truth of the incarnation. They believed and taught, as their name imports, that the actions and sufferings of Jesus Christ were not in reality, but only in appearance.

DOCIMASIA, in Greek antiquity, a probation of the magistrates and persons employed in public business at Athens. It was performed publicly in the forum, where they were obliged to give account of themselves and their past life before certain judges. Among several questions proposed to them, we find the following: Whether they had been dutiful to their parents, had served in the wars, and had a competent estate?

DOCIMASTIC ART, a name given to the art of essaying, by operations in small, the nature and quantity of metallic or other matters which may be obtained from mineral or other compound bodies. See REFINING and METALLURGY.

DOCIMENUM MARMOR, a name given by the ancients to a species of marble of a bright and clear white, much used in large and sumptuous buildings, such as temples and the like. It had its name from *Docimenos*, a city of Phrygia, afterwards called *Synaia*; near which it was dug, and from whence it was sent to Rome. It was accounted little inferior to the Parian in colour, but not capable of so elegant a polish; whence it was less used by the statuaries, or in other smaller works. The emperor Adrian is said to have used this marble in building the temple of Jupiter; and many of the great works of the Romans are constructed of the same materials.

DOCK, in *Botany*. See RUMEX, BOTANY *Index*.

DOCK, in the manege, is used for a large case of leather, as long as the dock of a horse's tail, which serves it for a cover. The French call the dock *troussequeue*. It is made fast by straps to the crupper, and has leathern thongs that pass between his thighs, and along his flanks to the saddle straps, in order to keep the tail tight, and to hinder it from whisking about.

DOCK, in maritime affairs, a sort of broad and deep trench formed on the side of a harbour, or on the banks of a river; and commodiously fitted either to build ships or receive them to be repaired and *breamed* therein. These sort of docks have generally strong flood-gates to prevent the flux of the tide from entering the dock while the ship is under repair.—There are likewise docks of another kind, called *wet docks*, where a ship can only be cleaned during the recess of the tide, or in the interval between the time when the tide left her dry aground, and the period when it again reaches her by the return of the flood. Docks of the latter kind are not furnished with the usual flood-gates. See the article DOCK, SUPPLEMENT.

DOCK-Yards, certain magazines containing all sorts of of naval stores and timber for ship-building. In England, the royal dock-yards are at Chatham, Portsmouth, Plymouth, Deptford, Woolwich, and Sheerness. His majesty's ships and vessels of war are generally moored at these ports during the time of peace; and such as want repairing are taken into the docks, examined, and refitted for service.

The principal dock-yards are governed by a commissioner, resident at the port; who superintends all the musters of the officers, artificers, and labourers, employed in the dock-yard and ordinary. He also controuls their payments therein; examines their accounts; contracts, and draw bills on the navy-office to supply the deficiency of stores; and, finally, regulates whatever belongs to the dock-yard, maintaining due order in the respective offices.

These yards are generally supplied from the northern crowns with hemp, pitch, tar, rosin, canvas, oak plank, and several other species. See the plan and fitting up of a dock-yard. See the article DOCKYARDS in the SUPPLEMENT.

DOCTOR, a person who has passed all the degrees of a faculty, and is empowered to teach or practise the same: thus we say, doctor in divinity, doctor in physic, doctor of laws.

The establishment of the *doctorate*, such as now in use among us, is ordinarily attributed to Irnerius, who himself drew up the formulary. The first ceremony of this kind was performed at Bologna, in the person of Bulgarus, who began to profess the Roman law, and on that occasion was solemnly promoted to the *doctorax*, i. e. installed *juris utriusque doctor*. But the custom was soon transferred from the faculty of law to that of theology; the first instance whereof was given in the university of Paris, where Peter Lombard and Gilbert de la Portree, the two chief divines of those days, were created doctors in theology, *sacræ theologiæ doctores*.

Spelman takes the title of doctor not to have commenced till after the publication of Lombard's sentences, about the year 1140; and affirms, that such as explained that work to their scholars were the first that had the appellation of doctors. Others go much higher, and hold Bede to have been the first doctor at Cambridge, and John de Beverley at Oxford, which latter died in the year 721. But Spelman will not allow doctor to have been the name of any title or degree in England till the reign of King John, about the year 1207.

To pass doctor in divinity at Oxford, it is necessary the candidate have been four years bachelor of divinity. For doctor of laws, he must have been seven years in the university to commence bachelor of law; five years after which he may be admitted doctor of laws. Otherwise, in three years after taking the degree of master of arts, he may take the degree of bachelor in law; and in four years more, that of LL. D. which same method and time are likewise required to pass the degree of doctor in physic.

At Cambridge, to take the degree of doctor in divinity, it is required the candidate have been seven years bachelor of divinity: Though in several of the colleges the taking of the bachelor of divinity's degree is dispensed with, and they may go out *per saltum*. To commence doctor in laws, the candidate must have been five years bachelor of law, or seven years master of arts. To pass doctor in physic, he must have been bachelor in physic five years, or seven years master of arts. A doctor of the civil law may exercise ecclesiastical jurisdiction, though a layman, stat. 37 Hen. VII. cap. 17. sect. 4.

DOCTOR of the Law, a title of honour among the Jews. The investiture, if we may so say, of this order, was performed by putting a key and table book, in their hands; which is what some authors imagine our Saviour had in view, Luke xi. 52. when, speaking of the doctors of the law, he says, "Wo unto you, doctors of the law, for you have taken away the key of knowledge: you entered not in yourselves, and them that were entering you hindered."

DOCTOR of the Church, a title given to certain of the fathers whose doctrines and opinions have been the most generally followed and authorized. We usually reckon four doctors of the Greek church, and three of the Latin. The first are, St Athanasius, St Basil, St Gregory Nazianzen, and St Chrysostom. The latter are St Jerome, St Augustine, and Gregory the Great. In the Roman breviary there is a particular office for the doctors. It only differs from that of the confessors, by the anthem of the Magnificat, and the lessons.

DOCTOR, is also an appellation adjoined to several specific epithets, expressing the merit of some of the schoolmen: thus, Alexander Hales is called the irrefragable doctor; Thomas Aquinas, the angelic doctor; St Bonaventure, the seraphic doctor; John Duns Scotus, the subtile doctor; Raimond Lully, the illuminated doctor; Roger Bacon, the admirable doctor, &c.

DOCTOR, (Διδασκαλος), in the Greek church, is a particular officer, appointed to interpret part of the scriptures. He who interprets the gospels, is called *doctor of the Gospel*; he who interprets St Paul's Epistles, *doctor of the Apostles*; he who interprets the Psalms, *doctor of the Psalter*.

DOCTORS Commons. See *COLLEGE of Civilians*.

DOCUMENT, in *Law*, some written monument produced in any thing asserted.

DODARTIA, a genus of plants belonging to the didynamia class; and in the natural method ranking under the 40th order, *Personatæ*. See BOTANY *Index*.

DODD, DR WILLIAM, an unfortunate English divine, eldest son of the Rev. William Dodd, many years vicar of Bourne in Lincolnshire, was born May 29. 1729. He was sent, at the age of 16, to the university of Cambridge; and admitted in the year 1745 a sizer of Clare-Hall. In 1749-50 he took the degree of B. A. with great honour, being upon that occasion in the list of wranglers. Leaving the university, he imprudently married a Miss Mary Perkins in 1751, was ordained a deacon the same year, priest in 1753, and soon became a celebrated and popular preacher. His first preferment was the lectureship of West-Ham. In 1754 he also was chosen lecturer of St Olave's, Hart-street; and in 1757 took the degree of M. A. at Cambridge. On the foundation of the Magdalen Hospital in 1758, he was a strenuous supporter of that charity, and soon after became preacher at the chapel of it. By the patronage of Bishop Squire, he in 1763 obtained a prebend of Brecon, and by the interest of some city friends procured himself to be appointed one

of

of the king's chaplains; soon after which he had the education of the earl of Chesterfield committed to his care. In 1766 he went to Cambridge and took the degree of LL. D. At this period, the estimation in which he was held by the world was sufficient to give him the expectations of preferment, and hopes of riches and honours; and these he might probably have acquired had he possessed a common portion of prudence and discretion. But, impatient of his situation, and eager for advancement, he rashly fell upon means which in the end were the occasion of his ruin. On the living of St George, Hanover Square, becoming vacant, he wrote an anonymous letter to the chancellor's lady, offering 3000 guineas, if by her assistance he was promoted to it. This being traced to him, complaint was immediately made to the king, and Dr Dodd was dismissed with disgrace from his office of chaplain. From this period he lived neglected, if not despised; and his extravagance still continuing, he became involved in difficulties, which tempted him to forge a bond from his late pupil Lord Chesterfield, Feb. 4. 1777, for 4200l. which he actually received: but being detected, he was tried at the Old Bailey, found guilty, and received sentence of death; and in spite of every application for mercy, was executed at Tyburn, June 27. 1777. Dr Dodd was a voluminous writer, and possessed considerable abilities, with little judgment and much vanity. An accurate list of his various writings is prefixed to his "Thoughts in Prison," edit. 1781.

chol's
ecdotes
Boyer.

DODDER. See Cuscuta, Botany *Index*.

DODDRIDGE, Philip, D. D. an eminent Presbyterian minister, was the son of Daniel Doddridge an oilman in London, where he was born on the 26th of June 1702; and having completed the study of the classics in several schools, was in 1719 placed under the tuition of the reverend Mr John Jennings, who kept an academy at Kilworth in Leicestershire. He was first settled as a minister at Kilworth, where he preached to a small congregation in an obscure village: but, on Mr Jennings's death, succeeded to the care of his academy; and soon after was chosen minister of a large congregation of Dissenters at Northampton, to which he removed his academy, and where the number of his pupils increased. He instructed his pupils with the freedom and tenderness of a father; and never expected nor desired that they should blindly follow his sentiments, but encouraged them to judge for themselves. He checked any appearance of bigotry and uncharitableness, and endeavoured to cure them by showing what might be said in defence of those principles they disliked. He died at Lisbon, whither he went for the recovery of his health; and his remains were interred in the burying-ground belonging to the British factory there, and a handsome monument was erected to his memory in the meeting-house at Northampton, at the expence of the congregation, on which is an epitaph written by Gilbert West, Esq. He wrote, 1. Free Thoughts on the most probable means of reviving the Dissenting Interest. 2. The Life of Colonel James Gardiner. 3. Sermons on the Education of Children. 4. The Rise and Progress of Religion in the Soul. 5. The Family Expositor, in 6 vols 4to. &c. And since the author's death, a volume of his hymns has been published, and his Theological Lectures. Several of his works have been translated into Dutch, German, and French.

DODECAGON, in *Geometry*, a regular polygon consisting of twelve equal sides and angles.

DODECAHEDRON, in *Geometry*, one of the platonic bodies, or regular solids, contained under twelve equal and regular pentagons.

DODECANDRIA, (from *δωδεκα*, *twelve*, and *ανηρ*, *a man*); the name of the eleventh class in Linnæus's sexual system, consisting of plants with hermaphrodite flowers, that, according to the title, have twelve stamina or male organs. This class, however, is not limited with respect to the number of stamina. Many genera have sixteen, eighteen, and even nineteen, stamina; the essential character seems to be, that in the class in question, the stamina, however numerous, are inserted into the receptacle; whereas in the next class, icosandria, which is as little determined in point of number as the present, they are attached to the inside of the calyx or flower-cup.

The orders of this class, which are six, are founded upon the number of the styles, or female organs. Asarabacca, mangostan, storax, purple loosestrife, wild Syrian rue, and purslain, have only one style; agrimony and heliocarpus have two; burning thorny plant, and bastard rocket, three; *glinus*, five; *illicium*, eight; and house leek, twelve.

DODECAS, a genus of plants belonging to the dodecandria class. See Botany *Index*.

DODECATHEON, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 21st order, *Preciæ*. See Botany *Index*.

DODO. See Didus, Ornithology *Index*.

DODONA, a town of Thesprotia in Epirus, or (according to others) in Thessaly. There was in its neighbourhood a celebrated oracle of Jupiter. The town and temple of the god were first built by Deucalion, after the universal deluge. It was supposed to be the most ancient oracle of all Greece; and according to the traditions of the Egyptians mentioned by Herodotus, it was founded by a dove. Two black doves, as he relates, took their flight from the city of Thebes in Egypt; one of which flew to the temple of Jupiter Ammon, and the other to Dodona, where with a human voice they acquainted the inhabitants of the country that Jupiter had consecrated the ground, which in future would give oracles. The extensive grove which surrounded Jupiter's temple was endowed with the gift of prophecy; and oracles were frequently delivered by the sacred oaks and the doves which inhabited the place. This fabulous tradition of the oracular power of the doves is explained by Herodotus, who observes that some Phenicians carried away two priestesses from Egypt, one of which went to fix her residence at Dodona, where the oracle was established. It may farther be observed, that the fable might have been founded upon the double meaning of the word τελειαι, which signifies *doves* in most parts of Greece, while in the dialect of the Epirots it implies *old women*. In ancient times the oracles were delivered by the murmuring of a neighbouring fountain; but the custom was afterwards changed. Large kettles were suspended in the air near a brazen statue, which held a lash in its hand. When the wind blew strong, the statue was agitated and struck against one of the kettles, which communicated the motion to all the rest, and raised that clattering and discordant din, which continued for a while, and from which the artifice of the priests drew the predictions. Some suppose that the noise was occasioned by the shaking of the leaves and boughs of an old oak, which the superstition of the people frequently consulted, and from which they pretended to receive oracles. It may be observed, with more probability, that the oracles were delivered by the priests, who, by artfully concealing themselves behind the oaks, gave occasion to the superstitious multitude to believe that the trees were endowed with the power of prophecy. As the ship Argo was built with some of the oaks of the forest of Dodona, there were some beams which gave oracles to the Argonauts, and warned them against the approach of calamity. Within the forest of Dodona there was a stream and a fountain of cool water which had the power of lighting a torch as soon as it touched it. This fountain was totally dry at noon day, and was restored to its full course at midnight, from which time till the following noon it began to decrease, and at the usual hour was again deprived of its waters. The oracles of Dodona were generally delivered by women.

DODONÆA, a genus of plants belonging to the octandria class. See BOTANY *Index*.

DODONIAN, (*Dodonæus*), in antiquity, an epithet given to Jupiter, because he was worshipped in a temple built in the forest of Dodona, where was the most famous, and (it is said) the most ancient, oracle of all Greece. See DODONA.

DODONIDES, the priestesses who gave oracles in the temple of Jupiter in Dodona. According to some traditions the temple was originally inhabited by seven daughters of Atlas, who nursed Bacchus. Their names were Ambrosia, Eudora, Pasithoe, Pytho, Plexaure, Coronis, Tythe or Tyche. In the latter ages the oracles were always delivered by three old women; which custom was first established when Jupiter enjoyed the company of Dione, whom he permitted to receive divine honour in his temple at Dodona. The Bœotians were the only people of Greece who received their oracles at Dodona from men, for reasons which Strabo, l. 9. fully explains.

DODRANS, in antiquity, three-fourths of the as. See the article AS.

DODSLEY, ROBERT, an eminent bookseller, and ingenious writer, born at Mansfield in Nottinghamshire, in the year 1703. He was not indebted to education for his literary fame, being originally a livery servant; but his natural genius, and early passion for reading, soon elevated him to a superior station. He wrote an elegant little satirical farce called *The Toyshop*, which was acted with applause in 1735, and which recommended him to the patronage of Mr Pope. The following year he produced the King and Miller of Mansfield. The profits of these two farces enabled him to commence bookseller, and his own merit procured him eminence in that profession. He wrote some other dramatic pieces, and published a collection of his works in one vol. 8vo, under the modest title of Trifles; which was followed by Public Virtue, a poem in 4to. Mr Dodsley was the author of the Economy of Human Life, a work which acquired considerable celebrity; but for this, it is supposed to have been indebted to the mistaken opinion which long prevailed of its being the production of Lord Chesterfield.

DODWELL, HENRY, a very learned controversial writer, born at Dublin, but of English extraction, in 1641. He wrote an incredible number of tracts: but his services were so little acknowledged, that Bishop Burnet and others accuse him of doing more hurt than good to the cause of Christianity, by his indiscreet love of paradoxes and novelties, and thus exposing himself to the scoffs of unbelievers. His pamphlet on the immortality of the soul gave rise to the well known controversy between Mr Collins and Dr Clark on that subject. He died in 1711.

DOESBURG, a town of the United Provinces, in the county of Zutphen and province of Guelderland. It is small, but well peopled, and very strong both by art and nature, having the river Yssel on one side, and a morass on the other, and is only to be approached by a narrow neck of land. E. Long. 5. 55. N. Lat. 52. 3.

DOG, in *Zoology*, an animal remarkable for its natural docility, fidelity, and affection for his master; which qualities mankind are careful to improve for their own advantage. These useful creatures guard our houses, gardens, and cattle, with spirit and vigilance. By their help we are enabled to take not only beasts, but birds; and to pursue game both over land and through the waters. In some northern countries, they serve to draw sledges, and are also employed to carry burdens. In several parts of Africa, China, and by the West Indian negroes, dogs are eaten, and accounted excellent food. Nay, we have the testimony of Mr Forster, that dogs flesh, in taste, exactly resembles mutton *. They were also used as food by the Romans, and long before them by the Greeks, as we learn from several treatises of Hippocrates. In the present times, their skins, dressed with the hair on, are used in muffs, made into a kind of buskins for persons in the gout, and for other purposes. Prepared in another way, they are used for ladies gloves, and the linings of masks, being thought to make the skin peculiarly white and smooth. The French import many of these skins from Scotland, under a small duty. Here, when tanned, they serve for upper leathers for neat pumps. Dogs skins dressed are exported under a small, and imported under a high duty. The French import from Denmark large quantities of dogs hair, both white and black. The last is esteemed the best, and is worked up in the black list of a particular kind of woollen cloth; but is not used, as many have supposed, in making of hats, being entirely unfit for this purpose.

With regard to the qualities of dogs, those bred in the island of Britain are justly reckoned superior to the dogs bred in any other country. The swiftness of the greyhound is amazing; as are also the steadiness and perseverance of other hounds and beagles; the boldness of terriers in unearthing foxes, &c.; the sagacity of pointers and setting dogs, who are taught a language by signs as intelligible to sportsmen as speech; and the invincible spirit of a bull dog, which can be quelled only by death.—All the nations in Europe not only do justice to the superior qualities of the British dogs, but adopt our terms and names, and thankfully receive the creatures

* See *Am rica*, N°

Dog.
rts.
ct.

creatures as presents.—It is remarkable, however, that almost every kind of British dogs degenerates in foreign countries; nor is it possible to prevent this degeneracy by any art whatever.

For the natural history of the dog, see CANIS, MAMMALIA *Index*.

Choosing of Dogs.—In order to choose a dog and bitch for good whelps, take care that the bitch come of a generous kind, be well proportioned, having large ribs and flanks; and likewise that the dog be of a good breed and young, for a young dog and an old bitch breed excellent whelps.

The best time for hounds nitches, or bratches, to be lined in, are the months of January, February, and March. The bitch should be used to a kennel, that she may like it after her whelping, and she ought to be kept warm. Let the whelps be weaned after two months old; and though it be some difficulty to choose a whelp under the dam that will prove the best of the litter, yet some approve that which is last, and account him to be the best. Others remove the whelps from the kennel, and lay them severally and apart one from the other; then they watch which of them the bitch first takes and carries into her kennel again, and that they suppose to be the best. Others again imagine that which weighs least when it sucks to be the best: this is certain, that the lighter whelp will prove the swifter. As soon as the bitch has littered, it is proper to choose them you intend to preserve, and drown the rest: keep the black, brown, or of one colour; for the spotted are not much to be esteemed, though of hounds the spotted are to be valued.

Hounds for chase are to be chosen by their colours. The white, with black ears, and a black spot at the setting on of the tail, are the most principal to compose a kennel of, and of good scent and condition. The black hound, or the black tanned, or the all liver-coloured or all white: the true talbots are the best of the stronger line; the grizzled, whether mixed or unmixed, so they be shag-haired, are the best verminers, and a couple of these are proper for a kennel.—In short, take these marks of a good hound: That his head be a middle proportion, rather long than round; his nostrils wide, his ears large, his back bowed; his fillet great, his haunches large, thighs well trussed, ham strait, tail big near the reins, the rest slender; the leg big, the sole of the foot dry, and in the form of that of a fox, with large claws.

Keeping Dogs in Health.—As pointers and spaniels, when good of their kinds and well broken, are very valuable to a sportsman, it is worth while to take some care to preserve them in health. This very much depends on their diet and lodging: frequent cleaning their kennels, and giving them fresh straw to lie on, is very necessary; or, in summer time, deal shavings, or sand, instead of straw, will check the breeding of fleas. If you rub your dog with chalk, and brush and comb him once or twice a-week, he will thrive much the better; the chalk will clear his skin from all greasiness, and he will be the less liable to be mangy. A dog is of a very hot nature: he should therefore never be without clean water by him, that he may drink when he is thirsty. In regard to their food, carrion is by no means proper for them; it must hurt their sense of smelling, on which the excellence

Dog.
Sports. Dict.

of these dogs greatly depends. Barley meal, the dross of wheat flour, or both mixed together, with broth or skimmed milk, is very proper food. For change, a small quantity of greaves from which the tallow is pressed by the chandlers, mixed with flour, or sheep's feet well baked or boiled, are a very good diet: and when you indulge them with flesh, it should always be boiled. In the season of hunting your dogs, it is proper to feed them in the evening before, and give them nothing in the morning you intend to take them out except a little milk. If you stop for your own refreshment in the day, you should also refresh your dogs with a little bread and milk. It has been already observed that dogs are of a hot constitution; the greatest relief to them in the summer is twitch-grass or dog-grass, which is the same thing. You should therefore plant some of it in a place where you can turn them into every morning: they will feed freely on it to be cured of the sickness they are subject to, and cured of any extraordinary heat of blood: but unless the grass be of this sort, it will have no effect.

Diseases of Dogs.—1. *Bites and Stings.* If dogs are bitten by any venomous creatures, as snakes, adders, &c. squeeze out the blood, and wash the place with salt and urine; then lay a plaster to it made of calamint, pounded in a mortar, with turpentine and yellow wax, till it come to a salve. If you give your dog some of the juice of calamint to drink in milk, it will be good; or an ounce of treacle dissolved in some sweet wine.

1. *Mange.*—Dogs are subject to the mange from being fed too high, and allowed no exercise or an opportunity of refreshing themselves with dog-grass; or by being starved at home, which will cause them to eat the vilest stuff abroad, such as carrion, or even human excrement; or by want of water, and sometimes by not being kept clean in their kennel, or by foundering and melting in their grease. Either of these will heat the blood to a great degree, which will have a tendency to make them mangy. The cure may be effected by giving stone brimstone powdered fine, either in milk or mixed up with butter, and rubbing them well every day for a week with an ointment made of some of the brimstone and pork lard, to which add a small quantity of oil of turpentine. Or, boil four ounces of quicksilver in two quarts of water to half the quantity; bathe them every day with this water, and let them have some of it to lick till the cure is perfected. Or, a small quantity of trooper's ointment rubbed on the parts on its first appearance will cure it. It will also free lousy puppies from their lice. Or, take two ounces of euphorbium; flour of sulphur, Flanders oil of bays, and soft soap, each four ounces. Anoint and rub your dog with it every other day; give him warm milk, and no water. The cure will be performed in about a week. The following receipt is also said to be efficacious. Take two handfuls of wild cresses, and as much elecampane, and also of the leaves and roots of roerb and sorrel, and two pounds of the roots of fodrels: boil all these well together in lye and vinegar; strain the decoction, and put into it two pounds of gray soap, and when it is melted, rub the dog with it four or five days successively, and it will cure him.

3. *Poison.*—If you suspect your dog to be poisoned with

Dog. Sports. Dict.

with nux vomica (the poison usually employed by the warreners, which causes convulsive fits and soon kills), the most effectual remedy, if immediately applied, is to give him a good deal of common salt; to administer which, you may open his mouth, and put a stick across to prevent the shutting it, whilst you cram his throat full of salt, at the same time holding his mouth upwards; and it will dissolve so that a sufficient quantity will be swallowed to purge and vomit him. When his stomach is sufficiently cleared by a free passage obtained by stool, give him some warm broth frequently, to prevent his expiring from faintness; and he will recover.

4. *Worms.*—Dogs are very frequently troubled with worms; but more particularly whilst they are young. Any thing bitter is so nauseous to these worms, that they are very often voided by taking two or three purges of aloes; or (which is the same thing) Scots pills, four or five being a dose for a large dog: this is to be repeated two or three times in a week. If this do not succeed, you may give him an ounce of powder of tin mixed up with butter, in three doses; which seldom fails to cure. Or, of the herb savin, dried and rubbed to powder, give about as much as will lie on a shilling for a dose; which will entirely destroy worms and their seed.

5. *Sore Feet.*—A pointer ought not to be hunted oftener than two or three days in a week; and unless you take care of his feet, and give him good lodging as well as proper food, he will not be able to perform that through the season. You should therefore, after a hard day's hunting, wash his feet with warm water and salt; and when dry, wash them with warm broth, or beer and butter, which will heal their soreness, and prevent a settled stiffness from fixing.

6. *Strains, Blows,* or *Small Wounds.*—If your dog has received any little wounds by forcing through hedges, or gets any lameness from a blow or strain; bathe the wound or grieved part with salt and cold vinegar (for warming it only evaporates the fine spirit); and when dry, if a wound, you may pour in it a little friar's balsam, which will perform the cure sooner than any method hitherto experienced.

7. *Coughs and Colds.*—Dogs are very subject to a cough, with an extraordinary choking, which is thought to arise generally from a cold or some inward disorder; and probably it is often occasioned by their eating of fish bones. To guard against it, order your servants to throw all such fish bones where the dogs cannot get at them. But if the disorder be from a cold, let bleeding be repeated in small quantities if necessary; but if it be what is called the *distemper* in dogs, and they appear to be very low in spirits, the bleeding is better omitted. Let meat broth, or milk broth warmed, be the principal part of his diet, using at the same time the following medicine. Take flour of sulphur, cold drawn linseed oil, and saltpetre, of each an ounce; divide it into four doses, giving him one dose every other day, and let him have plenty of clean straw to lie on; or one spoonful of honey daily.

Dog-Madness.—Of this there are no less than seven sorts common among dogs. The chief causes are, high feeding, want of exercise, fulness of blood, and costiveness. As for the two first, you must observe when you hunt them, that they should be better fed than when they rest; and let them be neither too fat nor too lean; but, of the two, rather fat than lean; by which means they will not only be preserved from madness, but also from the mange and scab: which diseases they will be subject to for want of air, water, or exercise: but if you have but the knowledge to keep them in an even temper, they may live long and continue sound. As for water, they should be left to their own pleasure; but for exercise and diet, it must be ordered according to discretion, observing a medium. Give them once a-week, especially in the heat of the year, five or six spoonfuls of salad oil, which will cleanse them: at other times, the quantity of a hazel nut of mithridate is an excellent thing to prevent diseases. It is also very good to bleed them under the tongue, and behind the ears.

Dog. Sports. Dict.

The symptoms of madness are many and easily discerned. When any dog separates himself contrary to his former use, becomes melancholy or droops his head, forbears eating, and as he runs snatches at every thing; if he often looks upwards, and his stern at his setting on be a little erect, and the rest hanging down; if his eyes be red, his breath strong, his voice hoarse, and he drivels and foams at the mouth; you may be assured he has this distemper.

The seven sorts of madness are as follows; of which the two first are incurable. 1. The hot burning madness. 2. The running madness. The animals labouring under these are peculiarly dangerous; for all things they bite and draw blood from will have the same distemper; and they generally seize on all they meet with, but chiefly on dogs. Their pain is so great it soon kills them.—The five curable madnesses are,

3. *Sleeping Madness,* so called from the dog's great drowsiness, and almost continual sleeping. This is caused by the little worms that breed in the mouth of the stomach, from corrupt humours, vapours, and fumes which ascend to the head; for cure of which, take six ounces of the juice of wormwood, two ounces of the powder of hartshorn burnt, and two drams of agaric; mix all these together in a little white wine, and give it the dog to drink in a drenching horn.

4. *Dumb Madness,* lies also in the blood, and causes the dog not to feed, but to hold his mouth always wide open, frequently putting his feet to his mouth, as if he had a bone in his throat; to cure this, take the juice of black hellebore, the juice of *spatula putrida*, and of rue, of each four ounces; strain them well, and put thereto two drachms of unprepared scammony, and being mixed well together, put it down the dog's throat with a drenching horn, keeping his head up for some time, lest he cast it out again; then bleed him in the mouth, by cutting two or three veins in his gums.

It is said, that about eight drachms of the juice of an herb called *hartshorn* or *dog's tooth*, being given to the dog, cures all sorts of madness.

5. *Lank Madness,* is so called by reason of the dog's leanness and pining away. For cure, give them a purge as before directed, and also bleed them; but some say there is no cure for it.

6. *Rheumatic* or *slavering madness,* occasions the dog's head to swell, his eyes to look yellow, and he will be always slavering and drivelling at the mouth. To cure which, take four ounces of the powder of the roots of polipody of the oak, six ounces of the juice of fennel

roots, with the like quantity of the roots of misletoe, and four ounces of the juice of ivy; boil all these together in white wine, and give it to the dog as hot as he can take it, in a drenching horn.

7. *Falling madness*, is so termed because it lies in the dog's head, and makes him reel as he goes, and to fall down. For the cure, take four ounces of the juice of bryony, and the same quantity of the juice of peony, with four drachms of stavesacre pulverized; mix these together, and give it the dog in a drenching horn; also let him blood in the ears, and in the two veins that come down his shoulders; and indeed bleeding is necessary for all sorts of madness in dogs.

When a dog happens to be bit by a mad one, there is nothing better than their licking the place with their own tongues, if they can reach it; if not, then let it be washed with butter and vinegar, made lukewarm, and let it afterwards be anointed with Venice turpentine; but, above all, take the juice of the stalks of strong tobacco boiled in water, and bathe the place therewith; also wash him in sea water, or water artificially made salt; give him likewise a little mithridate inwardly in two or three spoonfuls of sack; and so keep him apart; and if you find him after some time still to droop, the best way is to hang him.

Some have asserted their having cured several creatures that have been bit by mad dogs, with only giving them the middle yellow bark of buckthorn; which must be boiled in ale for a horse or cow, and in milk for a dog; but that it must be boiled till it is as bitter as you can take it.

As to the preventive of worming dogs, see WORMING.

Dog-Days. See CANICULA.

Dog-Fish. See SQUALUS, ICHTHYOLOGY *Index*.

Dogs-Bane. See APOCYNUM, BOTANY *Index*.

Dog-Wood-Tree. See PISCIDIA, BOTANY *Index*.

DOGE, the chief magistrate in the republic of Venice and Genoa.

The word properly signifies *duke*, being formed from the Latin *dux*; as *dogate*, and *dogado*, from *ducatus*, "duchy."

The dogate, or office and dignity of doge, is elective; at Venice the doge is elected for life; at Genoa, only for two years. He is addressed under the title of *Serenity*, which among the Venetians is superior to that of highness.

The doge is the chief of the council, and the mouth of the republic; yet the Venetians do not go into mourning at his death, as not being their sovereign, but only their first minister. In effect, the doge of Venice is no more than the phantom or shadow of the majesty of a prince; all the authority being reserved to the republic. He only lends his name to the senate; the power is diffused throughout the whole body, though the answers be all made in the name of the doge. If he gives any answers on his own account, they must be very cautiously expressed, and in general terms, otherwise he is sure to meet with a reprimand. So that it is absolutely necessary he be of an easy and pliable disposition.

Anciently the doges were sovereigns; but things are much altered; and at present, all the prerogatives reserved to the quality of doge, are these which follow: He gives audience to ambassadors; but does not give them any answer from himself, in matters of any importance; only he is allowed to answer according to his own pleasure, to the compliments they make to the signory; such answers being of no consequence. The doge, as being first magistrate, is head of all the councils; and the credentials which the senate furnishes its ministers in foreign courts, are written in his name: and yet he does not sign them; but a secretary of state signs them, and seals them with the arms of the republic. The ambassadors direct their dispatches to the doge, and yet he may not open them but in presence of the counsellors. The money is struck in the doge's name, but not with his stamp or arms. All the magistrates rise, and salute the doge when he comes into council; and the doge rises to none but foreign ambassadors.

The doge nominates to all the benefices in the church of St Mark; he is protector of the monastery delle Virgine; and bestows certain petty offices of ushers of the household, called *Commanders of the Palace*. His family is not under the jurisdiction of the master of the ceremonies; and his children may have staff officers, and gondoliers in livery.

His grandeur, at the same time, is tempered with a variety of circumstances, which render it burdensome. He may not go out of Venice without leave of the council; and if he does go out, he is liable to receive affronts, without being entitled to demand satisfaction; and, if any disorder should happen where he was, it belongs not to him, but to the podesta, as being invested with the public authority, to compose it.

The children and brothers of the doge are excluded from all the chief offices of state. They may not receive any benefice from the court of Rome; but are allowed to accept of the cardinalate, as being no benefice, nor including any jurisdiction. The doge may not divest himself of his dignity, for his ease; and after his death, his conduct is examined by three inquisitors, and five correctors, who sift it with great severity.

DOGGER, a Dutch fishing vessel navigated in the German ocean. It is generally employed in the herring fishery; being equipped with two masts, viz. a main-mast and a mizen-mast, and somewhat resembling a ketch. See the Plates at the article SHIP.

DOGGERS, in the English alum works, a name given by the workmen to a sort of stone found in the same mines with the true alum rock, and containing some alum, though not near so much as the right kind. The county of York, which abounds greatly with the true alum rock, affords also a very considerable quantity of these doggers; and in some places they approach so much to the nature of the true rock, that they are wrought to advantage.

DOGMA, a principal maxim, tenet, or settled opinion, particularly with regard to matters of faith and philosophy.

DOGMATICAL, something belonging to a doctrine or opinion. A dogmatical philosopher is one who asserts things positively; in opposition to a sceptic, who doubts of every thing.

DOGMATISTS, a sect of ancient physicians, of which Hippocrates was the first author. They are also called *logici*, "logicians," from their using the rules of logic in subjects of their profession. They laid down definitions and divisions; reducing diseases to certain genera, and those genera to species, and furnishing remedies for them all; supposing principles, drawing conclusions, and applying those principles and conclusions to particular diseases under consideration; in which sense, the dogmatists stand contradistinguished from empirics and methodists. They reject all medicinal virtues, that they think not reducible to manifest qualities; but Galen hath long ago observed of such men, that they must either deny plain matter of fact, or assign but very poor reasons and causes of many effects they pretend to explain.

DOLCE, Carlo, or Carlino, a celebrated history and portrait painter, was born at Florence in 1616, and was the disciple of Vignali. This great master was particularly fond of representing pious subjects, though he sometimes painted portraits; and his works are easily distinguished by the peculiar delicacy with which he perfected all his compositions, by a pleasing tint of colour, and by a judicious management of the chiaro scuro. His performance was remarkably slow; and it is reported that his brain was fatally affected by seeing Luca Jordana despatch more business in four or five hours than he could have done in as many months. He died in 1686.

DOLE, in the Saxon and British tongue, signified a part or portion, most commonly of a meadow where several persons have shares. It also still signifies a distribution or dealing of alms, or a liberal gift made by a great man to the people.

Dole, in *Scots Law*, signifies a malevolent intention. It is essential in every crime, that it be committed intentionally, or by an act of the will: hence the rule, *Crimen dolo contrahitur.*

DOLICHOS, a genus of plants belonging to the diadelphia class, and in the natural method ranking under the 32d order, *Papilionaceæ*. See Botany *Index*.

DOLLAR, or Daller, a silver coin nearly of the value of the Spanish piece of eight, or French crown. Dollars are coined in different parts of Germany and Holland; and have their diminutions, as semi-dollars, quarter-dollars, &c. See *Money Table*.

DOLLOND, John, a late eminent optician. See Supplement.

DOLOMIEU, D. G. S. T. a late eminent French mineralogist and geologist. See Supplement.

DOLPHIN. See Delphinus, Cetology *Index*.

Dolphin of the Mast, a peculiar kind of wreath, fomed of plaited cordage, to be fastened occasionally round the masts, as a support to the puddening, whose use is to sustain the weight of the fore and main yards, in case the rigging or chains by which those yards are suspended should be shot away in the time of battle; a circumstance which might render their sails useless at a season when their assistance is extremely necessary. See the article Puddening.

DOM, or Don, a title of honour invented and chiefly used by the Spaniards, signifying *sir* or *lord*.

This title, it seems, was first given to Pelayo, in the beginning of the eighth century. In Portugal no person can assume the title of *don* without the permission of the king, since it is looked upon as a mark of honour and nobility. In France it is sometimes used among the religious. It is an abridgement of *domnus*, from *dominus*.

Dom and Som, in old charters, signifies full property and jurisdiction.

DOMAIN, the inheritance, estate, or possession of any one. See Demesne.

DOMAR, John, a celebrated French lawyer, born in 1625, who observing the confused state of the laws, digested them in 4 vols 4to, under the title of The Civil Laws in their natural order: for which undertaking, Louis XIV. settled on him a pension of 2000 livres. Domar was intimate with the famous Pascal, who left him his private papers at his death: he himself died in 1696.

DOME, in *Architecture*, a spherical roof, or a roof of a spherical form, raised over the middle of a building, as a church, hall, pavilion, vestibule, staircase, &c. by way of crowning.

Dome, in *Chemistry*, the upper part of furnaces, particularly portable ones. It has the figure of a hollow hemisphere or small dome. Its use is to form a space in the upper part of the furnace, the air of which is continually expelled by the fire: hence the current of air is considerably increased, which is obliged to enter by the ash-hole, and to pass through the fire, to supply the place of the air driven from the dome. The form of this piece renders it proper to reflect or reverberate a part of the flame upon the matters which are in the furnace, which has occasioned this kind of furnace to be called a *reverberating* one. See Furnace.

Dome, or *Doom*, signifies judgment, sentence, or decree. The homagers oath in the black book of Hereford ends thus: "So help me God at his holy dome, and by my trowthe."

DOMENICHINO, a famous Italian painter, born of a good family at Bologna in 1581. He was at first a disciple of Calvart the Fleming, but soon quitted his school for that of the Caraccis. He always applied himself to his work with much study and thoughtfulness; and never offered to touch his pencil but when he found a proper kind of enthusiasm upon him. His great skill in architecture also procured him the appointment of chief architect of the apostolical palace from Pope Gregory XV.; nor was he without a theoretical knowledge in music. He died in 1641.

DOMESDAY, or Doomsday Book, a most ancient record, made in the time of William I. surnamed the *Conqueror*, and containing a survey of all the lands of England. It consists of two volumes, a greater and a less. The first is a large folio, written on 382 double pages of vellum, in a small but plain character; each page having a double column. Some of the capital letters and principal passages are touched with red ink; and some have strokes of red ink run across them, as if scratched out. This volume contains the description of 31 counties. The other volume is in quarto, written upon 450 double pages of vellum, but in a single column, and in a large but very fair character. It contains the counties of Essex, Norfolk, Suffolk, part of the county of Rutland, included in that of Northampton, and part of Lancashire in the counties of York and Chester.

This work, according to the red book in the exchequer, was begun by order of William the Conqueror, with the advice of his parliament, in the year of our Lord 1080, and completed in the year 1086. The reason given for taking this survey, as assigned by several ancient records and historians, was, that very man should be satisfied with his own right, and not usurp with impunity what belonged to another. But, besides this, it is said by others, that now all those who possessed landed estates became vassals to the king, and paid him so much money by way of fee or homage in proportion to the lands they held. This appears very probable, as there was at that time extant a general survey of the whole kingdom, made by order of King Alfred.

For the execution of the survey recorded in domesday book, commissioners were sent into every county and shire; and juries summoned in each hundred, out of all orders of freemen, from barons down to the lowest farmers. These commissioners were to be informed by the inhabitants, upon oath, of the name of each manor, and that of its owner; also by whom it was held in the time of Edward the Confessor; the number of hides; the quantity of wood, of pasture, and of meadow land; how many ploughs were in the demesne, and how many in the tenanted part of it; how many mills; how many fish-ponds or fisheries belonged to it; with the value of the whole together in the time of King Edward, as well as when granted by King William, and at the time of this survey; also whether it was capable of improvement or of being advanced in its value; they were likewise directed to return the tenants of every degree, the quantity of lands then and formerly held by each of them, what was the number of villains or slaves, and also the number and kinds of their cattle and live stock. These inquisitions being first methodized in the county, were afterwards sent up to the king's exchequer.

This survey, at the time it was made, gave great offence to the people; and occasioned a jealousy that it was intended for some new imposition. But notwithstanding all the precaution taken by the conqueror to have this survey faithfully and impartially executed, it appears from indisputable authority, that a false return was given in by some of the commissioners: and that, as it is said, out of a pious motive. This was particularly the case with the abbey of Croyland in Lincolnshire, the possessions of which were greatly underrated both with regard to quantity and value. Perhaps more of these pious frauds were discovered, as it is said Ralph Flambard, minister to William Rufus, proposed the making a fresh and more rigorous inquisition; but this was never executed.

Notwithstanding this proof of its falsehood in some instances, which must throw a suspicion on all others, the authority of domesday book was never permitted to be called in question; and always, when it hath been necessary to distinguish whether lands were held in ancient demesne, or in any other manner, recourse was had to domesday book, and to that only, to determine the doubt. From this definitive authority, from which, as from the sentence pronounced at *domesday* or the day of judgment, there could be no appeal, the name of the book is said to have been derived. But Stowe assigns another reason for this appellation; namely, that domesday book is a corruption of *domus Dei book*; a title given it because heretofore deposited in the king's treasury, in a place of the church of Westminster or Winchester, called *domus Dei*. From the great care formerly taken for the preservation of this survey, we may learn the estimation in which its importance was held. The dialogue de Sacrariis says, "*Liber ille* (domesday) *sigilli regis comes est individuus in thesauro*." Until lately it has been kept under three different locks and keys; one in custody of the treasurer, and the others in that of the two chamberlains of the exchequer. It is now deposited in the chapterhouse at Westminster, where it may be consulted on paying to the proper officers a fee of 6s. 8d. for a search, and fourpence per line for a transcript.

Besides the two volumes above mentioned, there is also a third made by order of the same king; and which differs from the others in form more than matter. There is also a fourth called *domesday*, which is kept in the exchequer; which, though a very large volume, is only an abridgement of the others. In the remembrancers office in the exchequer is kept a fifth book, likewise called *domesday*, which is the same with the fourth book already mentioned. King Alfred had a roll which he called *domesday*; and the domesday book made by William the Conqueror referred to the time of Edward the Confessor, as that of King Alfred did to the time of Ethelred. The fourth book of domesday having many pictures and gilt letters in the beginning relating to the time of King Edward the Confessor, this had led some into a false opinion that domesday book was composed in the reign of King Edward.

DOMESTIC, any man who acts under another, serving to compose his family; in which he lives, or is supposed to live, as a chaplain, secretary, &c. Sometimes domestics is applied to the wife and children; but very seldom to servants, such as footmen, lacquies, porters, &c.

Domestic, *adj.* is sometimes opposed to foreign. Thus "*domestic* occurrences" signify those events which happen in our own country, in contradistinction to those of which we receive intelligence from abroad.

In its more usual acceptation, the term implies something peculiar to *home* or *household*. Thus we speak of *domestic* happiness or pleasures: meaning the pleasures enjoyed in the bosom of one's family; in opposition to those found in the bustle of public life, or delusively sought in the haunts of dissipation.

The solace of domestic enjoyment has been coveted by the wisest and greatest of men. Senators and heroes have shut out the acclamations of an applauding world, to enjoy the prattling of their little ones, and to partake the endearments of family conversation. They knew that even their best friends, in the common intercourse of life, were in some degree actuated by interested motives in displaying their affection; that many of their followers applauded them in hopes of reward; and that the giddy multitude, however zealous, were not always judicious in their approbation. But the attentions paid them at their fire side, the smiles which exhilarated

exhilarated their own table, were the genuine result of undissembled love.

Knox's Essays, N° 43.

To pursue the observations of an elegant essayist: "The nursery has often alleviated the fatigues of the bar and the senate-house. Nothing contributes more to raise the gently pleasing emotions, than the view of infant innocence, enjoying the raptures of a game at play. All the sentiments of uncontrouled nature display themselves to the view, and furnish matter for agreeable reflection to the mind of the philosophical observer. To partake with children in their little pleasures, is by no means unmanly. It is one of the purest sources of mirth. It has an influence in amending the heart, which necessarily takes a tincture from the company that surrounds us. Innocence as well as guilt is communicated and increased by the contagion of example. And the great Author of evangelical philosophy has taught us to emulate the simplicity of the infantine age. He seems indeed himself to have been delighted with young children, and found in them, what he in vain sought among those who judged themselves their superiors, unpolluted purity of heart.

"Among the great variety of pictures which the vivid imagination of Homer has displayed throughout the Iliad, there is not one more pleasing than the family piece, which represents the parting interview between Hector and Andromache. It deeply interests the heart, while it delights the imagination. The hero ceases to be terrible, that he may become amiable. We admire him while he stands completely armed in the field of battle; but we love him more while he is taking off his helmet, that he may not frighten his little boy with its nodding plumes. We are refreshed with the tender scene of domestic love, while all around breathes rage and discord. We are pleased to see the arm, which is shortly to deal death and destruction among an host of foes, employed in caressing an infant son with the embraces of paternal love. A professed critic would attribute the pleasing effect entirely to contrast; but the heart has declared, previously to the inquiries of criticism, that it is chiefly derived from the satisfaction which we naturally take in beholding great characters engaged in tender and amiable employments.

"But after all that is said of the purity and the solidity of domestic pleasures, they unfortunately appear to a great part of mankind, insipid, unmanly, and capable of satisfying none but the weak, the spiritless, the inexperienced, and the effeminate. The pretenders to wit and modern philosophy are often found to renounce the received opinions of prudential conduct; and, while they affect a superior liberality, to regulate their lives by the most selfish principles. Whatever appears to have little tendency to promote personal pleasure and advantage, they leave to be performed by those simple individuals, who are dull enough, as they say, to pursue the journey of life by the straight road of common sense. It is true, they will allow, that the world must be replenished by a perpetual succession; and it is no less true, that an offspring, once introduced into the world, requires all the care of painful attention. But let the task be reserved for meaner spirits. If the passions can be gratified without the painful consequences of supporting a family, they eagerly seize the indulgence. But the toil of education they leave to those whom they deem fools enough to take a pleasure in it. There will always be a sufficient number, say they, whose folly will lead them, for the sake of a silly passion called virtuous love, to engage in a life of perpetual anxiety. The fool's paradise, they add with derision, will never be deserted.

"Presumptuous as are all such pretenders to newly invented systems of life and conduct, it is not to be supposed they will think themselves superior to Cicero. Yet Cicero, with all his liberality of mind, felt the tenderness of conjugal and parental attachment, and acknowledged that, at one time, he received no satisfaction in any company but that of his wife, his little daughter, and, to use his own epithet, his HONIED young Cicero. The great Sir Thomas More, whom nobody will suspect of narrowness of mind, who by a very singular treatise evinced that he was capable of thinking and of choosing for himself, has left it on record that he devoted a great share of his time, from the united motives of duty and delight, to the amusement of his children.

"It will be objected by those who pretend to have formed their ideas of life from actual observation, that domestic happiness, however pleasing in description, like many a poetic dream, is but an alluring picture, designed by a good heart, and painted in glowing colours by a lively fancy. The constant company, they urge, even of those we love, occasions an insipidity. Insipidity grows into disgust. Disgust, long continued, sours the temper. Peevishness is the natural consequence. The domestic circle becomes the scene of dispute. Mutual antipathy is ingenious in devising mutual torment. Sullen silence or malignant remarks fill up every hour, till the arrival of a stranger causes a temporary restraint, and excites that good humour which ought to be displayed among those whom the bonds of affection and blood have already united.

"Experience, indeed, proves that these remarks are sometimes verified. But that there is much domestic misery is no argument that there is no domestic happiness, or that the evil may not be removed. Natural stupidity, natural ill temper, acquired ill habits, want of education, illiberal manners, and a neglect of the common rules of discretion, will render every species of intercourse disagreeable. When those are united by connubial ties who were separated by natural and inherent diversity, no wonder if that degree of happiness which can only result from a proper union, is unknown. In the forced alliance, which the poet of Venusium mentions, of the serpent with the dove, of the tyger with the lamb, there can be no love. When we expatiate on the happiness of the domestic group, we presuppose that all who compose it are originally assimilated by affection, and are still kept in union by discreet friendship. When this is not the case, the censure must fall on the discordant disposition of the parties, and not on the essential nature of family intercourse.

"To form, under the direction of prudence, and by the impulse of virtuous love, an early conjugal attachment, is one of the best securities of virtue, as well as the most probable means of happiness. The duties, which are powerfully called forth by the relations of husband

husband and father, are of that tender kind which inspires goodness and humanity. He who beholds a woman whom he loves, and a helpless infant, looking up to him for support, will not easily be induced to indulge in unbecoming extravagance, or devote himself to indolence. He who has a rising family to introduce into a vicious world, will be cautious of setting a bad example, the contagion of which, when it proceeds from parental authority, must be irresistibly malignant. Thus many who, in their individual and unconnected state, would probably have spent a life not only useless to others, but profligate and careless in itself, have become valuable members of the community, and have arrived at a degree of moral improvement, to which they would not otherwise have attained.

"The contempt in which domestic pleasures have in modern times been held, is a mark of profligacy. It is also a proof of a prevailing ignorance of real enjoyment. It argues a defect in taste and judgment as well as in morals. For the general voice of the experienced has in all ages declared, that the truest happiness is to be found at home."

DOMICILE, in *Scots Law*, is the dwelling place where a person lives with an intention to remain.

DOMIFYING, in *Astrology*, the dividing or distributing the heavens into 12 houses, in order to erect a theme, or horoscope, by means of six great circles, called *circles of position*.

There are various ways of domifying: that of Regiomontanus, which is the most common, makes the circles of position pass through the intersections of the meridian and the horizon: others make them pass through the poles of the zodiac.

DOMINANT (from the Latin word *dominari*, "to rule or govern"), among musicians, is used either as an adjective or substantive; but these different acceptations are far from being indiscriminate. In both senses it is explained by Rousseau as follows:

The *dominant* or sensible chord is that which is practised upon the dominant of the tone, and which introduces a perfect cadence. Every perfect major chord becomes a *dominant* chord, as soon as the seventh minor is added to it.

DOMINANT (*subst.*). Of the three notes essential to the tone, it is that which is a fifth from the tonick.—The tonick and the *dominant* fix the tone: in it they are each of them the fundamental sound of a particular chord; whereas the mediant, which constitutes the mode, has no chord peculiar to itself, and only makes a part of the chord of the tonick.

Mr Rameau gives the name of *dominant* in general to every note which carries a chord of the seventh, and distinguishes that which carries the sensible chord by the name of a *tonick dominant;* but, on account of the length of the word, this addition to the name has not been adopted by artists: they continue simply to call that note a *dominant* which is a fifth from the tonick; and they do not call the other notes which carry a chord of the seventh *dominants*, but *fundamentals;* which is sufficient to render their meaning plain, and prevents confusion.

A *dominant*, in that species of church music which is called *plain-chant*, is that note which is most frequently repeated or beaten, in whatever degree it may be from the tonick. In this species of music there are *dominants* and *tonicks*, but no mediant.

DOMINATION, or DOMINION, in *Theology*, the fourth order of angels or blessed spirits in the hierarchy, reckoning from the seraphim. See ANGEL.

DOMINGO, or ST DOMINGO, the capital of the island of Hispaniola in the West Indies, is seated in that part belonging to the Spaniards on the south side of the island, and has a commodious harbour. The town is built in the Spanish manner, with a great square in the middle of it; about which are the cathedral and other public buildings. From this square run the principal streets, in a direct line, they being crossed by others at right angles, so that the form of the town is almost square. The country on the north and east side is pleasant and fruitful; and there is a large navigable river on the west, with the ocean on the south. It is the see of an archbishop, an ancient royal audience, and the seat of the governor. It has several fine churches and monasteries; and is so well fortified, that a fleet and army sent by Oliver Cromwell in 1654 could not take it. The inhabitants are Spaniards, Negroes, Mulattoes, Mestices, and Albatraces; of whom about a sixth part may be Spaniards. From this town the whole island has generally been named St Domingo. See DOMINGO, ST, SUPPLEMENT. The river on which it is seated is called *Ozama*. W. Long. 69. 30. N. Lat. 18. 25.

DOMINIC DE GUSMAN, founder of the Dominican order of monks, was born at Calaroga in Old Castile, 1170. He preached with great fury against the Albigenses, when Pope Innocent III. made a croisade against that unhappy people; and was inquisitor in Languedoc, where he founded his order, and got it confirmed by the Lateran council in 1215. He died at Bologna in 1221, and was afterwards canonized. The Dominican order has produced many illustrious men. See DOMINICANS.

DOMINICA, one of the Caribbee islands, in the West Indies, about 29 miles long and 16 broad, situated between 61° and 62° W. Long. and between 15° and 16° of N. Lat. This island formerly belonged to the French, but was ceded to Britain by the treaty in 1763. It contains many fertile valleys interspersed among high and rugged mountains, some of which are volcanic. It abounds in forests, and has several hot springs. The value of its imports in 1809 was 161,291l. and of its imports 315,584l. The population in 1805 consisted of 1594 whites, 2822 free persons of colour, and 22,083 slaves.

This island was reduced, in the year 1778, by the French, under the marquis de Bouille, governor of Martinico. At that time the island, though very well fortified, had been unaccountably neglected by the British government, in such a manner as to be almost entirely destitute of a garrison. The French commander, therefore, who made a descent with 2000 men, found only 100 regular forces and a few companies of militia to oppose him. All resistance therefore being vain, the only thing the garrison could do was to procure as favourable terms of capitulation as possible. These were granted with such readiness as did great honour to the character of this officer; the inhabitants experiencing no kind of change except that of transferring their obedience from Britain to France, being left unmolested in the enjoyment of all their rights both civil and religious. The capitulation was strictly observed by the marquis; no plunder or irregularity being allowed, and a pecuniary gratification being distributed among the soldiers and volunteers who accompanied him in the expedition. An hundred and sixty-four pieces of excellent cannon, and twenty-four brass mortars, besides a large quantity of military stores, were found in the place; insomuch that the French themselves expressed their surprise at finding so few hands to make use of them. The marquis, however, took care to supply this defect, by leaving a garrison of 1500 of the best men he had with him. It was restored to Britain at the conclusion of the peace in 1783.

La Dominica, one of the MARQUESAS islands in the South sea.

DOMINICAL LETTER, popularly called *Sunday Letter*, one of the seven letters A B C D E F G, used in almanacks, ephemerides, &c. to denote the Sundays throughout the year. See CHRONOLOGY, N° 32. The word is formed from *dominica* or *dominicus dies*, "Lord's day, Sunday."

The dominical letters were introduced in the kalendar by the primitive Christians in lieu of the NUNDINAL letters in the Roman kalendar.

DOMINICAL, in church history. The council of Auxerre, held in 578, decrees, that women communicate with their dominical. Some authors contend, that this dominical was a linen cloth, wherein they received the species; as not being allowed to receive them in the bare hand. Others will have it a kind of veil, wherewith they covered the head. The most probable account is, that it was a sort of linen cloth or handkerchief wherein they received and preserved the eucharist in times of persecution, to be taken on occasion at home. This appears to have been the case by the practice of the first Christians, and by Tertullian's book *Ad Uxorem.*

DOMINICANS, an order of religious, called in some places *Jacobins;* and in others *Predicants* or *Preaching Friars.*

The Dominicans take their name from their founder Dominic de Guzman, a Spanish gentleman, born in 1170, at Calaroga in Old Castile. He was first canon and archdeacon of Ossuna; and afterwards preached with great zeal and vehemence against the Albigenses in Languedoc, where he laid the first foundation of his order. It was approved of in 1215 by Innocent III. and confirmed in 1216 by a bull of Honorius III. under the title of *St Augustine;* to which Dominic added several austere precepts and observances, obliging the brethren to take a vow of absolute poverty, and to abandon entirely all their revenues and possessions; and also the title of *Preaching Friars*, beause public instruction was the main end of their institution.

The first convent was founded at Thoulouse by the bishop thereof and Simon de Montfort. Two years afterwards they had another at Paris, near the bishop's house; and some time after a third in the rue St Jacques, (St James's street), whence the denomination of *Jacobins.*

Just before his death, Dominic sent Gilbert de Fresney, with twelve of the brethren, into England, where they founded their first monastery at Oxford in the year 1221, and soon after another at London. In the year 1276 the mayor and aldermen of the city of London gave them two whole streets by the river Thames, where they erected a very commodious convent, whence that place is still called *Black Friars*, from the name by which the Dominicans were called in England.

St Dominic, at first, only took the habit of the regular canons; that is, a black cassock and rochet: but this he quitted in 1219, for that which they now wear, which it is pretended was shown by the blessed Virgin herself to the beatified Renaud d'Orleans.

This order is diffused throughout the whole known world. It has forty-five provinces under the general, who resides at Rome; and 12 particular congregations or reforms, governed by 12 vicars general.

They reckon three popes of this order, above sixty cardinals, several patriarchs, a hundred and fifty archbishops, and about eight hundred bishops; beside masters of the sacred palace, whose office has been constantly discharged by a religious of this order, ever since St Dominic, who held it under Honorius III. in 1218.

Of all the monastic orders, none enjoyed a higher degree of power and authority than the Dominican friars, whose credit was great, and their influence universal. But the measures they used in order to maintain and extend their authority were so perfidious and cruel, that their influence began to decline towards the beginning of the sixteenth century. The tragic story of Jetzer, conducted at Bern in 1509, for determining an uninteresting dispute between them and the Franciscans, relating to the *immaculate conception*, will reflect indelible infamy on this order. See an account of it in Burnet's Travels through France, Italy, Germany, and Switzerland, p. 31. or Mosheim's Eccl. Hist. vol. iii. p. 294. 8vo. They were indeed perpetually employed in stigmatizing with the opprobrious name of heresy numbers of learned and pious men; in encroaching upon the rights and properties of others, to augment their possessions; and in laying the most iniquitous snares and stratagems for the destruction of their adversaries. They were the principal counsellors, by whose instigation and advice Leo X. was determined to the public condemnation of Luther. The papal see never had more active and useful abettors than this order, and that of the Jesuits.

The dogmata of the Dominicans are usually opposite to those of the Franciscans.

There are also nuns or sisters of this order, called in some places *Preaching Sisters.* These are even more ancient than the friars; St Dominic having founded a society of religious maids at Prouilles some years before the institution of his order of men; viz. in 1206.

There is also a third order of Dominicans, both for men and women.

DOMINION, (*Dominium*) in the civil law, signifies the power to use or dispose of a thing as we please.

DOMINION, or *Domination.* See DOMINATION.

DOMINIS, MARK ANTONY DE, archbishop of Spalatro in Dalmatia at the close of the 15th and beginning of the 16th centuries, was a man whose fickleness in religion proved his ruin. His preferment, instead of of attaching him to the church of Rome, rendered him disaffected to it. Becoming acquainted with our Bishop Bedell, while chaplain to Sir Henry Wotton, ambassador from James I. at Venice, he communicated his books *De Republica Ecclesiastica* to him; which were afterwards published at London, with Bedell's corrections. He came to England with Bedell; where he was received with great respect, and preached and wrote against the Romish religion. He is said to have had a principal hand in publishing Father Paul's *History of the Council of Trent*, at London, which was inscribed to James in 1619. But on the promotion of Pope Gregory XIV. who had been his schoolfellow and old acquaintance, he was deluded by Gondomar the Spanish ambassador into the hopes of procuring a cardinal's hat, by which he fancied he should prove an instrument of great reformation to the church. Accordingly he returned to Rome in 1622, recanted his errors, and was at first well received; but he afterwards wrote letters to England, repenting his recantation; which being intercepted, he was imprisoned by Pope Urban VIII. and died in 1625. He was also the author of the first philosophical explanation of the rainbow, which before his time was regarded as a prodigy.

DOMINIUM EMINENS, in *Scots Law*, that power which the state or sovereign has over private property, and by which the proprietor may be compelled to sell it for an adequate price where public utility requires. See LAW *Index*.

DOMINIUM Directum, in *Scots Law*, the right which a superior retains in his lands, notwithstanding the feudal grant to his vassal. See LAW *Index*.

DOMINIUM Utile, in *Scots Law*, the right which the vassal acquires in the lands by the feudal grant from his superior. See LAW *Index*.

DOMINUS, in ancient times, a title prefixed to a name, usually to denote the person either a knight or a clergyman. See *VICE Dominus*.

The title was sometimes also given to a gentleman not dubbed; especially if he were lord of a manor. See DOM, GENTLEMAN, and SIRE.

In Holland the title *dominus* is still retained, to distinguish a minister of the reformed church.

DOMITIAN, the Roman emperor, son to Vespasian, was the last of the 12 Cæsars. See (*History of*) ROME.

DON, or TANAIS, a river of Russia, which takes its rise from the small lake of St John, near Tula, in the government of Moscow, and passing through part of the province of Voronetz, a small portion of the Ukraina-Slobodskaia, and the whole province of Azof, divides itself near Tcherkask into three streams, and falls in these separate branches into the sea of Azof. This river has so many windings, is in many parts so shallow, and abounds with such numerous shoals, as to be scarcely navigable, excepting in the spring, upon the melting of the snows; and its mouth is also so choked up with sand, that only flat-bottomed vessels, excepting in the same season, can pass into the sea of Azof. The banks of the Don, and the rivulets which fall into it, are clothed with large tracts of forest, whose timber is floated down the stream to St Demetri and Rostof, where the frigates for the sea of Azof are chiefly constructed. The navigation of the Don, Mr Coxe observes, may possibly hereafter be rendered highly valuable, by conveying to the Black sea, the iron of Siberia, the Chinese goods, and the Persian merchandise: which latter commodities, as well as the products of India, formerly found their way into Europe through this same channel.

DON is also the name of a river in Scotland, noticed under the article ABERDEEN; the Old Town being situated near its mouth. See ABERDEEN.

DON Martin de Mayorca, the name given by the Spaniards to a cluster of islands in the South sea, which were discovered in 1781 by Don F. A. Maurelle. According to the description given of these islands, they abound with tropical fruits and roots, are in a tolerable state of cultivation, and the inhabitants have made some progress in civilization. Their government, manners, and dress, resemble in most points those of the natives of the other South sea islands. In thieving, whether in disposition or dexterity, they seemed inferior to none. In one of these islands Don Maurelle found a good harbour, which he places in 18. 36. S. Lat. and in 177. 48. W. Long.

DONARIA, among the ancients, in its primary signification, was taken for the places where the oblations offered to the gods were kept: but afterwards was used to denote the offerings themselves; and sometimes, though improperly, the temples.

DONATIA, a genus of plants belonging to the triandria class. See BOTANY *Index*.

DONATION, (*Donatio*), an act or contract whereby a man transfers to another either the property or the use of the whole or a part of his effects as a free gift.

A donation, to be valid and complete, supposes a capacity both in the donor and the donee; and requires consent, acceptance, and delivery; and by the French law registry also.

DONATION Mortis Causa, in *Law*, a disposition of property made by a person in his last sickness, who apprehending his dissolution near, delivers, or causes to be delivered to another, the possession of any personal goods, to keep in case of his decease. If the donor dies, this gift needs not the consent of his executor; but it shall not prevail against creditors; and it is accompanied with this implied trust, that, if the donor lives, the property shall revert to himself, being only given in prospect of death, or *mortis causa*. This method of donation seems to have been conveyed to us from the civil lawyers, who borrowed it from the Greeks.

DONATISTS, ancient schismatics in Africa, so denominated from their leader Donatus.

This sect arose in the year 311, when, in the room of Mensurius, who died in that year on his return to Rome, Cæcilian was elected bishop of Carthage, and consecrated by the African bishops alone, without the concurrence of those of Numidia. The people refused to acknowledge him, and set up Majorinus in opposition; who, accordingly, was ordained by Donatus bishop of Casæ Nigræ. The Donatists were condemned, in a council held at Rome, two years after their separation; and afterwards in another at Arles, the year following: and again at Milan, before Constantine the Great, in 316, who deprived them of their churches, sent their seditious bishops into banishment, and even punished some of them with death. Their cause was espoused by another Donatus, called the *great*, the principal bishop of that sect, who, with numbers of his followers, was exiled by order of Constans. Many of them were punished with great severity. See CIRCUMCELLIONES. However, after the accession of Julian to the throne in 362, they were permitted to return, and restored to their former liberty. Gratian published several edicts against them; and in 377 deprived them of their churches, and prohibited all their assemblies. But notwithstanding the severities they suffered, it appears that they had a very considerable number of churches towards the close of this century; but at this time they began to decline, on account of a schism among themselves, occasioned by the election of two bishops, in the room of Parmenian, the successor of Donatus; one party elected Primian, and were called *Primianists*, and another Maximian, and were called *Maximianists*. Their decline was also precipitated by the zealous opposition of St Augustine, and by the violent measures which were pursued against them, by order of the emperor Honorius, at the solicitation of two councils held at Carthage; the one in 404, and the other in 411. Many of them were fined, the bishops were banished, and some put to death. This sect revived and multiplied under the protection of the Vandals, who invaded Africa in 427, and took possession of this province: but it sunk again under new severities, when their empire was overturned in 534. Nevertheless, they remained in a separate body till the close of this century, when Gregory, the Roman pontiff, used various methods for suppressing them; his zeal succeeded, and there are few traces to be found of the Donatists after this period. They were distinguished by other appellations; as *Circumcelliones*, *Montenses* or *Mountaineers*, *Campites*, *Rupites*, &c. They held three councils, or conciliabules; one at Cirta in Numidia, and two at Carthage.

The errors of the Donatists, besides their schism, were, 1. That baptism conferred out of the church, that is, out of their sect, was null; and accordingly they rebaptized those who joined their party from other churches, and re-ordained their ministers. 2. That theirs was the only true, pure, and holy church; all the rest of the churches they held as prostitute and fallen.

Donatus seems likewise to have given into the doctrine of the Arians, with whom he was closely allied; and accordingly, St Epiphanius, Theodoret, and some others, accused the Donatists of Arianism; and it is probable that the charge was well founded, because they were patronized by the Vandals, who held that doctrine. But St Augustine, Ep. 185. to Count Boniface, & Haer. 69. affirms, that the Donatists, in this point, kept clear of the errors of their leader.

DONATIVE, *(Donativum)*, a present made by any person; called also *gratuity*.

The Romans made large donatives to their soldiers. Julia Pia, wife of the emperor Severus, is called on certain medals *mater castrorum*, because of the care she took of the soldiery, by interposing for the augmentation of their donatives, &c.

Donative was properly a gift made to the soldiery; as congiarium was that made to the people. Salmasius, on his notes to Lampridius, in his Life of Heliogabalus, mentioning a donative that emperor gave of three pieces of gold per head, observes, that this was the common and legitimate rate of a donative. Casaubon, in his notes on the Life of Pertinax by Capitolinus, observes, that Pertinax made a promise of 3000 denarii to each soldier; which amounts to upwards of 97 pounds sterling. The same author writes, that the legal donative was 20,000 denarii; and that it was not customary to give less, especially to the prætorian soldiers; that the centurions had double, and the tribunes, &c. more in proportion.

DONATIVE, in the canon law, a benefice given, and collated to a person, by the founder or patron; without either presentation, institution, or induction by the ordinary.

If chapels founded by laymen be not approved by the diocesan, and, as it is called, *spiritualized*, they are not accounted proper benefices, neither can they be conferred by the bishop but remain to the pious disposition of the founders; so that the founders, and their heirs, may give such chapels without the bishop.

Gwin observes, that the king might of ancient time found a free chapel, and exempt it from the jurisdiction of the diocesan; so may he, by letters patent, give liberty to a common person to found such a chapel, and make it donative, not presentable; and the chaplain, or beneficiary, shall be deprivable by the founder or his heir, and not by the bishop. And this seems to be the original of donatives in England.

Donatives are within the statute against simony; and if they have cure of souls, within that against pluralities. If the patron of a donative doth not nominate a clerk, there can be no lapse thereof, unless it be specially provided for in the foundation; but the bishop may compel him to do it by spiritual censures. But if it be augmented by Queen Anne's bounty, it will lapse like other presentative livings. 1 Geo. I. stat. 2. cap. 10. The ordinary cannot visit a donative, and therefore it is free from procuration, and the incumbent is exempted from attendance at visitations.

All bishoprics in ancient times were donative by the king. Again, where a bishop has the gift of a benefice, it is properly called a *donative*, because he cannot present to himself.

DONATORY, in *Scots Law*, that person to whom the king bestows his right to any forfeiture that has fallen to the crown.

DONATUS, a schismatic bishop of Carthage, founder of the sect of DONATISTS. His followers honoured him like a god. He died about 368.

DONATUS, *Ælius*, a famous grammarian, lived at Rome in 354. He was one of St Jerome's masters; and composed commentaries on Terence and Virgil.

DONAWERT, a strong town of Germany. It is situated on the left bank of the Danube, at the influx of the Wernitz. It was formerly an imperial city, but is now subject to Bavaria. E. Long. 10. 32. N. Lat. 48. 32.

DONAX, a genus of shells belonging to the bivalves. See CONCHOLOGY *Index*.

DONCASTER, a market town of Yorkshire, 37 miles south of York. It has been long noted for the manufacture of stockings, knitted waistcoats and gloves. A theatre was erected here in 1795. It contained 6935 inhabitants in 1811. W. Long. 1. 12. N. Lat. 53. 33.

DONEGAL, a county in the north-west of Ireland, bounded by the sea on one side, and the counties of Tyrone and Londonderry on the other. Its greatest length is 90 miles, and breadth 45, and it contains 1,100,000 English acres. The climate is moist, and it abounds in bogs and mountains. Barley is the chief grain crop, but a great part of the agricultural labour is performed with the spade. See DONEGAL, SUPPLEMENT.

DONNE, Dr John, an excellent poet and divine of the 17th century. His parents were of the Romish religion, and used their utmost efforts to keep him firm to it; but his early examination of the controversy between the church of Rome and the Protestants, at last determined him to adhere to the latter. He travelled into Italy and Spain; where he made many useful observations, and learned their languages to perfection. Soon after his return to England, Sir Thomas Egerton, keeper of the great seal, appointed him his secretary; in which post he continued five years. He marrying privately Anne the daughter of Sir George Moore then chancellor of the garter, and niece to the lord keeper's lady, was dismissed from his place, and thrown into prison. But he was reconciled to Sir George by the good offices of Sir Francis Wolley. In 1612, he accompanied Sir Robert Drury to Paris. During this time, many of the nobility solicited the king for some secular employment for him. But his majesty, who took pleasure in his conversation, had engaged him in writing his *Pseudo Martyr*, printed at London in 1610; and he was so highly pleased with that work, that in 1614 he prevailed with him to enter into holy orders; appointed him one of his chaplains, and procured him the degree of doctor of divinity from the university of Oxford. In 1619, he attended the earl of Doncaster in his embassy into Germany. In 1621, he was made dean of St Paul's; and the vicarage of St Dunstan in the West, in London, soon after fell to him. He wrote, besides the above, 1. Devotions upon emergent occasions. 2. The ancient History of the Septuagint, translated from the Greek of Aristeus, quarto. 3. Three volumes of sermons, folio. 4. A considerable number of poems: and other works. His writings show him to be a man of incomparable wit and learning; but his greatest excellence was satire. He had a prodigious richness of fancy, but his thoughts were much debased by his versification.

DONOR, in *Law*, the person who gives lands or tenements to another in tail, &c.; as he to whom such lands, &c. are given, is the *donee*.

DOOMSDAY book. See DOMESDAY *Book*.

DOOR, in *Architecture*. See ARCHITECTURE, N° 76.

DOR, the English name of the common black beetle. Some apply it also to the dusty beetle, that flies about hedges in the evening. See SCARABÆUS, ENTOMOLOGY *Index*.

DORADO, in *Astronomy*, a southern constellation, not visible in our latitude; it is also called *xiphias*. The stars of this constellation, in Sharp's Catalogue, are six.

DORCHESTER, the capital of Dorsetshire, situated on the river Frome, on a Roman road, eight miles north of Weymouth. W. Long. 2. 45. N. Lat. 50. 40. It sends two members to parliament; and is a town of great antiquity. The inhabitants amounted to 2546 in 1811.

DOREE, or JOHN DOREE. See ZEUS, ICHTHYOLOGY *Index*.

DORIA, Andrew, a gallant Genoese sea officer, born in 1466. He entered into the service of Francis I. of France; but preserved that spirit of independence so natural to a sailor and a republican. When the French attempted to render Savona, long the object of jealousy of Genoa, its rival in trade, Doria remonstrated against the measure in a high tone; which bold action, represented by the malice of his courtiers in the most odious light, irritated Francis to that degree, that he ordered his admiral Barbesieux to sail to Genoa, then in the hands of the French troops, to arrest Doria, and to seize his galleys. This rash order Doria got timely hints of; retired with all his galleys to a place of safety; and, while his resentment was thus raised, he closed with the offers of the emperor Charles V. returned his commission with the collar of St Michael to Francis, and hoisted the Imperial colours. To deliver his country, weary alike of the French and Imperial yoke, from the dominion of foreigners, was now Doria's highest ambition; and the favourable moment offered. Genoa was afflicted with the pestilence, the French garrison was greatly reduced and ill paid, and the inhabitants were sufficiently disposed to second his views. He sailed to the harbour with 13 galleys, landed 500 men, and made himself master of the gates and the palace with very little resistance. The French governor with his feeble garrison retired to the citadel, but was quickly forced to capitulate; when the people ran together, and levelled the citadel with the ground. It was now in Doria's power to have rendered himself the sovereign of his country; but with a magnanimity of which there are few examples, he assembled the people in the court before the palace, disclaimed all pre-eminence, and recommended to them to settle that form of government they chose to establish. The people animated by his spirit, forgot their factions, and fixed that form of government which has subsisted ever since with little variation. This event happened in 1528. Doria lived to a great age, respected and beloved as a private citizen; and is still celebrated in Genoa by the most honourable of all appellations, "The father of his country, and the restorer of its liberty."

DORIC, in general, any thing belonging to the Dorians, an ancient people of Greece, inhabiting near Mount Parnassus. See DORIS.

Doric, in *Architecture*, is the second of the five orders; being that between the Tuscan and Ionic. It is usually placed upon the Attic base, though originally it had no base. See ARCHITECTURE, N° 43.

At its first invention it was more simple than at present; and when in after times it was more adorned and enriched, the appellation *Doric* was restrained to this richer manner, and the primitive simple manner was called by a new name, the Tuscan order, which was chiefly used in temples; as the former being more light and delicate, was for porticoes and theatres. The tradition is, that Dorus, king of Achaia, having first built a temple of this order at Argos, which he dedicated to Juno, occasioned it to be called *Doric;* though others derive its name from its being invented or used by the Dorians.

The moderns, on account of its solidity, use it in large strong buildings; as in the gates of cities and citadels, the outside of churches, and other massy works, where delicacy of ornament would be unsuitable. The gate of Burlington house in Piccadilly is of the Doric order.

Doric.

The most considerable ancient monuments of this order, are the theatre of Marcellus at Rome, wherein the capital, the height of the frize, and its projecture, are much smaller than in the modern architecture; and the Parthenion, or temple of Minerva at Athens, in which the short and massy columns bear upon the pavement without a base; and the capital is a simple torus, with its cincture, and a square, plain, and solid abacus.

Doric Cymatium. See CYMA.

Doric Dialect, one of the five dialects, or manners of speaking, which obtained among the Greeks.

It was first used by the Lacedæmonians, and particularly those of Argos; thence it passed into Epirus, Libya, Sicily, the islands of Rhodes and Crete. In this dialect, Archimedes and Theocritus wrote, who were both of Syracuse; as likewise Pindar.

In strictness, however, we should rather define Doric, the manner of speaking peculiar to the Dorians, after their recess near Parnassus and Asopus; and which afterwards came to obtain among the Lacedæmonians, &c. Some even distinguish between the Lacedæmonian and Doric; but in reality, they were the same; setting aside a few particularities in the language of the Lacedæmonians; as is shown by Rulandus, in his excellent treatise *De Lingua Græca ejusque Dialectis*, lib. v.

Beside the authors already mentioned to have written in the Doric dialect, we might add Archytas of Tarentum, Bion, Callinus, Simonides, Bacchylides, Cypselas, Alcman, and Sophron.

Most of the medals of the cities of Græcia Magna, and Sicily, savour of the Doric dialect in their inscription: witness, ΑΜΒΡΑΚΙΩΤΑΝ, ΑΠΟΛΛΩΝΙΑΤΑΝ, ΑΧΕΟΡΟΝΤΑΝ, ΑΧΥΡΙΤΑΝ, ΗΡΑΧΛΕΩΤΑΝ, ΤΡΑΧΙΝΙΩΝ, ΘΕΡΜΙΤΑΝ, ΚΑΥΛΟΝΙΑΤΑΝ, ΚΟΠΙΑΤΑΝ, ΤΑΥΡΟΜΕΝΙΤΑΝ, &c. Which shows the countries wherein the Doric dialect was used.

The general rules of this dialect are thus given by the Port Royalists.

D'ε Ητα *d'ω grand, d'ει d'ο et d'ου l'α fait le Dore.*
D'ευ fait ητα ; d'ου, ω ; et d'ω αν fait encore.
Oste ι de l'infini : et pour le singulier
Se sert au feminin du nombre plurier.

But they are much better explained in the fourth book of Rulandus; where he even notes the minuter differences of the dialects of Sicily, Crete, Tarentum, Rhodes, Lacedæmon, Laconia, Macedonia, and Thessaly.

The ω abounds everywhere in the Doric; but this dialect bears so near a conformity to the Æolic, that many reckon them but one.

Doric Mode, in *Music*, the first of the authentic modes of the ancients. Its character is to be severe, tempered with gravity and joy; and is proper upon religious occasions, as also to be used in war. It begins *D*, *la*, *sol*, *re*. Plato admires the music of the Doric mode, and judges it proper to preserve good manners as being masculine; and on this account allows it in his commonwealth. The ancients had likewise their subdoric or hypodoric mode, which was one of the plagal modes. Its character was to be very grave and solemn; it begins with *re*, a fourth lower than the Doric.

Doring, Doris.

DORING, or **DARING**, among sportsmen, a term used to express a method of taking larks, by means of a clap-net and a looking-glass. For this sport there must be provided four sticks very straight and light, about the bigness of a pike; two of these are to be four feet nine inches long, and all notched at the edges or the ends. At one end of each of these sticks there is to be fastened another of about a foot long on one side; and on the other side a small wooden peg about three inches long. Then four or more sticks are to be prepared, each of one foot length; and each of these must have a chord of nine feet long fastened to it at the end. Every one should have a buckle for the commodious fastening on to the respective sticks when the net is to be spread.—A cord must also be provided, which must have two branches. The one must be nine feet and a half, and the other ten feet long, with a buckle at the end of each; the rest, or body of the cord, must be 24 yards long. All these cords, as well the long ones as those about the sticks, must be well twisted and of the bigness of one's little finger. The next thing to be provided is a staff of four feet long, pointed at one end, and with a ball of wood at the other, for the carrying these conveniences in a sack or wallet.—There should also be carried on this occasion, a spade to level the ground where there may be any little irregularities; and two small rods, each eighteen inches long, and having a small rod fixed with a packthread at the larger end of the other. To these are to be tied some pack-thread loops, which are to fasten in the legs of some larks: and there are to be reels to these, that the birds may fly a little way up and down. When all this is done, the looking-glass is to be prepared in the following manner: Take a piece of wood about an inch and a half thick, and cut it in form of a bow, so that there may be about nine inches space between the two ends; and let it have its full thickness at the bottom; that it may receive into it a false piece; in the five corners of which there are to be set in five pieces of looking-glass. These are so fixed, that they may dart their light upwards; and the whole machine is to be supported on a moveable pin, with the end of a long line fixed to it, and made in the manner of the children's plaything of an apple and a plumbstone; so that the other end of the cord being carried through a hedge, the barely pulling it may set the whole machine of the glass a turning. This and the other contrivances are to be placed in the middle between the two nets. The larks fixed to the place, and termed *calls*, and the glittering of the looking glasses as they twirl round in the sun, invite the other larks down; and the cord that communicates with the nets, and goes through the hedge, gives the person behind an opportunity of pulling up the nets, so as to meet over the whole, and take every thing that is between them. The places where this sort of sporting succeeds best are open fields remote from any trees and hedges, except one by way of shelter for the sportsman: and the wind should always be either in the front or back; for if it blows sidewise, it prevents the playing of the net.

DORIS, a country of Greece, between Phocis, Thessaly, and Acarnania. It received its name from Dorus the son of Deucalion, who made a settlement there. It was called *Tetrapolis* from the four cities of

Pindus or Dryopis, Erineum, Cytinium, and Borium, which it contained. To these four some add Lilæum and Carphia, and therefore call it *Hexapolis*. The name of Doris has been common to many parts of Greece. The Dorians in the age of Deucalion inhabited Phthiotis, which they exchanged for Histiæotis, in the age of Dorus. From thence they were driven by the Cadmeans, and came to settle near the town of Pindus. From thence they passed into Dryopis, and afterwards into Peloponnesus. Hercules having re-established Ægimius king of Phthiotis or Doris, who had been driven from his country by the Lapithæ, the grateful king appointed Hyllus the son of his patron to be his successor, and the Heraclidæ marched from that part of the country to go to recover Peloponnesus. The Dorians sent many colonies into different places, which bore the same name as their native country. The most famous of these is in Asia Minor, of which Halicarnassus was once the capital. This part of Asia Minor was called *Hexapolis*, and afterwards *Pentapolis*.

DORIS, a genus of animals, belonging to the order of vermes mollusca. See HELMINTHOLOGY *Index*.

DORMANT, in *Heraldry*, is used for the posture of a lion, or any other beast, lying along in a sleeping attitude with the head on the fore paws: by which it is distinguished from the *couchant*, where, though the beast is lying, yet he holds up his head.

DORMER, in *Architecture*, signifies a window made in the roof of a house, or above the entablature, being raised upon the rafters.

DORMITORY, a gallery in convents or religious houses, divided into several cells, in which the religious sleep or lodge.

DORMOUSE. See MUS and SCIURUS, MAMMALIA *Index*.

DORONICUM, LEOPARD'S BANE; a genus of plants belonging to the syngenesia class; and in the natural method ranking under the 49th order, *Compositæ*. See BOTANY *Index*.

DORSAL, an appellation given to whatever belongs to the back. See DORSUM.

DORSET, THOMAS SACKVILLE, Lord Buckhurst. See SACKVILLE.

DORSET, *Charles Sackville*, earl of. See SACKVILLE.

DORSETSHIRE, a county of England, bounded on the south by the English channel, on the north by Somersetshire and Wiltshire, on the east by Hampshire, and on the west by Devonshire and some part of Somersetshire. It is between 40 and 50 miles long from east to west, and 34 broad from south to north, and contains 248 parishes, and about 775,000 acres. This country enjoys a mild, pleasant, and wholesome air, and a deep, rich, and fertile soil, finely diversified. Towards the north it is level, under the high lands that divide it from Somersetshire, where there are fine arable grounds that will yield large crops of different kinds of grain. But on the south, from the borders of Hampshire by the sea cost, for an extent of almost 20 miles in length, and in some places four or five in breadth, is a heathy common, which renders this county less populous than it otherwise would be. From east to west runs a ridge of hills called the *Downs*, abounding with sweet and short herbage, which nourishes a vast number of sheep equally esteemed for their flesh and fleece. The country is also very plentifully watered; and in all respects so well suited both for pleasure and profit, that it was distinguished by the Romans above all others. They had more stations and summer camps in Dorsetshire than in any other county. That the Saxons had the same regard for it, is evident from the number of palaces they had in it, the stately minsters they built, and the express directions they gave that their bodies should be interred in those monuments of their piety. This country yields many and very valuable commodities. The quarries in Purbeck and Portland supply stones of different qualities, suited to various uses, and in prodigious quantities, together with some very rich and beautiful marble. The best tobacco-pipe clay in England is also found in this county. The number of inhabitants in 1811 was 124,693. See DORSETSHIRE, SUPPLEMENT.

DORSIFEROUS PLANTS, among botanists, such as are of the capillary kind, without stalks, and which bear their seeds on the back side of their leaves.

DORSTENIA, CONTRAYERVA; a genus of plants belonging to the tetrandria class; and in the natural method ranking under the 53d order, *Scabridæ*. See BOTANY *Index*.

DORSUM, the BACK, in *Anatomy*, comprehends all the posterior part of the trunk of the body from the neck to the buttocks. See ANATOMY *Index*.

DORT, or DORDRECHT, a city of Holland, which held the first rank in the assembly of the states. It is seated in a small island formed by the rivers Meuse, Merue, Rhine, and Linghe. The Meuse, on which it stands, gives it a good harbour, and separates it from the islands of Isselmonde and Ablas. It is divided from Beyerland by a canal. The harbour is very commodious for the merchandises which come down the Rhine and the Meuse, which keep it in a flourishing condition. Its strength consists in being surrounded with water. Its walls are old, and defended by round towers. It is very rich, and well built with brick, and had formerly the exclusive right of coining money. It is at present the staple town for wines, particularly Rhenish. It was detached from the main land in 1421, on the 17th of November, by a flood occasioned by the breaking down of the dike, which overwhelmed 70 villages, and about 100,000 persons. However, by time and the industry of the inhabitants, a great part of the land is recovered. It has two principal canals, namely, the New and Old Haven, by which heavy loaded vessels may enter into the city. Over the Old Haven is a large bridge well built with brick.

Dort was almost reduced to ashes in the year 1457; there being then consumed 2000 houses, with the halls, hospital, and church of Notre Dame: but they are now well provided with fire engines and watchmen to prevent the like disaster. This city is famous for the meeting of the clergy called the *Synod of Dort*, in which the Calvinists obtained a sentence against the Arminians, who were called the *Remonstrants*. The dispute between the contending parties occasioned strange disorders, skirmishes and murders, in most of the principal cities. Those ministers who would not subscribe to the decree of the synod were banished, of whom there were above 100. E. Long. 4. 36. N. Lat. 51. 39.

Synod of Dort, a national synod, summoned by authority of the states-general, the provinces of Holland, Utrecht, and Overyssel excepted, and held at Dort in 1618. The most eminent divines of the United Provinces, and deputies from the churches of England, Scotland, Switzerland, Bremen, Hessia, and the Palatinate, assembled on this occasion, in order to decide the controversy between the Gomarists or Calvinists, and Arminians; the latter of whom were declared corrupters of the true religion. But the authority of this synod was far from being universally acknowledged either in Holland or in England. The provinces of Friesland, Zealand, Utrecht, Guelderland, and Groningen, could not be persuaded to adopt their decisions; and they were opposed by the authority of Archbishop Laud and King James I. in England The reformed churches in France, though at first disposed to give a favourable reception to the doctrines of this famous synod, in process of time espoused doctrines very different from those of the Gomarists; and the churches of Brandenburgh and Bremen would not suffer their doctors to be tied down to the opinions and tenets of the Dutch divines. The liberty of private judgment with respect to the doctrine of predestination and grace, which the spirit that prevailed among the divines of Dort seemed so much adapted to discourage and suppress, acquired new vigour in consequence of the arbitrary proceedings of this assembly.

DORTMUND, a city of Germany, in the circle of Westphalia. It is pretty large, but not well built. Formerly it was one of the Hanse towns. Its territory also was formerly a county, and had lords of its own. It was afterwards an imperial city, but in 1815 was delivered over to Prussia.

DORYPHORI (from δορυ *spear*, and φερω, *I bear*), an appellation given to the life-guard-men of the Roman emperors. They were held in such high estimation, as frequently to have the command of armies conferred on them.—It was usual also for chief commanders to have their doryphori or life guard to attend them.

DOSE, in *Pharmacy*, &c. the quantity of a medicine to be taken at one time. The word is formed from the Greek δοσις, which signifies *gift*, or a thing given; from διδωμι, *do*, "I give."

DOSITHEANS, (*Dosithei*), an ancient sect among the Samaritans in the first century of the Christian era.

Mention is made in Origen, Epiphanius, Jerome, and divers other Greek and Latin fathers, of one Dositheus the chief of a faction among the Samaritans; but the learned are not at all agreed as to the time wherein he lived. St Jerome, in his dialogue against the Luciferians, places him before our Saviour; wherein he is followed by Drusius, who in his answer to Serrarius places him about the time of Sennacherib king of Assyria. But Scaliger will have him posterior to our Saviour's time: And in effect Origen intimates him to have been contemporary with the apostles; where he observes, that he endeavoured to persuade the Samaritans, that he was the Messiah foretold by Moses.

He had many followers; and his sect was still subsisting at Alexandria in the time of the patriarch Eulogius, as appears from a decree of that patriarch published by Photius. In that decree, Eulogius accuses Dositheus of injuriously treating the ancient patriarchs and prophets, and of attributing to himself the spirit of prophecy. He makes him contemporary with Simon Magus; and accuses him of corrupting the Pentateuch in divers places, and of composing several books directly contrary to the law of God.

Archbishop Usher takes Dositheus to be the author of all the changes made in the Samaritan Pentateuch, which he argues from the authority of Eulogius. But all we can justly gather from the testimony of Eulogius is, that Dositheus corrupted the Samaritan copies since used by that sect; but that corruption did not pass into all the copies of the Samaritan Pentateuch now in use among us, which vary but little from the Jewish Pentateuch: And in this sense we are to understand that passage in a Samaritan chronicle, where it is said that Dousis, i. e. Dositheus, altered several things in the law of Moses. The author of that chronicle, who was a Samaritan by religion, adds, that their high-priest sent several Samaritans to seize Dousis and his corrupted copy of the Pentateuch.

Epiphanius takes Dositheus to have been a Jew by birth, and to have abandoned the Jewish party for that of the Samaritans. He imagines him likewise to have been the author of the sect of the Sadducees: Which seems inconsistent with his being later than our Saviour; and yet the Jesuit Serrarius agrees to make Dositheus the master of Sadoc, from whom the Sadducees are derived.

Tertullian, making mention of the same Dositheus, observes, that he was the first who dared to reject the authority of the prophets by denying their inspiration. But he charges that as a crime peculiar to that sectary, which in reality is common to the whole sect, who have never allowed any but the five books of Moses for divine.

DOSSER, a sort of basket to be carried on the shoulders of men. It is used in carrying the overplus earth from one part of a fortification to another where it is wanted. There are likewise small carts and wheelbarrows, for the same use.

DOSSIL, in *Surgery*, is lint made into a cylindric form, or resembling the shape of dates or olive stones. Dossils are sometimes secured by a thread tied round their middle.

DOTTEREL. See Charadrius, Ornithology *Index*.

DOU, or Douw, Gerard. See Douw.

DOUAY, or Doway, a large and strong city of the French Netherlands, situated in E. Long. 3. 0. N. Lat. 50. 25. It is situated on the river Scarpe, in a very fertile and pleasant country. The town is large and well fortified, and contains 18,000 inhabitants. You enter it by six gates, and the streets from each of these gates lead to the market-place. Here is a venerable old town-house, adorned with the statues of the earl of Flanders, in which the magistrates used to assemble. Here also were held several country courts for the dependencies of Douay, which contained about 30 villages. The parliament of Douay was at first only a supreme council, established at Tournay in 1668, and erected into a parliament in 1686. But Tournay being taken by the allies in 1709, the parliament was removed to Cambray; and upon the

the yielding of Tournay to the Austrians by the treaty of Utrecht, the parliament was removed to Douay, where it still continues. This city was erected into an university like that of Louvain by Philip II. because of its being in the middle of so many great cities, and Louvain at so great a distance, that the children on that side of the country were generally sent for their education into France. Before the French revolution it contained 14 colleges, all governed and settled after the manner of those at Louvain; and the schools of philosophy, canon and civil law, and physic, were disposed also after the same manner. There was a considerable seminary here of English Roman Catholics, founded by Philip II. of Spain about the year 1560. There were also a great number of convents; and amongst the rest two English, one of Franciscan friars, the other of Benedictine monks. Douay was taken from the Spaniards by the French king in person in 1667, after a short resistance. That prince made it very strong, and built a fort about a cannon shot below it upon the Scarpe, with sluices, by which the adjacent country could be drowned. The allies laid siege to it in 1710, under the command of the duke of Marlborough; and after a vigorous defence, the town and Fort Scarpe surrendered upon honourable terms. It was retaken by the French in 1712, after the suspension of arms between Great Britain and France.

DOUBLE; two of a sort, one corresponding to the other.

Double Children, Double Cats, Double Pears, &c. Instances of these are frequent in the *Philosoph. Trans.* and elsewhere. See MONSTER.

Sir John Floyer, in the same *Transactions*, giving an account of a *double turkey*, furnishes some reflections on the production of *double animals* in general. Two turkeys, he relates, were taken out of an egg of the common size, when the rest were all hatched, which grew together by the flesh of the breast-bone, but in all other parts were distinct. They seemed less than the ordinary size, as wanting bulk, nutriment, and room for their growth; which latter, too, was apparently the occasion of their cohesion. For having two distinct cavities in their bodies, and two hearts, they must have arisen from two cicatriculas; and, consequently, the egg had two yolks; which is no uncommon accident. He mentions a dried *double chicken* in his possession, which, though it had four legs, four wings, &c. had but one cavity in the body, one heart, and one head; and, consequently, was produced from one cicatricula.

So, Paræus mentions a *double infant*, with only one heart, in which case, the original or stamen of the infant was one, and the vessels regular; only, the nerves and arteries towards the extremities dividing into more branches than ordinary, produced *double* parts.

The same is the case in the *double flowers* of plants, occasioned by the richness of the soil. So it is in the eggs of quadrupeds, &c.

There are, therefore, two reasons of duplicity in embryos: 1. The conjoining or connection of two perfect animals; and, 2. An extraordinary division and ramification of the original vessels, nerves, arteries, &c.

Double Employment, in *Music*, a name given by M. Rameau to the two different manners in which the chord of the sub-dominant may be regarded and treated, viz. as the fundamental chord of the sixth superadded, or as the chord of the great sixth, inverted from a fundamental chord of the seventh. In reality, the chords carry exactly the same notes, are figured in the same manner, are employed upon the same chord of the tone, in such a manner, that frequently we cannot discern which of the two chords the author employs, but by the assistance of the subsequent chord, which resolves it, and which is different in these different cases.

To make this distinction, we must consider the diatonic progress of the two notes which form the fifth and the sixth, and which, constituting between them the interval of a second, must one or the other constitute the dissonance of the chord. Now this progress is determined by the motion of the bass. Of these two notes, then, if the superior be the dissonance, it will rise by one gradation into the subsequent chord, the lower note will keep its place, and the higher note will be a superadded sixth. If the lower be the dissonance, it will descend into the subsequent chord, the higher will remain in its place, and the chord will be that of the great sixth. See the two cases of the *double employment* in Rousseau's Musical Dictionary, Plate D, fig. 12.

With respect to the composer, the use which he may make of the double employment, is to consider the chord in its different points of view, that from thence he may know how to make his entrance to it, and his exit from it; so that having arrived, for instance, at the chord of the superadded sixth, he may resolve it as a chord of the great sixth, and reciprocally.

M. D'Alembert has shown, that one of the chief uses of the double employment is, that we be able to carry the diatonic succession of the gamut even to an octave, without changing the mode, at least whilst we rise; for in descending we must change it. Of this gamut and its fundamental bass, an example will be found in Rousseau's Musical Dictionary, Plate D, fig. 13. It is evident, according to the system of M. Rameau, that all the harmonic successions which result from it, are in the same tone: for, in strictness, no other chords are there employed but three, that of the tonic, that of the dominant, and that of the sub-dominant; as this last, in the double employment, constitutes the seventh from the second note, which is employed upon the sixth.

With respect to what M. D'Alembert adds in his Elements of Music, p. 70. and which he repeats in the Encyclopédie, article *Double emplai*, viz. that the chord of the seventh *re fa la ut*, though we should even regard it only as inversion of *fa, la, ut, re*, cannot be followed by the chord *ut mi sol ut*; "I cannot (says Rousseau) be of his opinion in this point.

The proof which he gives for it is, that the dissonance *ut* of the first cannot be resolved in the second; and this is true, since it remains in its place: but in this chord of the seventh *re fa la ut*, inverted from this chord of the superadded sixth, *fa la ut re*, it is not the *ut*, but the *re*, which is the dissonance; which, of consequence, ought to be resolved in ascending upon *mi*, as it really does in the subsequent chord; so that this procedure in the bass itself is forced, which, from *re*, cannot without an error return to *ut*, but ought to ascend to *mi*, in order to resolve the dissonance.

"M. D'Alembert afterwards shows, that this chord *re fa la ut*, when preceded and followed by that of the tonic, cannot be authorized by the double employment, and this is likewise very true; because this chord, though figured with a 7, is not treated as a chord of the seventh, neither when we make our entrance to it, nor our exit from it; or at least that it is not necessary to treat it as such, but simply as an inversion of the superadded sixth, of which the dissonance is the bass: in which case we ought by no means to forget, that this dissonance is never prepared. Thus, though in such a transition the double employment is not in question, though the chord of the seventh be no more than apparent, and impossible to be resolved by the rules, this does not hinder the transition from being proper and regular, as I have just proved to theorists. I shall immediately prove to practical artists, by an instance of this transition: which certainly will not be condemned by any one of them, nor justified by any other fundamental bass except my own. (See the Musical Dictionary, Plate D, fig. 14.).

"I acknowledge, that this inversion of the chord of the sixth superadded, which transfers the dissonance to the bass, has been censured by M. Rameau. This author, taking for a fundamental chord the chord of the seventh, which results from it, rather chose to make the fundamental bass descend diatonically, and resolve one seventh by another, than to unfold this seventh by an inversion. I had dissipated this error, and many others, in some papers which long ago had passed into the hands of M. D'Alembert, when he was composing his Elements of Music; so that it is not his sentiments which I attack, but my own opinion which I defend."

For what remains, the double employment cannot be used with too much reserve, and the greatest masters are the most temperate in putting it in practice.

Double *Fichy*, or *Fiché*, in *Heraldry*, the denomination of a cross, when the extremity has two points; in contradistinction to fiché, where the extremity is sharpened away to one point.

Double *Octave*, in *Music*, an interval composed of fifteen notes in diatonic progression; and which, for that reason, is called a *fifteenth*. "It is (says Rousseau) an interval composed of two octaves, called by the Greeks *disdiapason*.

It deserves, however, to be remarked, that in intervals less distant and compounded, as in the *third*, the *fifth*, the *simple octave*, &c. the lowest and highest extremes are included in the number from whence the interval takes its name. But, in the *double octave*, when termed a fifteenth, the simple number of which it is composed gives the name. This is by no means analogical, and may occasion some confusion. We should rather choose, therefore, to run any hazard which might occur from uniformly including all the terms of which the component intervals consist, and call the *double* octave a sixteenth, according to the general analogy. See Interval.

DOUBLET, among lapidaries, implies a counterfeit stone, composed of two pieces of crystal, and sometimes glass softened, together with proper colours betwixt them; so that they make the same appearance to the eye as if the whole substance of the crystal had been tinged with these colours.

The impracticability of imparting tinges to the body of crystals, while in their proper and natural state, and the softness of glass, which renders ornaments made of it greatly inferior in wear to crystal, give inducements to the introduction of colouring the surface of crystal wrought in a proper form, in such a manner, that the surfaces of two pieces so coloured being laid together, the effect might appear the same as if the whole surface of the crystal had been coloured. The crystals, and sometimes white transparent glass so treated, were called *doublets;* and at one time prevailed greatly in use, on account of the advantages, with respect to wear, such doublets had, when made of crystal, over glass, and the brightness of the colours which could with certainty be given to counterfeit stones this way, when coloured glass could not be procured, or at least not without a much greater expence. Doublets have not indeed the property which the others have, of bearing to be set transparent, as is frequently required in drops of ear-rings and other ornaments: but when mounted in rings, or used in such manner that the sides of the pieces where the joint is made, cannot be inspected, they have, when formed of crystal, the title to a preference to the coloured glass; and the art of managing them is therefore, in some degree, of the same importance with that of preparing glass for the counterfeiting gems; and is therefore properly an appendage to it, as being entirely subservient to the same intention. The manner of making doublets is as follows:

Let the crystal or glass be first cut by the lapidaries in the manner of a brilliant, except that, in this case, the figure must be composed from two separate stones, or parts of stones, formed in the manner of the upper and under parts of a brilliant, if it was divided into a horizontal direction, a little lower than the middle. After the two plates of the intended stone are thus cut, and fitted so exactly that no division can appear when they are laid together, the upper part must be polished ready for setting; and then the colour must be put betwixt the two plates by this method. "Take of Venice or Cyprus turpentine two scruples; and add to it one scruple of the grains of mastich chosen perfectly pure, free from foulness, and previously powdered. Melt them together in a small silver or brass spoon, ladle, or other vessel, and put to them gradually any of the coloured substances mentioned below, being first well powdered; stirring them together as the colour is put in, that they may be thoroughly commixed. Warm then the doublets to the same degree of heat as the melted mixture; and paint the upper surface of the lower part, and put the upper one instantly upon it, pressing them to each other, but taking care that they may be conjoined in the most perfectly even manner. When the cement or paint is quite cold and set, the redundant part of it, which has been pressed out of the joint of the two pieces, should be gently scraped off the side, till there be no appearance of any colour on the outside of the doublets; and they should then be skilfully set; observing to carry the mounting over the joint, that the upper piece may be well secured from separating from the under one.

The colour of the ruby may be best imitated, by mixing a fourth part of carmine with some of the finest crimson lake that can be procured.

The

The sapphire may be counterfeited with very bright Prussian blue, mixed with a little of the above-mentioned crimson lake, to give it a cast of the purple. The Prussian blue should not be very deep coloured, or but little of it should be used: for otherwise, it will give a black shade that will be injurious to the lustre of the doublets.

The emerald may be well counterfeited with distilled verdigrise, to which is added a little powdered aloes. But the mixture should not be strongly heated, or kept long over the fire after the verdigrise is added: for the colour is apt to be soon impaired by it.

The resemblance of the garnet may be made with dragon's blood; which, if it cannot be procured of sufficient brightness, may be helped by a very small quantity of carmine.

The amethyst may be imitated with the mixture of some Prussian blue with the crimson lake; but the proportions can only be regulated, by direction, as different parcels of the lake and Prussian blue vary extremely in the degree of strength of the colour.

The yellow topazes may be counterfeited by mixing the powdered aloes with a little dragon's blood, or by good Spanish anotto; but the colour must be very sparingly used, or the tinge will be too strong for the appearance of that stone.

The chrysolite, hyacinth, vinegar garnet, aigue marine, and other such weaker or more diluted colours, may be formed in the same manner, by lessening the proportions of the colours, or by compounding them together correspondently to the hue of the stone to be imitated; to which end it is proper to have an original stone, or an exact imitation of one, at hand when the mixture is made, in order to the more certain adapting the colours to the effect desired: and when these precautions are taken, and the operation is well conducted, it is practicable to bring the doublets to so near a resemblance of the true stone, that even the best judges cannot distinguish them, when well set, without a peculiar manner of inspection.

There is, however, an easy method of distinguishing doublets, which is only to behold them betwixt the eye and light, in such a position, that the light may pass through the upper part and corners of the stone; when it will easily be perceived that there is no colour in the body of the stone.

DOUBLETS, a game on dice within tables; the men, which are only 15, being placed thus: Upon the sice, cinque, and quatre points, there stand three men a-piece; and upon the trey, duce, and ace, only two. He that throws highest hath the benefit of throwing first, and what he throws he lays down, and so doth the other; what the one throws, and hath not, the other lays down for him, but on his own account; and thus they do till all the men are down, and then they bear. He that is down first, bears first; and will doubtless win the game, if the other throws not doublets to overtake him: which he is sure to do, since he advances or bears as many as the doublets make, viz. eight for two fours.

DOUBLING, in the military art, is the putting two ranks or files of soldiers into one. Thus, when the word of command is *double your ranks*, the second, fourth, and six ranks march into the first, third, and fifth, so that the six ranks are reduced to three, and the intervals between the ranks become double what they were before.

Doubling, among hunters, who say that a hare doubles, when she keeps in plain fields, and winds about to deceive the hounds.

Doubling, in the manege, a term applied to a horse, who is said to double his reins, when he leaps several times together, to throw his rider; thus it is said, *the ramingue doubles his reins, and makes pontlevis.*

Doubling, in *Navigation*, the art of sailing round, or passing beyond, a cape or promontory, so as that the cape or point of land separates the ship from her former situation, or lies between her and any distant observer.

Doubling Upon, in *Naval Tactics*, the act of enclosing any part of a hostile fleet between two fires, or of cannonading it on both sides.

It is usually performed by the van or rear of that fleet which is superior in number, taking the advantage of the wind, or of its situation, and taking or veering round the van or rear of the enemy, who can scarcely avoid being thrown into general confusion.

DOUBLON, or **Dubloon**, a Spanish and Portuguese coin, being the double of a Pistole.

DOUBS, the name of a river of France, which has its source in the mountains of Jura, and falls into the Saone; and also the name of a department which is nearly surrounded by that river.

DOUBTING, the act of withholding our assent from any proposition, on suspicion that we are not thoroughly apprised of the merits thereof, or from not being able peremptorily to decide between the reasons for and against it. Doubting is distinguished by the schoolmen into two kinds, *dubitatio sterilis*, and *dubitatio efficax*. The former is that where no determination ensues: in this manner the Sceptics and Academics doubt, who withhold their assent from every thing. See Sceptics, &c. The latter is followed by judgment, which distinguishes truth from falsehood: such is the doubting of the Peripatetics and Cartesians. The last in particular perpetually inculcate the deceitfulness of our senses, and tell us that we are to doubt of every one of their reports, till they have been examined and confirmed by reason. On the other hand, the Epicureans teach, that our senses always tell truth; and that, if you go ever so little from them, you come within the province of doubting. See Cartesians, Epicureans, &c.

Doubting, in *Rhetoric*, a figure wherein the orator appears some time fluctuating, and undetermined what to do or say. Tacitus furnishes us with an instance of doubting, almost to a degree of distraction, in those words of Tiberius written to the senate: *Quid scribam*, P. S. *aut quomodo scribam, aut quid omnino non scribam hoc tempore, dii me deæque pejus perdant quam perire quotidie sentio, si scio.*

DOUCETS, or **Doulcets**, among sportsmen, denote the testes of a deer or stag.

DOUCINE, in *Architecture*, a moulding concave above and convex below, serving commonly as a cymatium to a delicate corniche. It is likewise called Gula.

DOVE. See Columba, Ornithology *Index*.

Dove-Tailing, in carpentry, is the manner of fastening boards together by letting one piece into another in the form of the tail of a dove. The dove-tail is the strongest of the assemblages or joinings; because the tenon, or piece of wood which is put into the other, goes widening to the extreme, so that it cannot be drawn out again, by reason the extreme or tip is bigger than the hole.

DOVER, a borough and port town of England, in the county of Kent, situated in E. Long. 0. 25. N. Lat. 51. 10. It sends two members to parliament, styled *barons of the Cinque ports*, whereof Dover is the chief. The number of voters is about 1600. It contained 14,845 inhabitants in 1801, and 19,128 in 1811.

By the Romans this town was named *Dubris*, and by the Saxons *Dofra*, probably from the British word *Dour*, which signifies water. The convenience of its situation drew the attention of the Roman governors, who ruled here while they possessed this part of the island; and there still remain indubitable testimonies of their care and respect for this important place. For the defence of the town, the Romans, or, according to some, Arviragus, a British king, their confederate, by cutting out walls with infinite labour in the solid rock, constructed a stony fortress; and, as its venerable remains still prove, erected also a light-house, for the benefit of navigation. The Saxons, Danes, and Normans, had a very high opinion of this place; and when the barons invited over the young prince, afterwards Louis VIII. of France, his father Philip Augustus conceived a bad opinion of the expedition, because the castle and port of Dover were held for King John, though a great part of the kingdom had submitted to Louis. In its most flourishing state, the fortress was impregnable, and the town a very opulent emporium. It had 21 wards, each of which furnished a ship for the public service, 10 gates, 7 parish-churches, many religious houses, hospitals, and other public edifices. The decay of the town was brought on by that of the harbour. To recover this, Henry VIII. spent no less than 63,000l. in constructing piers; and 5000l. in building a castle between this and Folkstone, called *Sandgate*, where the shore was flat, and the landing easy. Notwithstanding all this expence, however, it was again choked up in the reign of Queen Elizabeth, by whom it was again cleared at a vast expence, so that ships of some hundred tons could enter it. After that time it again declined, notwithstanding of many efforts for its relief, and great assistance from time to time given by parliament for this purpose. At present the harbour is capable of receiving vessels of 400 or 500 tons; and as the packets to France and Flanders are stationed here in time of peace, it is still a place of some consequence, and the people are active and industrious.

Dover Straits, the narrow channel between Dover and Calais, which separates our island from the opposite continent. Britain is supposed by many to have been once peninsulated, the present straits occupying the site of the isthmus which joined it to Gaul. "No certain cause (says Mr Pennant*) can be given for the mighty convulsion which tore us from this continent; whether it was rent by an earthquake, or whether it was worn through by the continual dashing of the waters, no Pythagoras is left to solve the *fortuna locorum :*

Vidi ego, quod fuerat quondam solidissima tellus
Esse fretum.

But it is most probable, that the great philosopher alluded to the partial destruction of the *Atlantica insula*, mentioned by Plato as a distant tradition in his days. It was effected by an earthquake and a deluge, which might have rent asunder the narrow isthmus in question, and left Britain, large as it seems at present, the mere wreck of its original size. The Scilly isles, the Hebrides, Orkneys, Shetlands, and perhaps the Feroe islands, may possibly be no more than fragments of the once far-extended region. I have no quarrel about the word *island*. The little isthmus, compared to the whole, might have been a junction never attended to in the limited navigations of very early times. The peninsula had never been wholly explored, and it passed with the ancients for a genuine island. The correspondency of strata on part of the opposite shores of Britain and France, leaves no room to doubt but that they were once united. The chalky cliffs of Blancnez between Calais and Boulogne, and those to the westward of Dover, exactly tally: the last are vast and continued; the former short, and the termination of the immense bed. Between Boulogne and Folkstone (about six miles from the latter) is another memorial of the junction of the two countries; a narrow submarine hill, called the *Rip-raps*, about a quarter of a mile broad, and ten miles long, extending eastwards towards the Goodwin sands. Its materials are boulderstones, adventitious to many strata. The depth of water on it, in very low ebbs during spring tides, is only fourteen feet. The fishermen from Folkstone have often touched it with a fifteen feet oar; so that it is justly the dread of navigators. Many a tall ship has perished on it, and sunk instantly into twenty-one fathoms water. In July 1782, the Belleisle of sixty-four guns struck, and lay on it during three hours; but, by starting her beer and water, got clear off.

"These celebrated straits are only twenty-one miles wide in the narrowest part. From the pier at Dover to that at Calais is twenty-four. It is conjectured, that their breadth lessens, and that they are two miles narrower than they were in ancient times. An accurate observer of fifty years remarks to me, that the increased height of water, from a decrease of breadth, has been apparent even in that space. The depth of the channel at a medium in highest spring tides is about twenty-five fathoms. The bottom either coarse sand or rugged scars, which have for ages unknown resisted the attrition of the currents. From the straits both eastward and westward is a gradual increase of depth through the channel to a hundred fathoms, till soundings are totally lost or unattended to. The spring tides in the straits rise on an average twenty-four feet, the neap tides fifteen. The tide flows from the German sea, passes the straits, and meets, with a great rippling, the western tide from the ocean between Fairleigh near Hastings and Boulogne; a proof that, if the separation of the land was effected by the seas, it must have been by the overpowering weight of those of the north."

DOVER, a town of Delaware in North America. It is the chief town of the county of Kent in the Delaware state, and is the seat of government. It stands on Jones's creek, a few miles from the Delaware river, and consists of about 100 houses, principally of brick. Four streets intersect each other at right angles, in the centre

---

* *Arctic Zoology*, vol. I. Introd. p. ii.

over,
uglas.

centre of the town, whose incidencies form a spacious parade, on the east side of which is an elegant state-house of brick. The town has a lively appearance, and drives on a considerable trade with Philadelphia. Wheat is the principal article of export. The landing is five or six miles from the town of Dover.

DOUGLAS, Lord. See (*History of*) SCOTLAND.

Douglas, *Gavin*, bishop of Dunkeld in Scotland, was the third son of Archibald earl of Angus, and born in the year 1474. Where he was educated, is not known; but it is certain that he studied theology: a study, however, which did not estrange him from the muses; for he employed himself at intervals in translating into beautiful verse the poem of Ovid *de Remedio Amoris.* The advantages of foreign travel, and the conversation of the most learned men in France and Germany, to whom his merit produced the readiest access, completed his education. With his superior recommendations and worth, it was impossible he could remain unnoticed. His first preferment was to be provost of the collegiate church of St Giles in Edinburgh; a place at that time of great dignity and revenue. In the year 1514, the queen mother, then regent of Scotland, appointed Douglas abbot of Aberbrothock, and soon after archbishop of St Andrew's; but the queen's power not being sufficient to establish him in the possession of that dignity, he relinquished his claim in favour of his competitor Foreman, who was supported by the pope. In 1515, he was by the queen appointed bishop of Dunkeld; and that appointment was soon after confirmed by his holiness Leo X. Nevertheless it was some time before he could obtain peaceable possession of his see. The duke of Albany, who in this year was declared regent, opposed him because he was supported by the queen; and, in order to deprive him of his bishopric, accused him of acting contrary to law in receiving bulls from Rome. On this accusation he was committed to the castle of Edinburgh, where he continued in confinement above a year; but the regent and the queen being at last reconciled, he obtained his liberty, and was consecrated bishop of Dunkeld. In 1517, he attended the duke of Albany to France; but returned soon after to Scotland. In 1521, the disputes between the earls of Arran and Angus having thrown the kingdom into violent commotion, our prelate retired to England, where he became intimately acquainted with Polydore Virgil the historian. He died in London of the plague in 1522; and was buried in the Savoy. He wrote, 1. The Palace of Honour: a most ingenious poem under the similitude of a vision; in which he paints the vanity and inconstancy of all worldly glory. It abounds with incidents, and a very rich vein of poetry. The palace of happiness, in the picture of Cebes, seems to be the groundwork of it. 2. *Aureæ Narrationes:* a performance now lost; in which, it is said, he explained, in a most agreeable manner, the mythology of the poetical fictions of the ancients. 3. *Comœdiæ aliquot sacræ:* None of which are now to be found. 4. Thirteen Bukes of Eneades, of the famose poet Virgil, translatet out of Latin verses into Scottish metre, every buke having its particular prologe. Imprinted at London 1553, in 4to; and reprinted at Edinburgh 1710, in folio. The last is the most esteemed of all his works. He undertook it at the desire of Lord Henry Sinclair, a munificent patron of arts in those times: and he completed it in 18 months; a circumstance which his admirers are too fond of repeating to his advantage. David Hume of Godscroft, an author of uncommon merit, and an admirable judge of poetry, gives the following testimony in his favour. "He wrote (says he) in his native tongue divers things; but his chiefest work is his translation of Virgil, yet extant, in verse: in which he ties himself so strictly as is possible; and yet it is so well expressed, that whosoever will essay to do the like will find it a hard piece of work to go through with it. In his prologues before every book, where he hath his liberty, he showeth a natural and ample vein of poetry, so pure, pleasant, and judicious, that I believe there is none that hath written before or since but cometh short of him." It has been said, that he compiled an historical treatise *De Rebus Scoticis;* but no remain of it hath descended to the present times.

Douglas,
Douw.

Douglas, the principal town of the isle of Man, and which has lately increased both in trade and buildings. The harbour, for ships of a tolerable burden, is the safest in the island, and is much improved by a fine mole that has been built. Population 2631. W. Long. 3. 25. N. Lat. 54. 7.

DOUW, Gerhard, a celebrated painter, was born at Leyden in 1613; and received his first instructions in drawing and design from Bartholomew Dolendo an engraver, and also from Peter Kouwhoorn a painter on glass; but at the age of fifteen he became a disciple of Rembrandt. In that famous school he continued for three years; and then found himself qualified to study nature, the most unerring director.

From Rembrandt he learned the true principles of colouring, and obtained a complete knowledge of the chiaro-scuro: but to that knowledge he added a delicacy of pencil, and a patience in working up his colours to the highest degree of neatness, superior to any other master. He therefore was more pleased with those pictures of Rembrandt which were painted in his youth than those by which he was distinguished in his more advanced age; because the first seemed finished with more care and attention, the latter with more boldness, freedom, and negligence, which was quite opposite to the taste of Douw. But although his manner appears so different from that of his master, yet it was to Rembrandt alone that he owed all that excellence in colouring by which he triumphed over all the artists of his own country.

His pictures are usually of a small size, with figures so exquisitely touched, so transparent, so wonderfully delicate, as to excite astonishment as well as pleasure. He designed every object after nature, and with an exactness so singular, that each object appears as perfect as nature itself, in respect to colour, freshness and force. His general manner of painting portraits, was by the aid of a concave mirror, and sometimes by looking at the object through a frame with many exact squares of fine silk. But the latter custom is disused, as the eye of a good artist seems a more competent rule, though the use of the former is still practised by painters in miniature.

It is almost incredible what vast sums have been given and are given at this day for the pictures of Douw, even in his own country; as also in Italy and every polite part of Europe: for he was exceedingly curious in finishing them, and patiently assiduous beyond example. Of that patience Sandrart gives a strong proof in a circumstance which he mentions relative to this artist. He says, that having once, in company with Bamboccio, visited Gerhard Douw, they could not forbear to admire the prodigious neatness of a picture which he was then painting, in which they took particular notice of a broom; and expressing their surprise at the excessive neatness of the finishing that minute object, Douw told them he should spend three days more in working on that broom before he should account it entirely complete. In a family picture of Mrs Spiering, the same author observes, that the lady sat five days for the finishing one of her hands that leaned on an arm chair. For that reason not many would sit to him for their portraits; and he therefore indulged himself mostly in works of fancy, in which he could introduce objects of still life, and employ as much time on them as suited his own inclination. Houbraken testifies, that his great patron Mr Spiering allowed him a thousand guilders a-year, and paid beside whatever he demanded for his pictures, and purchased some of them for their weight in silver; but Sandrart, with more probability, assures us, that the thousand guilders a-year were paid to Gerhard, on no other consideration than that the artist should give his benefactor the option of every picture he painted, for which he was immediately to receive the utmost of his demand. This great master died in 1674, aged 61.

Douw appears incontestably to be the most wonderful in his finishing of all the Flemish masters. Every thing that came from his pencil is precious, and his colouring hath exactly the true and the lovely tints of nature; nor do his colours appear tortured, nor is their vigour lessened by his patient pencil; for whatever pains he may have taken, there is no look of labour or stiffness; and his pictures are remarkable, not only for retaining their original lustre, but for having the same beautiful effect at a proper distance as they have when brought to the nearest view.

At Turin are several pictures by Gerhard Douw, wonderfully beautiful; especially one, of a doctor attending a sick woman, and surveying an urinal. The execution of that painting is astonishingly fine, and although the shadows appear a little too dark, the whole has an inexpressible effect. In the gallery at Florence there is a night-piece by candle light, which is exquisitely finished; and in the same apartment, a mountebank attended by a number of figures, which it seems impossible either sufficiently to commend or to describe.

DOULEIA, (Δουλεια), among the Athenians, a kind of punishment by which the criminal was reduced into the condition of a slave. It was never inflicted upon any but the *ατιμοι*, *sojourners* and *freed servants*.

To DOUSE, in sea language, is to lower suddenly, or slacken; and it is applied to a sail in a squall of wind, an extended hawser, &c.

DOWAGER, *Dotisca* (*q. d.* a widow endowed, or that has a jointure), a title, or addition, applied to the widows of princes, dukes, earls, and persons of high rank only.

Queen Dowager, is the widow of the king, and as such enjoys most of the privileges belonging to her as queen consort: but it is not high treason to violate her chastity or conspire her death, because the succession is not endangered thereby; but no man can marry her without special license from the king, on pain of forfeiting his lands and goods. See Queen.

DOWER, (*Dotarium*, *Doarium*, or *Dos*), a portion of lands or tenements which a widow enjoys for term of life from her husband, in case she survives him; and which, at her death, descends to their children. But she must have been the wife of the party at the time of his decease; or not divorced *à vinculo matrimonii*: nor, if she has eloped from her husband, and lives with an adulterer, shall she be entitled to dower, unless her husband be voluntarily reconciled to her. The widows of traitors are also barred of their dower by 5 and 6 Edw. VI. cap. 11. but not the widows of felons. An alien cannot be endowed, unless she be queen consort. And if a woman levies a fine with her husband, or if a common recovery be had with the husband and wife of the husband's lands, she is barred of her dower.—A widow, clear of these impediments, is by law entitled to be endowed of all lands and tenements, of which her husband was seised in fee-simple or fee-tail at any time during the coverture; and of which any issue she might have had might by possibility have been heir. See Jointure.

DOWN, a county of Ireland in the province of Ulster; bounded on the east and south by St George's channel; on the west by the county of Armagh; and on the north by the county of Antrim. It lies opposite to the isle of Man, Cumberland, and Westmoreland; and the north part of it fronts the Mull of Galloway in Scotland, and is about 44 miles from it.—It is about 44 miles in length and 30 in breadth, and contains about 558,000 English acres. The county of Down contains 60 parishes, and in 1813 the population amounted to 204,500 souls.

This county is rough and full of hills; but the air is temperate and healthy. The soil naturally produces wood, unless constantly kept open and ploughed; and the low grounds degenerate into bogs and moss, where the drains are neglected. But by the industry of the inhabitants it produces good crops of corn, particularly oats; and, where marl is found, barley. This last is exported from Killogh to Dublin. The staple commodity of this county is the linen manufacture. See Down, Supplement.

Down, or *Down-Patrick*, a town of Ireland, in the county of Down, is one of the most ancient in that kingdom. It is a market town and a bishopric, said to be erected in the fifth century by St Patrick, but is now united to the see of Connor. Within 200 paces of the town, on the ascent of a hill, are the ruins of an old cathedral, remarkable for the tomb of St Patrick the founder, in which they say the bodies of St Bridget and St Columb are also laid. The town, which is seated on the south corner of Lough Coin, now called the *lake of Strangford*, is adorned with several handsome public buildings. Among the hills, and in many islands, are flights of swans and other water fowl; and the lough abounds with salmon, mullets,

lets, and other sea fish. About a mile from this town is St Patrick's well, which many people frequent to drink at some seasons of the year, and others to perform a penance enjoined them by the Popish priests.—The linen manufacture is carried on here, as it is in several places in this county. The population is about 5000. W. Long. 5. 50. N. Lat. 54. 23.

Down, the fine feathers from the breasts of several birds, particularly of the duck kind.—That of the eider duck is the most valuable. These birds pluck it from their breasts and line their nests with it. We are told that the quantity of down found in one nest more than filled the crown of a hat, yet weighed no more than three quarters of an ounce. Br. Zool.—Three pounds of this down may be compressed into a space scarce bigger than one's fist; yet it is afterwards so dilatable as to fill a quilt five feet square. Salern. Orn. p. 416.—That found in the nests is most valued, and termed *live down*; it is infinitely more elastic than that plucked from the dead bird, which is little esteemed in Iceland. The best sort is sold at 45 fish per pound when cleansed, and at 16 when not cleansed. There are generally exported every year, on the company's account, fifteen hundred or two thousand pounds of both sorts, exclusively of what is privately exported by foreigners. In 1750 the Iceland company sold as much in quantity of this article as amounted to three thousand seven hundred and forty-five banco dollars, besides what was sent directly to Gluckstadt.—*Von Troil*, p. 146.

Down, or hair of plants. See Hair.

DOWNETON, a borough town of Wiltshire, five miles south of Salisbury. It contained 2624 inhabitants in 1811, and sends two members to parliament.

DOWNHAM, a market town of Norfolk, 10 miles south of Lynn, famous for its good butter; there being 1000, and sometimes 2000, firkins bought here every Monday, and sent up the river Ouse to Cambridge, and thence to London. Population 1771 in 1811.

DOWNS, a bank or elevation of sand, which the sea gathers and forms along its shores; and which serves it as a barrier. The word is formed from the French *dune*, of the Celtic *dum*, a "mountain." Charles de Visch, in his *Compend. Chronolog. Exord. et Progress. Abbat. Clariss. B. Mariæ, de Dunis*, says, *Vallem reperit arenarum collibus (quos incolæ* Duynen *vocant) undique cinctam.*

Downs is particularly used for a famous road for ships, along the eastern coast of the county of Kent, from Dover to the North Foreland; where both the outward and homeward bound ships frequently make some stay; and squadrons of men of war rendezvous in time of war.

It affords excellent anchorage; and is defended by the castles of Deal, Dover, and Sandwich.

DOWRY, the money or fortune which the wife brings her husband in marriage; it is otherwise called *maritagium*, marriage goods, and differs from dower. See Dower.

DOXOLOGY, a hymn used in praise of the Almighty, distinguished by the title of *greater* and *lesser*.

The lesser doxology was anciently only a single sentence, without response, running in these words, *Glory be to the Father, and to the Son, and to the Holy Ghost, world without end, Amen.* Part of the latter clause, *As it was in the beginning, is now, and ever shall be*, was inserted some time after the first composition. Some read this ancient hymn, *Glory be to the Father, and to the Son with the Holy Ghost.* Others, *Glory be to the Father in or by the Son, and by the Holy Ghost.* This difference of expression occasioned no dispute in the church, till the rise of the Arian heresy; but when the followers of Arius began to make use of the latter as a distinguishing character of their party, it was entirely laid aside by the Catholics, and the use of it was enough to bring any one under suspicion of heterodoxy.

The doxology was used at the close of every solemn office. The western church repeated it at the end of every psalm, and the eastern church at the end of the last psalm. Many of their prayers were also concluded with it, particularly the solemn thanksgiving or consecration prayer at the eucharist. It was also the ordinary conclusion of their sermons.

The greater doxology, or angelic hymn, was likewise of great note in the ancient church. It began with these words, which the angels sung at our Saviour's birth, *Glory be to God on high*, &c. It was chiefly used in communion service, and in men's private devotions. Both the doxologies have a place in the church of England, the former being repeated after every psalm, and the latter used in the communion service.

DRABA, a genus of plants belonging to the tetradynamia class; and in the natural method ranking under the 39th order, *Siliquosæ*. See Botany *Index*.

DRABLER, in the sea-language, a small sail in a ship, which is the same to a bonnet as a bonnet is to a course, and is only used when the course and bonnet are too shoal to clothe the mast. See Bonnet and Course.

DRABLING, in *Angling*, is a method of catching barbels. Take a strong line of six yards; which, before you fasten it to your rod, must be put through a piece of lead, that if the fish bite, it may slip to and fro, and that the water may something move it on the ground; bait with a lob worm well secured, and so by its motion the barbel will be enticed into the danger without suspicion. The best places are in running water near piles, or under wooden bridges, supported with oaks floated and slimy.

DRABS, in the salt works, a kind of wooden boxes for holding the salt when taken out of the boiling pan; the bottoms of which are made shelving or inclining forwards, that the briny moisture of the salt may drain off.

DRAC, an imaginary being, much dreaded by the country people in many parts of France. The dracs are supposed to be malicious or at least tricksome demons; but, which is very rare, if one of them happens to take a fancy to a man or woman, they are sure to be the better for it. They are still said to lay gold cups and rings on the surface over pits and rivers, as baits to draw women and children in; though their usual dwelling is some old empty house, whence they make excursions in human form, visible or invisible as best suits their purpose. The country folks shudder at the very name of the drac. Some are positive that they have

seen

seen him; for happy indeed is that village in which there is not a house execrated as the lurking place of this tremendous drac.

DRACÆNA, Dragon-tree; a genus of plants belonging to the hexandria class. See Botany *Index*.

DRACHM, a Grecian coin, of the value of sevenpence three farthings. Drachm is also a weight used by our physicians; containing just sixty grains, or three scruples, or the eighth part of an ounce.

DRACO, a celebrated lawgiver of Athens. When he exercised the office of archon, he made a code of laws for the use of his citizens, which, on account of their severity, were said to be written in letters of blood. By them idleness was punished with as much severity as murder, and death was denounced against the one as well as the other. Such a code of rigorous laws gave occasion to a certain Athenian to ask of the legislator, why he was so severe in his punishments? and Draco gave for answer, that as the smallest transgression had appeared to him deserving death, he could not find any punishment more rigorous for more atrocious crimes. These laws were at first enforced, but they were often neglected on account of their extreme severity; and Solon totally abolished them, except that one which punished a murderer with death. The popularity of Draco was uncommon, but the gratitude of his admirers proved fatal to him. When once he appeared on the theatre, he was received with repeated applause; and the people, according to the custom of the Athenians, showed their respect to their lawgiver by throwing garments upon him. This was done in such profusion, that Draco was soon hid under them, and smothered by the too great veneration of his citizens. He lived about 624 years before the Christian era.

Draco, the *Dragon*, a genus of reptiles belonging to the class of amphibia. See Erpetology *Index*.

Draco Volans, in *Meteorology*, a fiery exhalation, frequent in marshy and cold countries.

It is most common in summer; and though principally seen playing near the banks of rivers, or in boggy places, yet sometimes mounts up to a considerable height in the air, to the no small terror of the amazed beholders: it appearance being that of an oblong, sometimes roundish, fiery body, with a long tail. It is entirely harmless, frequently sticking to the hands and clothes of people without injuring them in the least.

Draco, in *Astronomy*, a constellation of the northern hemisphere; whose stars, according to Ptolemy, are 81: according to Tycho, 32; according to Hevelius, 40; according to Bayer, 33; and according to Mr Flamstead, 80. See Astronomy, N° 406.

DRACOCEPHALUM, Dragon's Head; a genus of plants belonging to the didynamia class. See Botany *Index*.

DRACONARIUS, in antiquity, Dragon-bearer. Several nations, as the Persians, Parthians, Scythians, &c. bore dragons on their standards; whence the standards themselves were called *dracones*, "dragons." The Romans borrowed the same custom from the Parthians; or, as Casaubon has it, from the Daci; or, as Codin, from the Assyrians.

The Roman dracones were figures of dragons painted in red on the flags, as appears from Ammianus Marcellinus: but among the Persians and Parthians they were, like the Roman eagle, figures in full relievo; so that the Romans were frequently deceived, and took them for real dragons.

The soldier who bore the dragon or standard was called by the Romans *draconarius;* and by the Greeks δϱακοναϱιος and δϱακοντειοφοϱος; for the emperors carried the custom with them to Constantinople.

DRACONTIC month, the time of the revolution of the moon from her ascending node, called *caput draconis*, to her return thither.

DRACONTIUM, Dragons; a genus of plants belonging to the gynandria class; and in the natural method ranking under the first order, *Palmæ*. See Botany *Index*.

DRACUNCULI, in *Medicine*, a peculiar eruption, which was supposed to be worms in the muscular parts of the arms and legs, called *Guinea worms*. These worms were removed by the point of a needle; and to prevent their forming again, the usual custom is to wash the parts with wine and vinegar, with alum, nitre, or common salt, or with a strong lixivium of oak ashes, and afterwards anoint them with an ointment of the common kind used for scorbutic eruptions, with a small mixture of quicksilver.

DRACUNCULUS. See Arum, Botany *Index*.

DRAFF, a name given in some places to the wash given to hogs, and the grain given to cows.

DRAG, in building. A door is said to *drag* when in opening or shutting it hangs or grates upon the floor.

Drag, in sea language, is a machine consisting of a sharp, square, iron ring, encircled with a net, and commonly used to take the wheel off from the platform or bottom of the decks.

DRAGOMAN, or Drogman, a term of general use through the east for an interpreter, whose office is to facilitate commerce between the orientals and occidentals. These are kept by the ambassadors of Christian nations residing at the Porte for this purpose.

The word is formed from the Arabic *targeman* or *targiman*, of the verb *taragem*, "he has interpreted." From *dragoman* the Italians formed *dragomano* and, with a nearer relation to its Arabic etymology, *turcimanno;* whence the French and our *trucheman*, as well as *dragoman* and *drogman*.

DRAGON, in *Astronomy*. See Draco.

Dragon's Head and Tail (*caput et cauda draconis*), are the nodes of the planets; or the two points wherein the ecliptic is intersected by the orbits of the planets and particularly that of the moon; making with it angles of five degrees and eighteen minutes. One of these points looks northward; the moon beginning then to have north latitude, and the other southward, where she commences south. Thus her deviation from the ecliptic seems (according to the fancy of some) to make a figure like that of a dragon, whose belly is where she has the greatest latitude; the intersection representing the head and tail, from which resemblance the denomination arises.

But note, that these points abide not always in one place, but have a motion of their own in the zodiac, and retrograde-wise, 3 minutes 11 seconds per day; completing their circle in 18 years 225 days; so that the

the moon can be but twice in the ecliptic during her monthly period, but at all other times she will have a latitude or declination from the ecliptic.

It is about these points of intersection that all eclipses happen. They are usually denoted by these characters, ☊ dragon's head, ☋ dragon's tail.

Dragon, in *Zoology*. See Draco.

Dragon's-Blood, a gummi-resinous substance brought from the East Indies, either in oval drops wrapped up in flag leaves, or in large masses composed of smaller tears. It is said to be obtained from the palmijuncus draco, the calamus rotang, the dracæna draco, the pterocarpus draco, and several other vegetables.

The writers on the materia medica in general give the preference to the former, though the others are not unfrequently of equal goodness. The fine dragon's blood of either sort breaks smooth, free from any visible impurities, of a dark red colour, which changes upon being powdered into an elegant bright crimson. Several artificial compositions, coloured with the true dragon's blood, or Brazil wood, are sometimes sold in the room of this commodity. Some of these dissolve like gums in water; others crackle in the fire without proving inflammable; whilst the genuine sanguis draconis readily melts and catches flame, and is not acted on by watery liquors. It totally dissolves in pure spirit, and tinges a large quantity of the menstruum of a deep red colour. It is likewise soluble in expressed oils, and gives them a red hue, less beautiful than that communicated by anchusa. This drug in substance has no sensible smell or taste; when dissolved, it discovers some degree of warmth and pungency. It is usually, but without foundation, looked upon as a gentle astringent; and sometimes directed as such in extemporaneous prescription against seminal gleets, the fluor albus, and other fluxes. In these cases, it is supposed to produce the general effects of resinous bodies, lightly incrassating the fluids, and somewhat strengthening the solids. But in the present practice it is very little used either externally or internally.

A solution of dragon's blood in spirit of wine is used for staining marble, to which it gives a red tinge, which penetrates more or less deeply according to the heat of the marble during the time of application. But as it spreads at the same time that it sinks deep, for fine designs the marble should be cold. M. Dufay says, that by adding pitch to this solution the colour may be rendered deeper.

Dragon Fish, or *Dragonet*. See Callionymus, Ichthyology *Index*.

Dragon Fly. See Libellula, Entomology *Index*.

Dragon Shell, in *Natural History*, a name given by some to a species of concamerated patella or limpet. This has a top very much bent; and is of an ash colour on the outside, but of an elegant and bright flesh-colour within. This has been found sticking on the back of a tortoise, as the common limpets do on the sides of rocks; and some have been found affixed to large shells of the pinna marina brought from the East Indies at different times.

Dragons. See Dracontium, Botany *Index*.

DRAGONET, or *Dragon Fish*. See Callionymus, Ichthyology *Index*.

DRAGONNE'E, in *Heraldry*. A lion dragonée is where the upper half resembles a lion, the other half going off like the hinder part of a dragon. The same may be said of any other beast as well as a lion.

DRAGOON, in military affairs, a musqueteer mounted on horseback, who sometimes fights or marches on foot, as occasion requires.

Menage derives the word *dragoon* from the Latin *draconarius*, which in Vegetius is used to signify *soldier*. But it is more probably derived from the German *tragen* or *dragen*, which signifies *to carry*; as being infantry carried on horseback.

Dragoons are divided into brigades as the cavalry; and each regiment into troops; each troop having a captain, lieutenant, cornet, quarter-master, two serjeants, three corporals, and two drums. Some regiments have hautboys. They are very useful on any expedition that requires despatch; for they can keep pace with the cavalry, and do the duty of infantry; they encamp generally on the wings of the army, or at the passes leading to the camp; and sometimes they are brought to cover the general's quarters: they march in the front and rear of the army.

The first regiment of dragoons raised in England was in 1681, and called the regiment of dragoons of North Britain. In battle or attacks they generally fight sword in hand after the first fire. Their arms are, a sword, firelock, and bayonet. In the French service, when the dragoons march on foot, their officers bear the pike and the serjeants the halbert, neither of which are used in the English service.

DRAGOONING, one of the methods used by Papists for converting refractory heretics, and bringing them within the pale of the true church.

The following method of dragooning the French Protestants, after the revocation of the edict of Nantz, under Louis XIV. is taken from a French work translated in 1686.

"The troopers, soldiers, and dragoons, went into the Protestants houses, where they marred and defaced their household stuff, broke their looking glasses, and other utensils and ornaments, let their wine run about their cellars, and threw about their corn and spoiled it. And as to those things which they could not destroy in this manner, such as furniture of beds, linen, wearing apparel, plate, &c. they carried them to the market place, and sold them to the Jesuits and other Roman Catholics. By these means the Protestants in Montaubon alone were, in four or five days, stripped of above a million of money. But this was not the worst.

"They turned the dining rooms of gentlemen into stables for their horses; and treated the owners of the houses where they quartered with the highest indignity and cruelty, lashing them about from one to another, day and night, without intermission, not suffering them to eat or drink; and when they began to sink under the fatigue and pains they had undergone, they laid them on a bed, and when they thought them somewhat recovered, made them rise, and repeated the same tortures. When they saw the blood and sweat run down their faces and other parts of their bodies, they sluiced them with water, and putting over their heads kettle drums, turned upside down, they made a continual din upon them till these unhappy creatures lost their senses. When one party of these tormentors

mentors were weary, they were relieved by another, who practised the same cruelties with fresh vigour.

" At Negreplisse, a town near Montaubon, they hung up Isaac Favin, a Protestant citizen of that place, by his armpits, and tormented him a whole night by pinching and tearing off his flesh with pincers. They made a great fire round a boy of about 12 years old, who with his hands and eyes lifted up to heaven cried out "My God, help me!" And when they found the youth resolved to die rather than renounce his religion, they snatched him from the fire just as he was on the point of being burnt.

" In several places the soldiers applied red-hot irons to the hands and feet of men and breasts of women. At Nantz they hung up several women and maids by their feet, and others by their armpits, and thus exposed them to public view stark naked. They bound to posts mothers that gave suck, and let their sucking infants lie languishing in their sight for several days and nights, crying, mourning, and gasping for life. Some they bound before a great fire, and being half roasted, let them go: a punishment worse than death. Amidst a thousand hideous cries and a thousand blasphemies, they hung up men and women by the hair, and some by their feet, on hooks in chimneys, and smoked them with wisps of wet hay till they were suffocated. They tied some under the arms with ropes, and plunged them again and again into wells; they bound others like criminals, put them to the torture, and with a funnel filled them with wine till the fumes of it took away their reason, when they made them say, they consented to be Catholics. They stripped them naked, and after a thousand indignities, stuck them with pins and needles from head to foot. They cut and slashed them with knives; and sometimes with red-hot pincers took hold of them by the nose and other parts of the body, and dragged them about the rooms till they made them promise to be Catholics, or till the cries of these miserable wretches, calling upon God for help, forced them to let them go. They beat them with staves, and thus bruised, and with broken bones, dragged them to church, where their forced presence was taken for an abjuration. In some places they tied fathers and husbands to their bed-posts, and before their eyes ravished their wives and daughters with impunity. They blew up men and women with bellows till they burst them. If any to escape these barbarities endeavoured to save themselves by flight, they pursued them into the fields and woods, where they shot at them like wild beasts, and prohibited them from departing the kingdom (a cruelty never practised by Nero or Dioclesian) upon pain of confiscation of effects, the galleys, the lash, and perpetual imprisonment; insomuch that the prisons of the seaport towns were crammed with men, women, and children, who endeavoured to save themselves by flight from their dreadful persecution. With these scenes of desolation and horror, the Popish clergy feasted their eyes, and made them only a matter of laughter and sport.

" Though my heart aches (says the writer of the piece from which we are transcribing) whilst I am relating these barbarities, yet for a perpetual memorial of the infernal cruelty practised by these monsters I beg the reader's patience to lay before him two other instances, which, if he hath a heart like mine, he will not be able to read without watering these sheets with his tears.

" The first is of a young woman, who being brought before the council, upon refusing to abjure her religion, was ordered to prison. There they shaved her head, singed off the hair from other parts of her body; and having stripped her stark naked, led her through the streets of the city, where many a blow was given her, and stones flung at her; then they set her up to the neck in a tub full of water, where, after she had been for a while, they took her out, and put on her a shift dipt in wine, which, as it dried and stuck to her sore and bruised body, they snatched off again, and then had another ready dipt in wine to clap on her. This they repeated six times, thereby making her body exceeding raw and sore. When all these cruelties could not shake her constancy, they fastened her by her feet in a kind of gibbet, and let her hang in that posture, with her head downward, till she expired.

" The other is of a man in whose house were quartered some of these missionary dragoons. One day, having drank plentifully of his wine, and broken their glasses at every health, they filled the floor with the fragments, and by often walking over them reduced them to very small pieces. This done, in the insolence of their mirth, they resolved on a dance, and told their Protestant host that he must be one of their company; but as he would not be of their religion, he must dance quite barefoot; and thus barefoot they drove him about the room, treading on the sharp points of the broken glasses. When he was no longer able to stand, they laid him on a bed, and, in a short time, stripped him stark naked, and rolled him from one end of the room to the other, till every part of his body was full of the fragments of glass. After this they dragged him to his bed, and having sent for a surgeon, obliged him to cut out the pieces of glass with his instruments, thereby putting him to the most exquisite and horrible pains that can possibly be conceived.

" These, fellow Protestants, were the methods used by the most Christian king's apostolic dragoons to convert his heretical subjects to the Roman Catholic faith! These, and many other of the like nature, were the torments to which Louis XIV. delivered them over to bring them to his own church! and as Popery is unchangeably the same, these are the tortures prepared for you, if ever that religion should be permitted to become settled amongst you; the consideration of which made Luther say of it, what every man that knows any thing of Christianity must agree with him in, 'If you had no other reason to go out of the Roman church, this alone would suffice, that you see and hear, how contrary to the law of God, they shed innocent blood. This single circumstance shall, God willing, ever separate me from the Papacy. And if I was now subject to it, and could blame nothing in any of their doctrines; yet for this crime of cruelty, I would fly from her communion, as from a den of thieves and murderers."

DRAGS, in the sea language, are whatever hangs over the ship in the sea, as shirts, coats, or the like; and boats, when towed, or whatever else that after this

this manner may hinder the ship's way when she sails, are called *drags*.

DRAIN, a cut or ditch for carrying off water from the soil, to improve it for the purposes of agriculture. In the fen countries of England drains are 20, 30, and sometimes 40 feet wide, carried through the marshy ground to some river or other place capable of discharging the water which they carry out of the fen lands.

DRAINING. For the different methods, see AGRICULTURE *Index*.

DRAKE, the male of the duck kind. See ANAS, ORNITHOLOGY *Index*.

DRAKE, *Sir Francis*, a celebrated English admiral, was the son of Edmund Drake a sailor, and born near Tavistock in Devonshire, in the year 1545. He was brought up at the expence, and under the care of, Sir John Hawkins, who was his kinsman; and, at the age of 18, was purser of a ship trading to Biscay. At 20, he made a voyage to Guinea; and, at 22, had the honour to be made captain of the Judith. In that capacity he was in the harbour of St John de Ulloa, in the gulf of Mexico, where he behaved most gallantly in the glorious actions under Sir John Hawkins, and returned with him to England with great reputation, though not worth a groat. Upon this he projected a design against the Spaniards in the West Indies; which he no sooner published, than he had volunteers enough ready to accompany him. In 1570, he made his first expedition with two ships; and the next year with only one, in which he returned safe, if not with such advantages, as he expected. He made another expedition in 1572, wherein he did the Spaniards some mischief, and gained considerable booties. In these expeditions he was much assisted by a nation of Indians, who then were, and have been ever since, engaged in perpetual wars with the Spaniards. The prince of these people was named *Pedro*; to whom Drake presented a fine cutlass from his side, which he saw the Indian greatly admired. Pedro, in return, gave him four large wedges of gold; which Drake threw into the common stock, saying, That he thought it but just that such as bore the charge of so uncertain a voyage on his credit, should share the utmost advantage that voyage produced. Then, embarking his men with all the wealth he had obtained, which was very considerable, he bore away for England, where he arrived in August 1573.

His success in this expedition, joined to his honourable behaviour towards his owners, gained him high reputation; and the use he made of his riches, a still greater. For, fitting out three stout frigates at his own expence, he sailed with them to Ireland; where, under Walter earl of Essex, the father of the famous unfortunate earl, he served as a volunteer, and did many glorious actions. After the death of his noble patron, he, returned to England; where Sir Christopher Hatton introduced him to her majesty, and procured him countenance and protection at court. By this means he acquired a capacity of undertaking that grand expedition which will render his name immortal. The first thing he proposed was a voyage into the South seas through the straits of Magellan; which was what hitherto no Englishman had ever attempted. This project was well received at court: the queen furnished him with means; and his own fame quickly drew together a sufficient force. The fleet with which he sailed on this extraordinary undertaking, consisted only of five vessels, small when compared with modern ships, and no more than 164 able men. He sailed on the 13th of December 1577; on the 25th fell in with the coast of Barbary, and on the 29th with Cape Verd. On the 18th of March he passed the equinoctial, made the coast of Brazil on the 5th of April, and entered the river de la Plata, where he lost the company of two of his ships; but meeting them again, and taking out their provisions, he turned them adrift. On the 29th of May he entered the port of St Julian's, where he continued two months for the sake of laying in provisions; on the 20th of August he entered the straits of Magellan, and on the 25th of September passed them, having then only his own ship. On the 25th of November he came to Macao, which he had appointed for a place of rendezvous in case his ships separated; but Captain Winter his vice admiral having repassed the straits, was returned to England. Thence he continued his voyage along the coast of Chili and Peru, taking all opportunities of seizing Spanish ships, and attacking them on shore, till his men were sated with plunder; and then, coasting America to the height of 48 degrees, he endeavoured to find a passage that way back into our seas, but could not. However he landed, and called the country *New Albion*, taking possession of it in the name and for the use of Queen Elizabeth; and having careened his ship, set sail from thence on the 29th September 1579, for the Moluccas. He is supposed to have chosen this passage round, partly to avoid being attacked by the Spaniards at a disadvantage, and partly from the lateness of the season, whence dangerous storms and hurricanes were apprehended. On the 13th of October he fell in with certain islands inhabited by the most barbarous people he had met with in all his voyage: on the 4th of November he had sight of the Moluccas; and, coming to Ternate, was extremely well received by the king thereof, who appears from the most authentic relations of this voyage to have been a wise and politic prince. On the 10th of December he made Celebes; where his ship unfortunately ran upon a rock, the 9th of January following; from which, beyond all expectation, and in a manner miraculously, they got off, and continued their course. On the 16th of March he arrived at Java Major; and from thence he intended to have directed his course to Malacca; but found himself obliged to alter his purpose, and to think of returning home. On the 25th of March 1580, he put this design in execution; and on the 15th of June he doubled the Cape of Good Hope, having then on board 57 men, and but three casks of water. On the 12th of July he passed the line, reached the coast of Guinea on the 16th, and there watered. On the 11th of September he made the island of Tercera; and on the 3d of November entered the harbour of Plymouth. This voyage round the world was performed in two years and about ten months. Shortly after his arrival, the queen going to Deptford went on board his ship; where, after dinner, she conferred on him the order of knighthood, and declared her absolute approbation of all he had done. She likewise gave directions for the preservation of his ship, that it might remain a monument of his own and his

Drake.

country's glory. This celebrated ship, which had been contemplated many years at Deptford, at length decaying, it was broke up, and a chair, made out of the planks, was presented to the university of Oxford; upon which the famous Abraham Cowley made the following verses:

> To this great ship, which round the world has run,
> And match'd in race the chariot of the sun:
> This Pythagorean ship (for it may claim
> Without presumption, so deserv'd a name,
> By knowledge once, and transformation now)
> In her new shape this sacred port allow.
> Drake and his ship could not have wished, from fate,
> A happier station, or more blest estate:
> For lo! a seat of endless rest is given,
> To her in Oxford, and to him in heaven.
>
> Works, Vol. II.

In the year 1585, he sailed with a fleet to the West Indies, and took the cities of St Jago, St Domingo, Carthagena, and St Augustine. In 1587, he went to Lisbon with a fleet of 30 sail; and having intelligence of a great fleet assembled in the bay of Cadiz, which was to have made part of the armada, he with great courage entered that port, and burnt there upwards of 10,000 tons of shipping: which he afterwards merrily called *burning the king of Spain's beard*. In 1588, when the armada from Spain was approaching our coasts, Sir Francis Drake was appointed vice-admiral under Charles Lord Howard of Effingham, high admiral of England, where fortune favoured him as remarkably as ever: for he made prize of a very large galleon, commanded by Don Pedro de Valdez, who was reputed the projector of this invasion. This affair happened in the following manner: On the 22d of July, Sir Francis observing a great Spanish ship floating at a distance from both fleets, sent his pinnace to summon the commander to yield. Valdez replied, with much Spanish solemnity, that they were 450 strong; that he himself was Don Pedro, and stood much upon his honour; and thereupon propounded several conditions, upon which he was willing to yield. But the vice-admiral replied, that he had no leisnre to parley; but if he thought fit instantly to yield, he might; if not, he should soon find that Drake was no coward. Pedro, hearing the name of Drake, immediately yielded, and with 46 of his attendants came on board Drake's ship. This Don Pedro remained about two years Sir Francis Drake's prisoner in England; and when he was released, paid him for his own and his captain's liberties a ransom of 3500l. Drake's soldiers were well recompensed with the plunder of this ship; for they found in it 55,000 ducats of gold, which were divided among them.

A little before this formidable Spanish armament put to sea, the ambassador of his Catholic majesty had the confidence to propound to Queen Elizabeth, in Latin verse, the terms upon which she might hope for peace; which, with an English translation by Dr Fuller, we will insert in this place, because Drake's expedition to the West Indies makes a part of this message. The verses are these:

> *Te veto ne pergas bello defendere Belgas;*
> *Quæ Dracus eripuit nunc restituantur oportet:*
> *Quas pater evertit jubeo te condere cellas:*
> *Religio Papæ fac restituantur ad unguem.*

Drake, Drakenborch.

> These to you are our commands,
> Send no help to th' Netherlands:
> Of the treasure took by Drake,
> Restitution you must make:
> And those abbeys build anew,
> Which your father overthrew:
> If for any peace you hope,
> In all points restore the pope.

The queen's extempore return:

> *Ad Græcas, bone rex, fiant mandata kalendas.*

> Worthy king, know this yonr will
> At Latter Lammas we'll fulfil.

In the year 1559, Sir Francis Drake commanded as admiral the fleet sent to restore Don Antonio king of Portugal, the command of the land forces being given to Sir John Norris: but they were hardly got to sea, before the commanders differed, and so the attempt proved abortive. The war with Spain continuing, a more effectual expedition was undertaken by Sir John Hawkins and Sir Francis Drake, against thier settlements in the West Indies, than had hitherto been made during the whole course of it: but the commanders here again not agreeing about the plan, this also did not turn out so successfully as was expected. All difficulties, before these two last expeditions, had given way to the skill and fortune of Sir Francis Drake; which probably was the reason why he did not bear these disappointments so well as he otherwise would have done. A strong sense of them is supposed to have thrown him into a melancholy, which occasioned a bloody flux; and of this he died on board his own ship, near the town of Nombre de Dios in the West Indies, on the 28th of January 1595-6. His death was lamented by the whole nation, and particularly by his countrymen; who had great reason to love him from the circumstance of his private life, as well as to esteem him in his public character. He was elected burgess for the town of Bossiny, alias Tintagal, in the county of Cornwall, in the 27th parliament of Queen Elizabeth; and for Plymouth in Devonshire, in the 35th of the same reign. This town had very particular obligations to him: for, in the year 1587, he undertook to bring water into it, through the want of which, till then, it had been grievously distressed; and he performed it by conducting thither a stream from springs at eight miles distance, that is to say, in a straight line: for in the manner he brought it, the course of it runs upwards of 20 miles.

DRAKENBORCH, Arnold, doctor of laws. This celebrated literary character was a native of Utrecht, and was born on the 1st of January 1684, and in which city he was afterwards professor of rhetoric and history. Grævius and Burmann taught him the belles lettres, and Cornelius Van Eck was his preceptor while he devoted his attention to the law. He succeeded Professor Burmann in the year 1716, and terminated his mortal career in 1748, in the 64th year of his age. He was an author of very considerable eminence, as the following publications sufficiently evince. His dissertation entitled, *Disputatio Philolog. Hist.*

Hist. de præfectis urbis, in 4to, proves him to have been an able philologist, and gave flattering indications of future eminence. Its intrinsic merit caused it to be reprinted at Frankfort-on-the-Oder, in 1750, by Professor Uhl, accompanied with a life of its learned author. His next work, entitled *Disputatio de officio præfectorum prætorio*, was published in the year 1707; and ten years after his *C. Silii Italici Punicorum*, in 17 books, to render which perfect and complete, nothing was omitted by this great man; many historical subjects being engraved for the purpose of elucidating the text, to which his own copious and learned annotations most powerfully contributed. His splendid edition of Livy, with a life of that eminent historian, will render his name immortal. It is entitled *T. Livii Patavini historiarum ab urbe condita libri, qui supersunt, omnes.* Lugd. Batav. 1738 and 1746; 7 tom. The preface to this work is very long, and replete with erudition, giving a particular account of all the literary characters who have at different periods commented on the works of Livy. He took the edition of Gronovius for his model, as being in his estimation the most correct; but he made many important alterations on the authority of manuscripts which it is probable Gronovius had either never seen, or not taken the pains to consult. Upon the whole, this edition of Livy is at once the most elaborate, interesting, and instructive, ever given to the world, since into it he has introduced the criticisms of Duchier, Gronovius, Perizonius, and Sigonius; in addition to his own, which are certainly fraught with much literature and deep discernment.

DRAMA, a poem containing some certain action, and representing a true picture of human life, for the delight and improvement of mankind. The principal species of the drama are two, comedy and tragedy. See the subject fully considered in a historical view of the ancient and modern drama, in the article DRAMA, SUPPLEMENT.

DRAMATIC, an epithet given to pieces written for the stage. See POETRY.

DRAN, HENRY FRANCIS LE, a French surgeon of distinguished eminence, was born in the year 1685. His father followed the same profession at Paris, and was highly celebrated for his treatment of cancers. Dran had much experience as well as abilities, although his anatomical knowledge was rather circumscribed, and his acquaintance with books was far from being extensive. In 1730, he published in 8vo a valuable work, entitled *Parallele des differentes Manières de tirer la Pierre hors de la Vessie.* In this work he takes a comparative view of the different modes of performing the hazardous operation of lithotomy, preferring the lateral method which was practised by Cheselden. In the year 1731, he published his *Observations de Chirurgie, avec des Reflections*, in 2 vols 12mo, which is justly considered as a valuable performance for men who are employed in the practice of surgery. In 1757, appeared his *Traité ou Reflections tirées de la Pratique sur les Playes d' Armes à Feu*; in which he gives the results of his own practice while in the army, with efficacious methods for the cure of gun-shot wounds. Gataker translated into English his *Traité des Operations de Chirurgie*, to which many interesting observations were added by Cheselden. In 1763, were published his *Consultations sur la plupart des Maladies qui sont du Ressort de la Chirurgie*; the plan of which is admirably calculated for the instruction of young practitioners. As at least one evidence of the merit of Dran's works, translations of them have been made into various languages. If his judgment was penetrating, he was equally famed for his successful operations. He died at Paris in the year 1770, in the 85th year of his age.

DRANK, among farmers, a term used to denote wild oats, which never fail to infest worn-out lands; so that, when ploughed lands run to these weeds and thistles, the farmer knows it is high time to fallow them, or else to sow them with hay seed, and make pasture of them.

DRAPERY, in *Sculpture* and *Painting*, signifies the representation of the clothing of human figures, and also hangings, tapestry, curtains, and most other things that are not carnations or landscapes. See PAINTING, CRAYON, DRAWING, and MINIATURE.

DRASTIC, in *Physic*, an epithet bestowed on such medicines as are of present efficacy, and potent in operation; and is commonly applied to emetics and cathartics.

DRAVE, a large navigable river, which, taking its rise in the archbishopric of Saltzburgh, in Germany, runs south-east through Stiria; and continuing its course, divides Hungary from Sclavonia, and falls into the Danube at Esseck.

DRAUGHT, in *Medicine*. See POTION.

DRAUGHT, in trade, called also *cloff* or *clouch*, is a small allowance on weighable goods, made by the king to the importer, or by the seller to the buyer, that the weight may hold out when the goods are weighed again.

The king allows 1℔ draught for goods weighing no less than 1 cwt. 2℔ for goods weighing between 1 and 2 cwt. 3℔ for goods weighing between 2 and 3 cwt. 4℔ from 3 to 10 cwt. 7℔ from 10 to 18 cwt. 9℔ from 18 to 30 or upwards.

DRAUGHT is also used sometimes for a bill of exchange, and commonly for an order for the payment of any sum of money due, &c. Then the person who gives the order, is said to draw upon the other.

DRAUGHT, or, as it is pronounced, *Draft*, in *Architecture*, the figure of an intended building described on paper; wherein are laid down, by scale and compass, the several divisions and partitions of the apartments, rooms, doors, passages, conveniences, &c, in their due proportion.

It is usual, and exceedingly convenient, before a building is begun to be raised, to have draughts of the ichnography, or ground-plot of each floor or story: as also of the form and fashion of each front, with the windows, doors, ornaments, &c. in an orthography, or upright. Sometimes the several fronts, &c. are taken, and represented in the same draught, to show the effect of the whole building: this is called a *scenography*, or *perspective*.

DRAUGHT, the depth of a body of water necessary to float a ship: hence a ship is said to draw so many feet of water, when she is borne up by a column of water of that particular depth. Thus, if it requires a body of water whose depth is equal to 12 feet, to float or buoy up a ship on its surface, she is said to draw 12 feet water; and that this draught may be more readily known, the feet are marked on the stem and stern post, regularly from the keel upwards.

Draught-Hooks, are large hooks of iron, fixed on the cheeks of a cannon carriage, two on each side, one near the trunnion-hole, and the other at the train, distinguished by the name of *fore* and *hind draught hooks.* Large guns have draught hooks near the middle transom, to which are fixed the chains that serve to keep the shafts of the limbers on a march. The fore and hind hooks are used for drawing a gun backwards or forewards, by men with strong ropes, called *draught-ropes*, fixed to these hooks.

Draught-Horse, in farming, a sort of coarse-made horse, destined for the service of a cart or plough.

DRAWBACK, in commerce, certain duties, either of the customs or of the excise, allowed upon the exportation of some of our own manufactures; or upon certain foreign merchandises, that have paid duty on importation.

The oaths of the merchants importing and exporting are required to obtain the drawback on foreign goods, affirming the truth of the officers certificate on the entry, and the due payment of the duties: and these may be made by the agent or husband of any corporation or company; or by the known servant of any merchant usually employed in making his entries, and paying his customs. In regard to foreign goods entered outward, if less quantity or value be fraudulently shipped out than what is expressed in the exporter's certificate, the goods therein mentioned, or their value, are forfeited, and no drawback to be allowed for the same. Foreign goods exported by certificate in order to obtain the drawback, not shipped or exported, or relanded in Great Britain, unless in case of distress to save them from perishing, are to lose the benefit of the drawback, and are forfeited, or their value, with the vessel, horses, carriages, &c. employed in the relanding thereof; and the persons employed in the relanding them, or by whose privity they are relanded, or into whose hands they shall knowingly come, are to forfeit double the amount of the drawback. Officers of the customs conniving at, or assisting in any fraud relating to certificate goods, besides other penalties, are to forfeit their office, and suffer six months imprisonment without bail or mainprise; as are also masters, or persons belonging to the ships employed therein. Bonds given for the exportation of certificate goods to Ireland must not be delivered up, nor drawback allowed for any goods, till a certificate under the hands and seals of the collector or comptroller, &c. of the customs be produced, testifying the landing.

Draw-Bridge, a bridge made after the manner of a float, to draw up or let down, as occasions serve, before the gate of a town or castle. See Bridge.

A draw-bridge may be made after several different ways; but the most common are made with plyers, twice the length of the gate, and a foot in diameter. The inner square is traversed with a cross, which serves for a counterpoise; and the chains which hang from the extremities of the plyers to lift up or let down the bridge are of iron or brass.

In navigable rivers it is sometimes necessary to make the middle arch of bridges with two moveable platforms, to be raised occasionally, in order to let the masts and rigging of ships pass through. This kind of draw-bridge is represented in Plate CLXVIII. where AB is the width of the middle arch; AL and BL, the two piers that support the draw-bridge NO, one of the platforms of which is raised, and the other let down, having the beam PQ for its plyer. To NO are suspended two moveable braces EH, EH; which resting on the support E, press against the bracket M, and thereby strengthen the draw-bridge. These braces are conducted to the rest by means of the weight S, pulling the chain SLF.

Draw-Net, a kind of net for taking the larger sort of wildfowl, which ought to be made of the best sort of packthread, with wide meshes; they should be about two fathoms deep and six long, verged on each side with a very strong cord, and stretched at each end on long poles. It should be spread smooth and flat upon the ground; and strewed over with grass, sedge, or the like, to hide it from the fowl: and the sportsman is to place himself in some shelter of grass, fern, or some such thing.

DRAWING, in general, denotes the action of pulling out, or hauling along; thus we read of tooth-drawing, wire-drawing, &c.

DRAWING,

THE art of representing the appearances of objects upon a plane surface, by means of lines, shades, and shadows, formed with certain materials adapted to the purpose.

§ 1. *Of the proper Materials for Drawing, and the manner of using them.*

The first thing necessary for a beginner is to furnish himself with proper materials, such as black lead pencils, crayons of black, white, or red chalk, crow-quill pens, a rule and compasses, camels hair pencils, and Indian ink. He must accustom himself to hold the pencil farther from the point than one does a pen in writing; which will give him a better command of it, and contribute to render the strokes more free and bold. The use of the pencil is to draw the first sketches or outlines of the piece, as any stroke or line that is amiss may in this be more easily rubbed out than in any other thing; and when he has made the sketch as correct as he can with the pencil, he may then draw carefully the best outline he has got, with his crow-quill pen and ink (A); after which he may discharge the pencil lines, by rubbing the piece gently with the crumb of stale bread or Indian rubber. Having thus got the outline clear, his next work is to shade the piece properly, either by drawing fine strokes with his pen where it requires to be shaded, or by washing it with his pencil and the Indian ink. As to his rule and compasses, they are never, or very rarely to be used, except in measuring the proportions of figures after he has drawn them, to prove whether they are right or not; or in houses, fortifications, and other pieces of architecture.

§ 2. *Of Drawing Lines, Squares, Circles, and other regular and irregular Figures.*

Having got all these implements in readiness, the first practice must be to draw straight and curve lines, with ease and freedom, upwards and downwards, sidewise to the right or left, or in any direction whatsoever. He must also learn to draw, by command of hand, squares, circles, ovals, and other geometrical figures: for, as the alphabet, or a knowledge of the letters, is an introduction to grammar; so is geometry to drawing. The practice of drawing these simple figures till he is master of them, will enable him to imitate, with greater ease and accuraey, many things both in nature and art. And here it is proper to admonish him, never to be in a hurry: but to make himself perfectly master of one figure before he proceeds to another: the advantage, and even necessity, of this, will appear as he proceeds. Two observations more may be added: 1. That he accustom himself to draw all his figures very large, which is the only way of acquiring a free bold manner of designing. 2. That he practise drawing till he has gained a tolerable mastery of his pencil, before he attempts to shadow any figure or object of any kind whatever.

§ 3. *Of Drawing Eyes, Ears, Legs, Arms, Hands, Feet, &c.*

As to the drawing of eyes and ears, legs and arms, the learner will have very little more to do than to copy carefully the examples given in Plate CLXXVII. and CLXXVIII. taken from Sebastian le Clerc's drawing book. But the actions and postures of the hands are so many and various, that no certain rules can be giving for drawing them, that will universally hold good. Yet as the hands and feet are difficult members to draw, it is very necessary, and well worth while, to bestow some time and pains about them, carefully imitating their various postures and actions, so as not only to avoid all lameness and imperfection, but also to give them life and spirit. To arrive at this, great eare, study, and practice, are requisite; particularly in imitating the best prints or drawings that can be got of hands and feet (some good examples of which are given in Plate CLXXVIII.); for, as to the mechanical rules of drawing them by lines and measures, they are not only perplexed and difficult, but also contrary to the practice of the best masters. One general rule, however, may be given (which is universally to be observed in all subjects), and that is, Not to finish perfectly at first any single part, but to sketch out faintly, and with light strokes of the pencil, the shape and proportion of the whole hand, with the action and turn of it; and after considering carefully whether this first sketch be perfect, and altering it wherever it is amiss, you may then proceed to the bending of the joints, the knuckles, the veins, and other small particulars, which, when the learner has got the whole shape and proportion of the hand or foot, will not only be more easily but also more perfectly designed.

§ 4. *Of Drawing Faces.*

The head is usually divided into four equal parts, (1.) From the crown of the head to the top of the forehead. (2.) From the top of the forehead to the eyebrows. (3.) From the eyebrows to the bottom of the nose. (4.) From thence to the bottom of the chin. But this proportion is not constant; those features in different men being often very different as to length and shape. In a well-proportioned face, however, they are nearly right. To direct the learner therefore in forming a perfect face, his first business is to draw an oval, or rather the form of an egg; in the middle of which, from the top to the bottom, draw a perpendicular line. Through the centre or middle of this line draw a diameter line, directly across from one side to the other of your oval. On these two lines all the features of your face are to be placed as follows: Divide your perpendicular line into four equal parts; the first must be allotted to the hair of the head; the second is from the top of the forehead to the top of the nose between the eyebrows; the third is from thence to the bottom of the nose; and the fourth includes the lips and chin. Your diameter line, or the breadth of the face, is always supposed to be the length of five eyes; you must therefore divide it into five equal parts, and place the eyes upon it so as to leave exactly the length of one eye betwixt them. This is to be understood only of a full front face, Plate CLXXVII. fig. *a*; for if it turn to either side, then the distances are to be lessened on that side which turns from you, less or more in proportion to its turning (fig. *b b b*). The top of the ear is to rise parallel to the eyebrows, at the end of the diameter line; and the bottom of it must be equal to the bottom of the nose. The nostrils ought not to come out farther than the corner of the eye in any face; and the middle of the mouth must always be placed upon the perpendicular line.

§ 5. *Of Drawing Human Figures.*

When the learner is tolerably perfect in drawing faces, heads, hands, and feet, he may next attempt to draw the human figure at length. In order to which, let him first sketch the head; then draw a perpendicular

---

(A) The ink made use of for this purpose must not be common but Indian ink; which is much softer than the other, and does not run: by mixing it with water, it may be made to any degree of strength, and used in a pen like common ink.

lar line from the bottom of the head seven times its length (for the length of the head is about one-eighth part of the length of the figure).

The best proportioned figures of the ancients are 7$\frac{3}{4}$ heads in height. If, therefore, the figure stands upright, (as fig. *a*, Plate CLXXIX.) draw a perpendicular line from the top of the head to the heel, which must be divided into two equal parts. The bottom of the belly is exactly the centre. Divide the lower part into two equal parts again, the middle of which is the middle of the knee. For the upper part of the figure, the matter must be varied. Take off with your compasses the length of the face (which is three parts in four of the length of the head; from the throat pit to the pit of the stomach is one face, from thence to the navel is another, and from thence to the lower rim of the belly is a third. The line must be divided into seven equal parts. Against the end of the first division, place the breasts; the second comes down to the navel; the third to the privities; the fourth to the middle of the thigh; the fifth to the lower part of the knee; the sixth to the lower part of the calf; and the seventh to the bottom of the heel, the heel of the bearing leg being always exactly under the pit of the throat. But as the essence of all drawing consists in making at first a good sketch, the learner must in this particular be very careful and accurate; he ought to draw no one part perfect or exact till he see whether the whole draught be good; and when he has altered that to his mind, he may then finish one part after another as perfectly as he can.

There are some who, having a statue to copy, begin with the head, which they finish, and then proceed in the same manner to the other parts of the body, finishing as they go: but this method generally succeeds ill; for if the head be made in the least too big or too little, the consequence is a disproportion between all the parts, occasioned by their not having sketched the whole proportionably at first. Let the learner remember, therefore, in whatever he intends to draw, first to sketch its several parts, measuring the distances and proportions between each with his finger or pencil, without using the compasses; and then judge of them by the eye, which by degrees will be able to judge of truth and proportion, and will become his best and principal guide. And let him observe, as a general rule, always to begin with the right side of the piece he is copying: for by that means he will always have what he has done before his eyes; and the rest will follow more naturally, and with greater ease; whereas if he begin with the left side, his hand and arm will cover what he does first, and deprive him of the sight of it; by which means he will not be able to proceed with so much ease, pleasure, or certainty.

As to the order and manner of proceeding in drawing the human body, he must first sketch the head; then the shoulders in the exact breadth; then draw the trunk of the body, beginning with the armpits (leaving the arms till afterwards), and so draw down to the hips on both sides; and be sure he observe the exact breadth of the waist. When he has done this, let him then draw that leg which the body stands upon; and afterwards the other which stands loose; then the arms; and last of all the hands.

He must take notice also of the bowings and bendings that are in the body; making the part which is opposite to that which bends correspond to it in bending with it. For instance: If one side of the body bend in, the other must stand out answerable to it; if the back bend in, the belly must stick out; if the knee bend out, the ham must fall in; and so of any other joint of the body. Finally, he must endeavour to form all parts of the figure with truth, and in just proportion; not one arm or one leg bigger or less than the other; not broad Herculean shoulders, with a thin and slender waist; nor raw and bony arms, with thick and gouty legs: but let there be a kind of harmonious agreement amongst the members, and a beautiful symmetry throughout the whole figure.

Proportions and Measures of the Human Body. The centre or middle part, between the two extremes of the head and feet of a new born child, is in the navel, but that of an adult is in the os pubis; and the practice of dividing the measures of children into four, five, or six parts, whereof the head is one, is made use of by painters and sculptors.

A child of two years old has about five heads in its whole length, but one of four or five years old has near six; about the fifteenth or sixteenth year, seven heads are the proportion or measure, and the centre inclines to the upper part of the pubis. Hence it appears, as the growth of the body advances, there is a gradual approach to the proportion of an adult of near eight heads in the whole length, of which, as mentioned above, the head makes one.

Agreeable to these principles, the following Table is constructed, exhibiting the proportions of the parts of a man and of a woman, as they were fixed by the ancients, and measured by M. Audran from the Apollo Pythius (Plate CLXXX.) in the garden of the Vatican at Rome, and the Venus Aphrodites (Plate CLXXXI.) belonging to the family of the Medicis. Supposing the figures to stand upright and duly poised on both legs, the whole height of the former is divided into 31$\frac{1}{2}$ parts, being 7 heads 3 parts and 6 minutes; and that of the latter into 31 parts, being 7 heads and 3 parts.

LENGTH of the HEAD and TRUNK of the BODY.	*Apollo.*			*Venus.*		
	Hds.	Pts.	Min.	Hds.	Pts.	Min.
From the top of the head to the bottom of the chin 4 parts, or - -	1	0	0	1	0	0
the bottom of the chin to the top of the sternum or breast-bone -	0	1	7	0	1	8
the top of the sternum to the pit of the stomach - - - -	0	3	10	0	3	6
the pit of the stomach to the navel - - - -	0	2	10	0	2	7
the navel to the pubis - - - - -	0	3	6	0	3	9
Length of the head and trunk of the body - -	3	3	9	3	3	6

LENGTH

Length of the Lower Extremities.

	Apollo.			*Venus.*		
	Hds.	Pts.	Min.	Hds.	Pts.	Min.
From the pubis to the small of the thigh above the patella or knee-pan	1	2	6	1	2	3
the small of the thigh to the joint or middle of the knee	0	1	9	0	1	6
the joint of the knee to the small of the leg above the ankle	1	1	9	1	2	0
the top to the bottom of the ankle	0	1	0	0	1	0
the bottom of the ankle to the bottom of the heel	0	0	9	0	0	9
Length of the lower extremities	3	3	9	3	3	6
Length of the head and trunk, as above	3	3	9	3	3	6
Total length of the figures	7	3	6	7	3	0

Length of the Fore Arm or Upper Extremities.

From the top of the shoulder to the elbow	1	2	3	1	2	3
the elbow to the hand	1	1	2	1	0	6
the joint of the hand to the root of the middle finger	0	1	8	0	1	6
the root to the tip of the middle finger	0	1	10	0	1	7
Length of the upper extremities	3	2	11	3	1	10

Breadth between the outward angles of the eyes	0	1	6	0	1	7
of the face at the temples	0	2	2	0	2	2
of the upper part of the neck	0	2	0	0	1	11
over the shoulders	0	0	0	1	3	8
of the body below the armpits	1	2	5	1	1	8
between the nipples	2	0	7	0	3	8
from the bottom of the chin to the horizontal line of the nipples	1	0	7	1	0	1
of the body at the small of the waist	1	1	0	1	0	8
over the loins or os ilium	1	1	3	1	1	6
over the haunches or thigh-bones	1	1	5	1	2	3
of the thigh at the top	0	3	0	0	3	1
of the thigh below the middle	0	2	8½	0	2	7
of the thigh above the knee	0	1	8	0	2	0
of the leg below the knee	0	1	6	0	1	10½
at the calf of the leg	0	2	4	0	2	3
below the calf	0	1	7	0	1	11½
above the ankle	0	1	2	0	1	2
of the ankle	0	1	4	0	1	3
below the ankle	0	1	1½	0	1	1
middle of the foot	0	1	4	0	1	3
at the roots of the toes	0	1	7	0	1	7
of the arm over the biceps muscle	0	1	8	0	1	9
of the arm over the elbow	0	1	6	0	1	5
of the arm below the elbow over the long supinator	0	1	10	0	1	7
at the wrist	0	1	1	0	1	0
of the hand over the first joint of the thumb	0	1	9	0	1	8
of the hand over the roots of the fingers	0	1	7	0	1	6
over the heads of the scapulæ or shoulder-blades	1	2	0	1	1	4
Length of both arms and hands, each of the Apollo's being 3h. 2p. 11m. and the Venus 3h. 1p. 5m.	7	1	10	6	2	10
Breadth between the tips of the middle fingers of each hand when the arms are stretched out horizontally	8	3	10	8	0	2

Side View.

Length from the top of the head to the shoulder	1	1	8	1	1	6
from the top of the shoulder to the loins above the hip	1	3	8	1	1	7
from the loins to the lower part of the hip	1	0	2	1	2	1
from the hip to the side of the knee, opposite to the top of the patella	1	2	0	1	0	11
from the side of the knee to the bottom of the heel	2	0	5	2	0	11
Length of the figures	7	3	6	7	3	0

Side View.

	Apollo.			Venus.		
	Hds.	Pts.	Min.	Hds	Pts.	Min.
Thickness from the fore to the back part of the skull	0	3	6	0	3	4
from the wing of the nose to the tip of the ear	0	1	8½	0	1	6
of the upper part of the neck	0	2	0	0	1	11
from the breast to the back over the nipples	1	0	6	1	0	6
from the belly to the small of the back	0	3	6	0	3	7
from the belly above the navel to the back of the loins	0	3	9	1	0	2
from the bottom of the belly to the round of the hip	1	0	0	1	0	5
from the fore part of the thigh to the bottom of the hip	0	3	2	0	3	7
of the thigh at middle	0	3	3	0	3	6½
of the thigh above the knee	0	2	1	0	2	3
at the middle of the knee below the patella	0	2	1	0	2	2
of the leg below the knee	0	1	9	0	1	11
of the leg at the calf	0	1	8	0	1	9
of the leg at the ankle	0	1	5½	0	1	4
of the foot at the thickest part	0	0	0	0	0	3
length of the foot	1	0	6	1	0	4½
from the fore part of the bend of the foot to the lower and back part of the heel	0	0	0	0	2	2
of the arm over the biceps	0	2	0	0	1	9
over the elbow	0	1	6	0	1	6
below the elbow	0	1	5	0	1	7
at the wrist	0	1	1	0	0	11
below the joint of the wrist	0	1	0	0	0	10
of the hand at the roots of the fingers	0	0	5½	0	0	5
at the roots of the nails	0	0	3½	0	0	3

The other most admired antique statues differ a little from these proportions, the Laocoon measuring 7 h. 2 p. 3 m. the Hercules 7 h. 3 p. 7 m. the Pyramus 7 h. 2 p. the Antinous 7 h. 2 p. the Grecian shepherdess 7 h. 3 p. 6 m. and the Mirmillo 8 h. But all their other proportions are allowed to be harmonious and agreeable to the characters of the figures they represent.

The most remarkable differences of the symmetry or proportions of a man and of a woman to be observed from the Table are: First, The shoulders of a man are broader, measuring two heads, and the haunches narrower, measuring 1 h. 1 p. 5 m. whereas the shoulders of a woman measure only 1 h. 3 p. 8 m. and the haunches measure 1 h. 2 p. 3 m. The sternum or breast-bone of a man is longer, measuring 3 p. 8 m. and the sternum of the woman only 3 p. 3 m. On the contrary, the pelvis of a man is less, measuring from the top to bottom only 4 p. whereas the pelvis of a woman measures from the top to the bottom 4 p. 3 m.

It is a leading principle, in which every person conversant in designing has agreed, that without a perfect knowledge of the proportions, nothing can be produced but monstrous and extravagant figures; and it is also universally admitted, that the ancient Greek and Roman sculptors attained the highest success in producing the most perfect models.

The greatest of the modern artists who have examined their figures with attention admit, that several of the ancient sculptors in some degree have excelled nature, they never having found any man so perfect in all his parts as some of their figures are. Their opportunities indeed were great; Greece abounded with beauties; and Rome being mistress of the world, every thing that was curious and beautiful was brought to it from all parts. Their motives were also powerful; religion, glory, and interest. They considered it as a kind of religious worship to give the figures of their gods so much nobleness and beauty as to be able to attract the love and veneration of the people. Their own glory was also concerned, particular honours being bestowed on those who succeeded; and for their fortune they had no further care to take when they once arrived at a certain degree of merit.

Attitudes and Action of the Muscles. If a strong person is to be represented in a vigorous action, such as Hercules, &c. after a suitable proportion to such a figure and the action is designed, the parts or limbs employed in the chiefest force of the action ought to be considered. If the figure is standing, the foot must be placed in a right line, or perpendicular to the trunk or bulk of the body, where the centre of gravity may be placed *in æquilibrio*. This centre is determined by the heel: or, if the figure is upon tiptoe, then the ball of the great toe is in the centre. The muscles of the leg which supports the body ought to be swelled, and their tendons drawn more to extension than those of the other leg, which is only placed so as to receive the weight of the body towards that way to which the action inclines it. For example, suppose Hercules with a club striking at any thing before him towards the left side: Then let his right leg be placed so as to receive the whole weight of the body, and the left loosely touching the ground with his toes. Here the external muscles of the right leg ought to be expressed very strong; but those of the left scarcely appearing more than if it were in some sedentary posture, except in the present case. The foot being extended, the muscles which compose the calf of the leg are in action and appear very strong; though it is not meant that *all* the muscles of the right leg, which supports the weight of of the body, ought to be expressed very strong or equally swelled, but those most tumefied which are chiefly concerned in the action or posture that the leg is then in. For example, if the leg or tibia is extended, then the extending muscles placed on the thigh are most swelled: if it is bended, then the bending muscles and their tendons appear most. The like may be observed of the whole body in general when it is put into vigorous action. The Laocoon formerly in the Vatican garden at Rome, now in the Louvre at Paris, furnishes an example of this muscular appearance through the whole; but in the Antinous, Apollo, also in the Louvre, and other figures of the ancients, in postures where no considerable actions are designed, we see their muscles expressed but faintly, or scarcely appearing.

The clavicles or collar-bones, and muscles in general, do not appear in women as in men; nor will any action in which a woman uses her utmost strength occasion such swellings or risings of the muscles to appear as they do in men, since the great quantity of fat placed under the skin of women so clothes their muscles, &c. as to prevent any such appearance.

Effects of the Exertion of the Muscles. The following are the most obvious effects of the exertion of several of the muscles; of those, to wit, which chiefly demand the attention of an artist.

If either of the mastoid muscles (Plate CLXXXII. 1. 1.) act, the head is turned to the contrary side, and the muscle which performs that action appears very plain under the skin.

If the arms are lifted up, the deltoid muscles placed on the shoulders, which perform that action, swell, and make the extremities of the spines of the shoulder-blades (Plate CLXXXIII. 3. 3.), called the tops of the shoulders, appear indented or hollow.

The shoulder-blades following the elevation of the arms, their bases (Plate CLXXXIII. 4. 4.) incline at that time obliquely downward.

If the arms are drawn down, put forwards, or pulled backwards, the shoulder-blades necessarily vary their positions accordingly. All these particulars are to be learned by consulting the life only; when being well acquainted with what then appears in every action, the artist will be able to form an adequate idea how it ought to be expressed. These circumstances are little known; hence seldom attended to in designing.

When the cubit or fore-arm is bended, the biceps (Plate CLXXXII. 5. 5.) has its belly very much raised, as appears in the left arm. The like may be observed of the triceps (Plate CLXXXIII. 6. 6.) when the arm is extended as observed in the right arm.

The straight muscles of the abdomen (Plate CLXXXII. 7. 7.) appear very strong when rising from a decumbent posture.

The parts of the great serratus muscle (ib. 8. 8.) which are received in the teeth or beginnings of the oblique descending muscle immediately below, are very much swelled when the shoulder on the same side is brought forwards; that serratus muscle then being in action in drawing the scapular forwards.

The long extending muscles of the trunk (Plate CLXXXIII. 9. 9.) act alternately in walking, after this manner: If the right leg bears the weight of the body, and the left is in translation as on tiptoe, the last-mentioned muscles of the back on the left side may be observed to be tumefied on the other side about the region of the loins, and so on the other side.

The trochanters, or outward and uppermost heads of the thigh-bones (Plate CLXXXIII. 10. 10.), vary in their positions in such a manner as no precise observation can explain their several appearances; but the study after the life ought to be carefully attended to.

If the thigh is extended, as when the whole weight of the body rests on that side, the gluteus or buttock muscle (Plate CLXXXIII. 11. 11.) makes a very different appearance from what offers at another time; but if the thigh is drawn backwards, that muscle appears still more and more tumefied.

When the whole leg is drawn upwards forwards, and at the same time the foot is inclined inwards, the upper part of the sartorius muscle (Plate CLXXXII. 12. 12.) appears rising very strong; in other positions of the thigh, that muscle makes a furrowing appearance in its whole progress.

If a man is upon tiptoe, the extending muscles of the leg placed on the fore part of the thigh (Plate CLXXXII. 13. 13. 13.), and those of the foot that compose the calf of the leg (Plate CLXXXIII. 14. 14.) appear very strong, and the long peronæus (Plate CLXXXII. 15.) makes a considerable indentation or furrowing at that time in its progress on the outside of the leg.

Many other remarks might here be offered: but a due attention to nature will soon discover them.

§ 6. *Of Light and Shade.*

After the learner has made himself in some measure perfect in drawing outlines, his next endeavour must be to shade them properly. It is this which gives an appearance of substance, shape, distance, and distinction, to whatever body he endeavours to represent, whether animate or inanimate. The best rule for doing this is, to consider from what point, and in what direction, the light falls upon the objects which he is delineating, and to let all his lights and shades be placed according to that direction throughout the whole work. That part of the object must be lightest which hath the light most directly opposite to it; if the light falls sideways on the picture, he must make that side which is opposite to it lightest, and that side which is farthest from it darkest. If he is drawing the figure of a man, and the light be placed above the head, then the top of the head must be made lightest, the shoulders next lightest, and the lower parts darker by degrees. That part of the object, whether in naked figures or drapery, or buildings, that stands farthest out, must be made the lightest, because it comes nearest to the light; and the light loseth so much of its brightness, by how much any part of the body bends inward, because those parts that stick out hinder the lustre and full brightness of the light from striking on those parts that fall in. Titian used to say, that he knew no better rule for the distribution of lights and shadows than his observations drawn from a bunch of grapes. Satins and silks, and all other shining stuffs, have certain glancing reflections, exceeding bright where the light falls strongest. The like is seen in armour, brass pots, or any other glittering metal, where you see a sudden brightness in the middle or centre of the light, which

which discovers the shining nature of such things. Observe also, that a strong light requires a strong shade, a fainter light a fainter shade; and that an equal balance be preserved throughout the piece between the lights and shades. Those parts which must appear round require but one stroke in shading, and that sometimes but very faint; such parts as should appear steep or hollow, require two strokes across each other, or sometimes three, which is sufficient for the deepest shade. Care must be also taken to make the outlines faint and small in such parts as receive the light; but where the shades fall, the outline must be strong and bold. The learner must begin his shadings from the top, and proceed downward, and use his utmost endeavours both by practice and observation to learn how to vary the shadings properly; for in this consists a great deal of the beauty and elegance of drawing. Another thing to be observed is, that as the human sight is weakened by distances, so objects must seem more or less confused or clear according to the places they hold in the piece: Those that are very distant,—weak, faint, and confused; those that are near and on the foremost ground,—clear, strong, and accurately finished.

§ 7. *Of Drapery.*

In the art of clothing the figures, or casting the drapery properly and elegantly upon them, many things are to be observed. 1. The eye must never be in doubt of its object; but the shape and proportion of the part or limb, which the drapery is supposed to cover, must appear; at least so far as art and probability will permit: and this is so material a consideration, that many artists draw first the naked figure, and afterwards put the draperies upon it. 2. The drapery must not sit too close to the parts of the body: but let it seem to flow round, and as it were to embrace them; yet so as that the figure may be easy, and have a free motion. 3. The draperies which cover those parts that are exposed to great light must not be so deeply shaded as to seem to pierce them; nor should those members be crossed by folds that are too strong, lest by the too great darkness of the shades the members look as if they were broken. 4. The great folds must be drawn first, and then stroked into lesser ones: and great care must be taken that they do not cross one another improperly. 5. Folds in general should be large, and as few as possible. However, they must be greater or less according to the quantity and quality of the stuffs of which the drapery is supposed to be made. The quality of the person is also to be considered in the drapery. If they are magistrates, their draperies ought to be large and ample: if country clowns or slaves, they ought to be coarse and short; if ladies or nymphs, light and soft. 6. Suit the garments to the body, and make them bend with it, according as it stands in or out, straight or crooked; or as it bends one way or another; and the closer the garment sits to the body, the narrower and smaller must be the folds. 7. Folds well imagined give much spirit to any kind of action; because their motion implies a motion in the acting member, which seems to draw them forcibly, and makes them more or less stirring as the action is more or less violent. 8. An artful complication of folds in a circular manner greatly helps the effect of foreshortenings. 9. All folds consist of two shades, and no more; which you may turn with the garment at pleasure, shadowing the inner side deeper, and the outer more faintly. 10. The shades in silk and fine linen are very thick and small, requiring little folds and a light shadow. 11. Observe the motion of the air or wind, in order to draw the loose apparel all flying one way; and draw that part of the garment that adheres closest to the body before you draw the looser part that flies off from it; lest, by drawing the loose part of the garment first, you should mistake the position of the figure, and place it awry. 12. Rich ornaments, when judiciously and sparingly used, may sometimes contribute to the beauty of draperies. But such ornaments are far below the dignity of angels or heavenly figures; the grandeur of whose draperies ought rather to consist in the boldness and nobleness of the folds, than in the quality of the stuff or the glitter of ornaments. 13. Light and flying draperies are proper only to figures in great motion, or in the wind: but when in a calm place, and free from violent action, their draperies should be large and flowing; that by their contrast and the fall of the folds, they may appear with grace and dignity. Thus much for draperies; an example or two of which are given in Plate CLXXIX. But see farther the articles CRAYON and PAINTING.

§ 8. *On the Passions.*

The passions, says M. le Brun, are motions of the soul, either upon her pursuing what she judges to be for her good, or shunning what she thinks hurtful to her; and commonly, whatever causes emotion or passion in the soul, creates also some action in the body. It is therefore necessary for a painter to know which are the different actions in the body that express the several passions of the soul, and how to delineate them.

M. le Brun has been extremely happy in expressing many of the passions, and the learner cannot study any thing better than the examples which he has left us of them. However, as M. de Piles justly observes, it is absurd as well as impossible to pretend to give such particular demonstrations of them as to fix their expression to certain strokes, which the painter should be obliged to make use of as essential and invariable rules. This (says he) would be depriving the art of that excellent variety of expression which has no other principle than diversity of imagination, the number of which is infinite. The same passion may be finely expressed several ways, each yielding more or less pleasure in proportion to the painter's understanding and the spectator's discernment.

Though every part of the face contributes towards expressing the sentiments of the heart, yet the eyebrow, according to M. le Brun, is the principal seat of expression, and where the passions best make themselves known. It is certain, says he, that the pupil of the eye, by its fire and motion, very well shows the agitation of the soul, but then it does not express the kind or nature of such an agitation; whereas the motion of the eyebrow differs according as the passions change their nature. To express a simple passion, the motion is simple; to express a mixed passion, the motion is compound: if the passion be gentle, the motion is gentle; and if it be violent, the motion is so too. We may observe farther, says he, that there are two

two kinds of elevation in the eyebrows. One, in which the eyebrows rise up in the middle; this elevation expresses agreeable sensations, and it is to be observed that then the mouth rises at the corners: Another, in which the eyebrows rise up at the ends, and fall in the middle; this motion denotes bodily pain, and then the mouth falls at the corners. In laughter, all the parts agree; for the eyebrows, which fall toward the middle of the forehead, make the nose, the mouth, and the eyes, follow the same motion. In weeping, the motions are compound and contrary; for the eyebrows fall toward the nose and over the eyes, and the mouth rises that way. It is to be observed also, that the mouth is the part of the face which more particularly expresses the emotions of the heart: for when the heart complains, the mouth falls at the corners; when it is at ease, the corners of the mouth are elevated; and when it has an aversion, the mouth shoots forward, and rises in the middle.

"The head (says M. de Piles) contributes more to the expression of the passions than all the other parts of the body put together. Those separately can only show some few passions, but the head expresses them all. Some, however, are more particularly expressed by it than others: as humility, by hanging it down; arrogance, by lifting it up; languishment, by inclining it to one side; and obstinacy, when with a stiff and resolute air it stands upright, fixed, and stiff between the two shoulders. The head also best shows our supplications, threats, mildness, pride, love, hatred, joy, and grief. The whole face, and every feature, contributes something: especially the eyes; which, as Cicero says, are the windows of the soul. The passions they more particularly discover are, pleasure, languishing, scorn, severity, mildness, admiration, and anger; to which one might add joy and grief, if they did not proceed more particularly from the eyebrows and mouth; but when those two passions fall in also with the language of the eyes, the harmony will be wonderful. But though the passions of the soul are more visible in the lines and features of the face, they often require the assistance also of the other parts of the body. Without the hands, for instance, all action is weak and imperfect; their motions, which are almost infinite, create numberless expressions: it is by them that we *desire, hope, promise, call, send back;* they are the instruments of *threatening, prayer, horror,* and *praise;* by them we *approve, condemn, refuse, admit, fear, ask;* express our *joy* and *grief,* our *doubts, regrets, pain,* and *admiration.* In a word, it may be said, as they are the language of the dumb, that they contribute not a little to speak a language common to all nations, which is the language of painting. But to say how these parts must be disposed for expressing the various passions, is impossible; nor can any exact rules be given for it, both because the task would be infinite, and because every one must be guided in this by his own genius and the particular turn of his own studies." See the article PASSIONS, and the Plate there referred to.

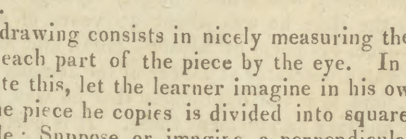
§ 9. *Of drawing Flowers, Fruits, Birds, Beasts,* &c.

The learner may proceed now to make some attempts at drawing flowers, fruits, birds, beasts, and the like; not only as it will be a more pleasing employment, but as it is an easier task, than the drawing of hands and feet, and other parts of the human body, which require not only more care, but greater exactness and nicer judgment. Very few rules or instructions are requisite upon this head: the best thing the learner can do is, to furnish himself with good prints or drawings by way of examples, and with great care and exactness to copy them. If it is the figure of a beast, begin with the forehead, and draw the nose, the upper and under jaw, and stop at the throat. Then go to the top of the head, and form the ears, neck, back, and continue the line till you have given the full shape of the buttock. Then form the breast, and mark out the legs and feet, and all the smaller parts. And, last of all, finish it with the proper shadows. It is not amiss, by way of ornament, to give a small sketch of landscape; and let it be suitable and natural to the place or country of the beast you draw. Much the same may be said with regard to birds. Of these, as well as beasts and other objects, the learner will find many examples among the plates given in this work.

§ 10. *Of drawing Landscapes, Buildings,* &c.

Of all the parts of drawing, this is the most useful and necessary, and it is what every man may have occasion for at one time or another. To be able, on the spot, to take the sketch of a fine building, or a beautiful prospect; of any curious production of art, or uncommon appearance in nature; is not only a very desirable accomplishment, but a very agreeable amusement. Rocks, mountains, fields, woods, rivers, cataracts, cities, towns, castles, houses, fortifications, ruins, or whatsoever else may present itself to view on our journeys or travels in our own or foreign countries, may be thus brought home, and preserved for our future use either in business or conversation. On this part, therefore, more than ordinary pains should be bestowed.

All drawing consists in nicely measuring the distances of each part of the piece by the eye. In order to facilitate this, let the learner imagine in his own mind, that the piece he copies is divided into squares. For example: Suppose or imagine a perpendicular and a horizontal line crossing each other in the centre of the picture you are drawing from; then suppose also two such lines crossing your own copy. Observe in the original, what parts of the design those lines intersect, and let them fall on the same parts of the supposed lines in the copy: We say, the supposed lines; because though engravers, and others who copy with great exactness, divide both the copy and original into many squares, as below; yet this is a method not to be recommended, as it will be apt to deceive the learner, who will fancy himself a tolerable proficient, till he comes to draw after nature, where these helps are not to be had, when he will find himself miserably defective and utterly at a loss.



If he is to draw a landscape from nature, let him take his station on a rising ground, where he will have a large horizon; and mark his tablet into three divisions, downwards from the top to the bottom; and divide in his own mind the landscape he is to take, into three divisions also. Then let him turn his face directly opposite to the midst of the horizon, keeping his body fixed, and draw what is directly before his eyes upon the middle division of the tablet; then turn his head, but not his body, to the left hand, and delineate what he views there, joining it properly to what he had done before; and, lastly, do the same by what is to be seen upon his right hand, laying down every thing exactly both with respect to distance and proportion. One example is given on Plate CLXXIX.

The best artists, in drawing their landscapes, make them shoot away one part lower than another. Those who make their landscapes mount up higher and higher, as if they stood at the bottom of a hill to take the prospect, commit a great error: the best way is to get upon a rising ground, make the nearest objects in the piece the highest, and those that are farther off to shoot away lower and lower till they come almost level with the line of the horizon, lessening every thing proportionably to its distance, and observing also to make the objects fainter and less distinct the farther they are removed from the eye. He must make all his lights and shades fall one way, and let every thing have its proper motion: as trees shaken by the wind, the small boughs bending more, and the large ones less: water agitated by the wind, and dashing against ships or boats, or falling from a precipice upon rocks and stones, and spirting up again into the air, and sprinkling all about: clouds also in the air; now gathered with the winds; now violently condensed into hail, rain, and the like: Always remembering, that whatever motions are caused by the wind must be made all to move the same way, because the wind can blow but one way at once.

Finally, It must be observed, that in order to attain any considerable proficiency in drawing, a knowledge of PERSPECTIVE is absolutely necessary: see that article.

Dray, Drayton.

DRAY, a kind of cart used by brewers for carrying barrels of beer or ale; also a sledge drawn without wheels.

DRAY, among sportsmen, denotes squirrel nests built in the tops of trees.

DRAYTON, MICHAEL, an eminent English poet, was born in 1563, of an ancient family in Warwickshire. His propensity to poetry was extremely strong, even from his infancy; and we find the most of his principal poems published, and himself highly distinguished as a poet, by the time he was about 30 years of age.—It appears from his poem of Moses's Birth and Miracles, that he was a spectator at Dover of the famous Spanish armada, and it is not improbable that he was engaged in some military employment there. It is certain, that not only for his merit as a writer but his valuable qualities as a man, he was held in high estimation, and strongly patronized by several personages of consequence; particularly by Sir Henry Goodere, Sir Walter Aston, and the countess of Bedford; to the first of whom he owns himself indebted for great part of his education, and by the second he was for many years supported.

His poems are very numerous; and so elegant, that his manner has been copied by many modern writers of eminence since. Among these the most celebrated one is the Poly-Albion, a chorographical description of England, with its commodities, antiquities, and curiosities, in metre of 12 syllables; which he dedicated to Prince Henry, by whose encouragement it was written: and whatever may be thought of the poetry, his descriptions are allowed to be exact. He was styled *poet laureat* in his time: which, as Ben Johnson was then in that office, is to be understood in a loose sense of approbation as an excellent poet; and was bestowed on others as well as Drayton, without being confined strictly to the office known by that appellation. He died in 1631; and was buried in Westminster abbey among the poets, where his bust is to be seen, with an epitaph penned by Ben Johnson.

Drayton, Dreams

DREAMS, are all those thoughts which people feel passing through their minds, and those imaginary transactions in which they often fancy themselves engaged, when in the state of sleep.

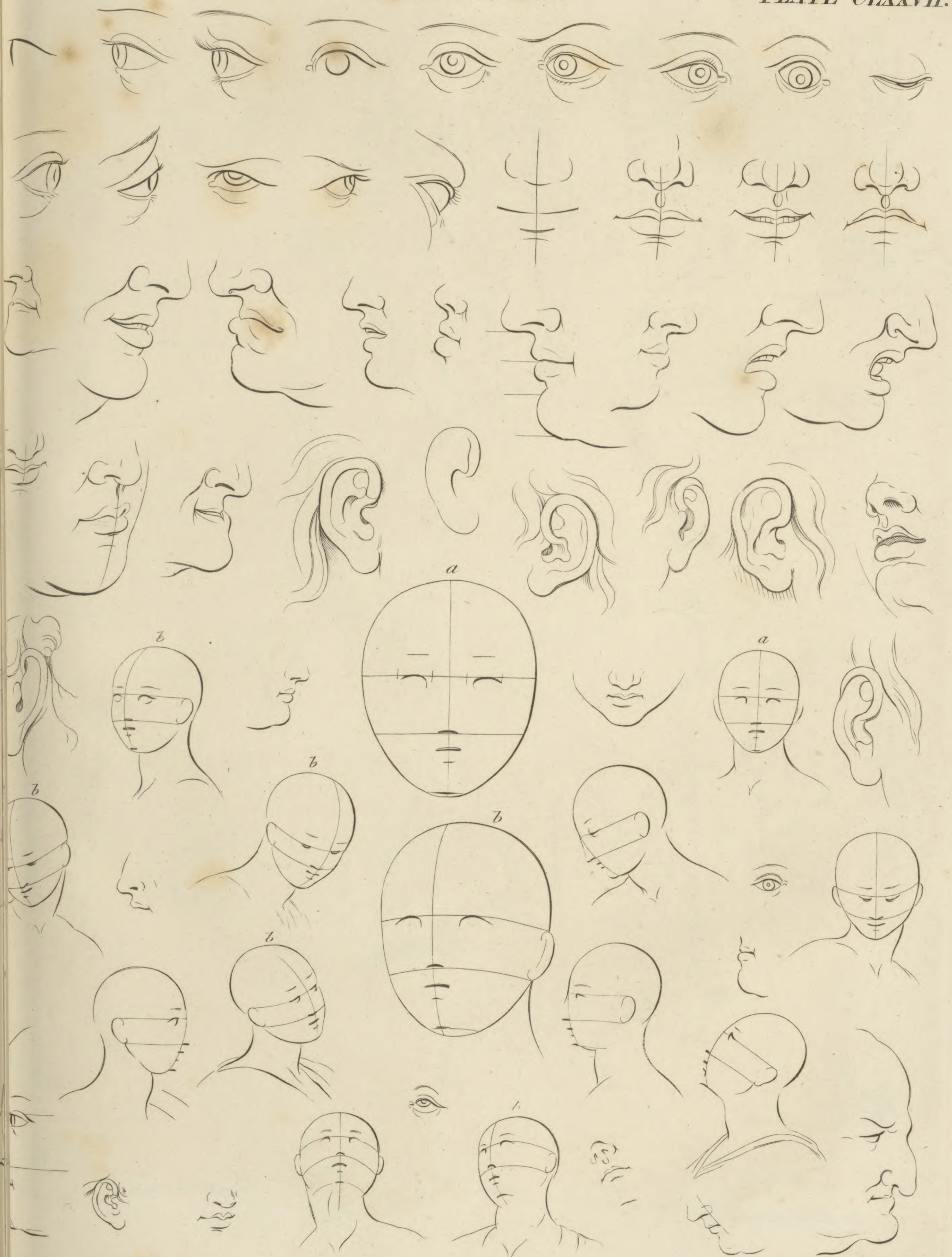
Scarce any part of nature is less open to our observation than the human mind in this state. The dreamer himself cannot well observe the manner in which dreams arise or disappear to him. When he awakes, he cannot recollect the circumstances of his dreams with sufficient accuracy. Were we to watch over him with the most vigilant attention, we could not perceive with certainty what emotions are excited in his mind, or what thoughts pass through it, during his sleep. But though we could ascertain these phenomena, many other difficulties would still remain. What parts of a human being are active, what dormant, when he dreams? Why does not he always dream while asleep? Or why dreams he at all? Do any circumstances in our constitution, situation, and peculiar character, determine the nature of our dreams?

We may lay before our readers such facts as have been ascertained concerning dreaming, and the most plausible conjectures that have been offered to explain those particulars, about which we can only conjecture, or have at least hitherto obtained nothing more certain than conjecture.

1. In dreaming, we are not conscious of being asleep. This is well known from a thousand circumstances. When awake, we often recollect our dreams; and we remember on such occasions, that while those dreams were passing through our minds, it never occurred to us that we were separated by sleep from the active world. We are often observed to act and talk in dreaming as if we were busily engaged in the intercourse of social life.

2. In dreaming, we do not consider ourselves as witnessing

DRAWING. *PLATE CLXXVII.*



W. Archibald Sculp.

A. Bell Prin. Wal. Sculptor fecit.

A. Wilson Sculp.t

DRAWING. PLATE CLXXX.

W. Archibald Sculp.

W. Archibald Sculpt.

A. Bell Prin. Wal. Sculptor fecit.

DRAWING. PLATE CLXXXIII.

Engd by W. Archibald Edinr

witnessing or bearing a part in a fictitious scene: we seem not to be in a similar situation with the actors in a dramatic performance, or the spectators before whom they exhibit, but engaged in the business of real life. All the varieties of thought that pass through our minds when awake may also occur in dreams; all the images which imagination presents in the former state, she is also able to call up in the latter; all the same emotions may be excited, and we are often actuated by equal violence of passion; none of the transactions in which we are capable of engaging while awake is impossible in dreams: in short, our range of action and observation is equally wide in the one state as in the other; and while dreaming, we are not sensible of any distinction between our dreams and the events and transactions in which we are actually concerned in our intercourse with the world.

3. It is said that all men are not liable to dream. Dr Beattie, in a very pleasing essay on this subject, relates, that he knew a gentleman who never dreamed except when his health was in a disordered state; and Locke mentions that a certain person of his acquaintance was almost a stranger to dreaming till the 26th year of his age; and then began to dream in consequence of having a fever. These instances, however, are too few, and we have not been able to obtain more; and, besides, it does not appear that those persons had always attended, with the care of a philosopher making an experiment, to the circumstances of their sleep. They might dream, but not recollect their dreams on awaking; and they might both dream and recollect their dreams immediately upon awaking, yet afterwards suffer the remembrance of them to slip out of their memory. We do not advance this, therefore, as a certain fact concerning dreaming; we are rather inclined to think it a mistake.

But though it appears to be by no means certain that any of the human race are through the whole of life absolute strangers to dreaming; yet it is well known that all men are not equally liable to dream. The same person dreams more or less at different times; and as one person may be more exposed than another to those circumstances which promote this exercise of fancy, one person may therefore dream more than another. The same diversity will naturally take place in this as in other accidents to which mankind are in general liable.

4. Though in dreams imagination appears to be free from all restraint, and indulges in the most wanton freaks; yet it is generally agreed, that the imaginary transactions of the dreamer bear always some relation to his particular character in the world, his habits of action, and the circumstances of his life. The lover, we are told, dreams of his mistress; the miser of his money; the philosopher renews his researches in sleep often with the same pain and fatigue as when awake; and even the merchant, at times, returns to balance his books, and computes the profits of an adventure, when slumbering on his pillow. And not only do the more general circumstances of a person's life influence his dreams; his passions and habits are nearly the same when asleep as when awake. A person whose habits of life are virtuous, does not in his dreams plunge into a series of crimes; nor are the vicious reformed when they pass into this imaginary world. The choleric man finds himself offended by slight provocations as well in his dreams as in his ordinary intercourse with the world, and a mild temper continues pacific in sleep.

5. The character of a person's dreams is influenced by his circumstances when awake in a still more unaccountable manner. Certain dreams usually arise in the mind after a person has been in certain situations. Dr Beattie relates, that he once, after riding 30 miles in a high wind, passed a part of the succeeding night in dreams beyond description terrible. The state of a person's health, and the manner in which the vital functions are carried on, have a considerable influence in determining the character of dreams. After too full a meal, or after eating of an unusual sort of food, a person is very apt to be harassed with dreams.

6. In dreaming, the mind for the most part carries on no intercourse through the senses with surrounding objects. Touch a person gently who is asleep, he feels not the impression. You may awake him by a smart blow; but when the stroke is not sufficiently violent to awake him, he remains insensible of it. We speak softly beside a person asleep without fearing that he overhear us. His eyelids are shut; and even though light should fall upon the eyeball, yet still his powers of vision are not wakened to active exertion, unless the light be so strong as to rouse him from sleep. He is insensible both to sweet and to disagreeable smells. It is not easy to try whether his organs of taste retain their activity, without awakening him; yet from analogy it may be presumed that these too are inactive. With respect to the circumstances here enumerated, it is indifferent whether a person be dreaming or buried in deep sleep.

Yet there is one remarkable fact concerning dreaming, which may seem to contradict what has been here asserted. In dreams we are liable not only to speak aloud in consequence of the suggestions of imagination, but even to get up, and walk about and engage in little enterprises, without awaking. Now, as we are in this instance so active it seems that we cannot be then insensible of the presence of surrounding objects. The sleepwalker is really sensible in a certain degree of the presence of the objects around him; but he does not attend to them with all their circumstances, nor do they excite in him the same emotions as if he were awake. He feels no terror on the brink of a precipice; and in consequence of being free from fear, he is also without danger in such a situation unless suddenly awaked. This is one of the most inexplicable phenomena of dreaming.

There is also another fact not quite consonant with what has been above mentioned. It is said, that in sleep a person will continue to hear the noise of a cataract in the neighbourhood, or regular strokes with a hammer, or any similar sound sufficiently loud, and continued uninterruptedly from before the time of his falling asleep. We know not whether he awakes on the sudden cessation of the noise. The fact is asserted on sufficient evidence: it is curious. Even when awake, if very deeply intent on any piece of study, or closely occupied in business, the sound of a clock striking in the neighbourhood, or the beating of a drum, will escape us unnoticed; and it is therefore the more surprising that we should thus continue sensible to sounds when asleep.

7. Not only do a person's general character, habits of life, and state of health, influence his dreams; but those concerns in which he has been most deeply interested during the preceding day, and the views which have arisen most frequently to his imagination, very often afford the subjects of his dreams. When I look forward with anxious expectation towards any future event, I am likely to dream either of the disappointment or the gratification of my wishes. Have I been engaged through the day, either in business or amusements which I have found exceedingly agreeable, or in a way in which I have been extremely unhappy; either my happiness or my misery is likely to be renewed in my dreams.

8. Though dreams have been regarded among almost all nations through the world, at least in some periods of their history, as prophetic of future events; yet it does not appear that this popular opinion has been established on good grounds. Christianity, indeed, teaches us to believe, that the Supreme Being may, and actually does, operate on our minds, and influence at times the determinations of our will, without making us sensible of the restraint to which we are thus subjected. And, in the same manner, no doubt, the suggestions which arise to us in dreams, may be produced. The imaginary transactions in which we are then engaged, may be such as are actually to occupy us in life; the strange and seemingly incoherent appearances which are then presented to the mind's eye, may allude to some events which are to befal ourselves or others. It is, therefore, by no means impossible, or inconsistent with the general analogy of nature, that dreams should have a respect to futurity. We have no reason to regard the dreams which are related in the Holy Scriptures to have been prophetic of future events, as not inspired by Heaven, or to laugh at the idea of a prophetic dream as absurd or ridiculous.

Yet it would be too much to allow to dreams all that importance which has been ascribed to them by the priesthood among heathen nations, or by the vulgar among ourselves. We know how easily ignorance imposes on itself, and what arts imposture adopts to impose upon others. We cannot trace any certain connexion between our dreams and those events to which the simplicity of the vulgar pretends that they refer. And we cannot, therefore, if disposed to confine our belief to certain or probable truths, join with the vulgar in believing them really referable to futurity.

9. It appears that the brutes are also capable of dreaming. The dog is often observed to start suddenly up in his sleep, in a manner which cannot be accounted for in any other way than by supposing that he is roused by some impulse received in a dream. The same thing is observable of others of the inferior animals. That they should dream, is not an idea inconsistent with what we know of their economy and manners in general. We may, therefore, consider it as a pretty certain truth, that many, if not all, of the lower species are liable to dream as well as human beings.

It appears, then, that in dreaming we are not conscious of being asleep; that to a person dreaming, his dreams seem realities; that though it be uncertain whether mankind are all liable to dreams, yet it is well known that they are not all *equally* liable to dream: that the nature of a person's dreams depends in some measure on his habits of action, and on the circumstances of his life: that the state of the health too, and the manner in which the vital functions are carried on, have a powerful influence in determining the character of a person's dreams: that in sleep and in dreaming, the senses are either absolutely inactive, or nearly so: that such concerns as we have been very deeply interested in during the preceding day, are very likely to return upon our minds in dreams in the hours of rest: that dreams may be rendered prophetic of future events; and therefore, wherever we have such evidence of their having been prophetic as we would accept on any other occasion, we cannot reasonably reject the fact on account of its absurdity; but that they do not appear to have been actually such, in those instances in which the superstition of nations, ignorant of true religion, has represented them as referring to futurity, nor in those instances in which they are viewed in the same light by the vulgar among ourselves; and, lastly, that dreaming is not a phenomenon peculiar to human nature, but common to mankind with the brutes.

We know of no other facts that have been fully ascertained concerning *dreaming*. But we are by no means sufficiently acquainted with this important phenomenon in the history of mind. We cannot tell by what laws of our constitution we are thus liable to be so frequently engaged in imaginary transactions, nor what are the particular means by which the delusion is accomplished. The delusion is indeed remarkably strong. One will sometimes have a book presented to him in a dream, and fancy that he reads; and actually enter into the nature of the imaginary composition before him, and even remember, after he awakes, what he knows that he only fancied himself reading (A). Can this be delusion? If delusion, how or for what purposes is it produced? The mind, it would appear, does not, in sleep, become inactive like the body; or at least is not always inactive while we are asleep. When we do not dream, the mind must either be inactive, or the connexion between the mind and the body must be considered as in some manner suspended: and, when we dream, the mind, though it probably acts in concert with the body, yet does not act in the same manner as when we are awake. It seems to be clouded or bewildered, in consequence of being deprived for a time of the service of the senses. Imagination becomes more active and more capricious: and all the other powers, especially judgment and memory, become disordered and irregular in their operation.

Various theories have been proposed to explain what appears here most inexplicable. The ingenious Mr Baxter,

---

(A) The writer of this article has been told by a respectable old gentleman of his acquaintance, since dead, that he had frequently dreams of this nature. The fact may therefore be considered as unquestionable.

Baxter, in his Treatise on the Immateriality of the Human Soul, endeavours to prove that dreams are produced by the agency of some spiritual beings, who either amuse or employ themselves seriously in engaging mankind in all those imaginary transactions with which they are employed in dreaming. This theory, however, is far from being plausible. It leads us entirely beyond the limits of our knowledge. It requires us to believe without evidence. It is unsupported by any analogy. It creates difficulties still more inexplicable than those which it has been proposed to remove. Till it appear that our dreams cannot possibly be produced without the interference of other spiritual agents, possessing such influence over our minds as to deceive us with fancied joys, and involve us in imaginary afflictions, we cannot reasonably refer them to such a cause. Besides, from the facts which have been stated as well known concerning dreams, it appears that their nature depends both on the state of the human body and on that of the mind. But were they owing to the agency of other spiritual beings, how could they be influenced by the state of the body? Those must be a *curious* set of spiritual beings who depend in such a manner on the state of our corporeal frame. Better not to allow them existence at all, than to place them in such a dependence.

Wolfius, and after him M. Formey, have supposed, that dreams never arise in the mind, except in consequence of some of the organs of sensation having been previously excited. Either the ear or the eye, or the organs of touching, tasting, or smelling, communicate information, somehow, in a tacit, secret manner; and thus partly rouse its faculties from the lethargy in which they are buried in sleep, and engage them in a series of confused and imperfect exertions. But what passes in dreams is so very different from all that we do when awake, that it is impossible for the dreamer himself to distinguish, whether his powers of sensation *perform* any part on the occasion. It is not necessary that imagination be always excited by sensation. Fancy, even when we are awake, often wanders from the present scene. *Absence of mind* is incident to the studious: the poet and the mathematician many times forget where they are. We cannot discover from any thing that a person in dreaming displays to the observation of others, that his organs of sensation take a part in the imaginary transactions in which he is employed. In those instances, indeed, in which persons asleep are said to hear sounds; the sounds which they hear are said also to influence, in some manner, the nature of their dreams. But such instances are singular. Since then it appears that the person who dreams is himself incapable of distinguishing either during his dreams, or by recollection when awake, whether any new impressions are communicated to him in that state by his organs of sensation; that even by watching over him, and comparing our observations of his circumstances and emotions, in his dreams, with what he recollects of them after awaking, we cannot, except in one or two singular instances, ascertain this fact; and that the mind is not incapable of acting while the organs of sensation are at rest, and on many occasions refuses to listen to the information which they convey; we may, without hesitation, conclude, that the theory of Wolfius and Formey has been too hastily and incautiously advanced.

Other physiologists tell us, that the mind, when we dream, is in a state of *delirium*. Sleep, they say, is attended with what is called a *collapse* of the brain; during which either the whole or a part of the nerves of which it consists, are in a state in which they cannot carry on the usual intercourse between the mind and the organs of sensation. When the whole of the brain is in this state, we become entirely unconscious of existence, and the mind sinks into inactivity: when only a part of the brain is *collapsed*, as they term it, we are then neither asleep nor awake, but in a sort of delirium between the two. This theory, like the last mentioned, supposes the mind incapable of acting without the help of sensation: it supposes that we know the nature of a state of which we cannot ascertain the phenomena: it also contradicts a known fact, in representing dreams as confused images of things around us, not fanciful combinations of things not existing together in nature or in human life. We must treat it likewise, therefore, as a baseless fabric.

In the last edition of this work, a theory somewhat different from any of the foregoing was advanced in this subject. It was observed, that the nervous fluid, which is allowed to be secreted from the blood by the brain, appears to be likewise absorbed from the blood by the extremities of the nerves. It was farther advanced, that as this fluid was to be considered as the principle of sensibility; therefore, in all cases in which a sufficient supply of it was not absorbed from the blood by the extremities of the nerves, the parts of the body to which those nerves belonged, must be, in some degree, deprived of sensation. From these positions it was inferred, that as long as impressions of external objects continue to communicate a certain motion from the sentient extremities of the nerves to the brain,—so long we continue awake; and that, when there is a deficiency of this vital fluid in the extremities of the nerves, or when from any other cause it ceases to communicate to the brain the peculiar motion alluded to, we must naturally fall asleep, and become insensible of our existence. It followed of consequence, that, in sleep, the nervous fluid between the extreme parts of the nerves and the brain must either be at rest, or be deficient, or be prevented by some means from passing into the brain: and it was concluded, that whenever irregular motions of this fluid were occasioned by an internal cause, *dreaming* was produced. In this manner it appeared that we might be deceived with regard to the operation of any of the senses;—so as to fancy that we saw objects not actually before us,—to hear imaginary sounds,—to taste,—to feel, and to smell in imagination. The instances of visions which will sometimes arise, and as it were swim before us when awake, though our eyes be shut, *tinnitus aurium*, which is often a symptom in nervous diseases, and the strange feelings in the case of the amputated limb, were produced in proof of this theory, and applied so as to confirm it.

We are still of opinion, that this theory is more plausible, and goes farther toward explaining the nature of *dreaming*, and the manner in which *dreams* are produced, than any other with which we are acquainted. But it must be confessed, upon a review, that even in it there is too much supposition. The nature of the nervous fluid is but imperfectly known, and even its existence not very fully ascertained. The nature of the connexion by which the soul and body are united, seems to be almost beyond our comprehension. And till we can apply experiment and observation in a better manner to this branch of physiology, it must undoubtedly remain unknown. To something mysterious in the nature of that connexion, the delusion produced in dreams is in all probability owing.

Amid this uncertainty with respect to the manner in which the powers of mind and body perform their functions in dreaming, it is pleasing to find that we can, however, apply to useful purposes the imperfect knowledge which we have been able to acquire concerning this series of phenomena. Our dreams are affected by the state of our health, by the manner in which we have passed the preceding day, by our general habits of life, by the hopes which we most fondly indulge, and the fears which prevail most over our fortitude when we are awake. From recollecting our dreams, therefore, we may learn to correct many improprieties in our conduct; to refrain from bodily exercises, or from meats and drinks that have unfavourable effects on our constitution; to resist, in due time, evil habits that are stealing upon us; and to guard against hopes and fears which detach us from our proper concerns, and unfit us for the duties of life. Instead of thinking what our dreams may forebode, we may with much better reason reflect by what they have been occasioned, and look back to those circumstances in our past life to which they are owing. The sleep of innocence and health is sound and refreshing; their dreams delightful and pleasing. A distempered body, and a polluted or perturbed mind, are haunted in sleep with frightful, impure, and unpleasing dreams.

Some very beautiful fables have been written both by ancients and moderns in the form of dreams. The *Somnium Scipionis* is one of the finest of Cicero's compositions. He who shall carefully peruse this piece, with Macrobius's commentary upon it, will acquire from them considerable knowledge of ancient philosophy. In the periodical publications, which have diffused so much elegant and useful knowledge through Britain, the Tatlers, Spectators, Guardians, &c. we find a number of excellent dreams. Addison excelled in this way of writing. The public are now less partial to this species of composition than they formerly were.

Dr Beattie, in his valuable essay on the subject of dreaming, quotes a very fine one from the Tatler, and gives it due praise.

DREDGING, a process for removing mud and other deposited matters from the beds of rivers, canals, &c. See SUPPLEMENT.

DRELINCOURT, CHARLES, minister of the reformed church at Paris, was born at Sedan in 1593, where his father enjoyed a considerable post. He had all the qualifications that compose a respectable clergyman; and though he defended the Protestant cause against the Romish religion, was much esteemed even among the Catholics. He is best known in England by his Consolations against the Fears of Death, which work was translated, and is often printed. He married the daughter of a rich merchant at Paris, by whom he had 16 children. His third son, professor of physic at Leyden, was physician to the prince and princess of Orange before their accession to the crown of England. Bayle has given him a high character. Mr Drelincourt died in 1660.

DRENCH, among farriers, a physical potion for horses. The ingredients for this purpose are to be beat coarsely, and either mingled with a decoction or with wine. Then let all infuse about a quarter of an hour, and give it to the horse with a horn after he has been tied up two hours to the rack.

DREPANE, the ancient name of Corcyra, from the curvity of its figure, resembling a sickle.

DREPANE, (*Drepanum*) in *Ancient Geography*, a town of Bithynia, situated between the Sinus Astacenus and the Bosphorus Thracius; called *Helenopolis* by Constantine, in honour of his mother. (Nicephorus Callistus).

DREPANUM, in *Ancient Geography*, the promontory Rhium in Achaia; so called because bent in the manner of a sickle. Another *Drepanum* on the Arabic gulf, on the side of Egypt. A third on the north side of Crete, situated between Cydonia and the Sinus Amphimallus. A fourth on the west side of Cyprus. A fifth, a promontory of Cyrenaica, on the Mediterranean.

DREPANUM, *-i;* or *Drepana, -orum;* a town and port on the west side of Sicily, and to the west of Mount Eryx; *Drepanitani* the people. Now *Trepano*, a city and port town on the westmost point of Sicily. E. Long. 12. 8. N. Lat. 38. 0.

DRESDEN, the capital city of the electorate of Saxony in Germany. It is seated on the river Elbe, which divides it into two parts. One part is called *Old Dresden*, and the other the *New Town*, in the German language *New Stadt*. They are joined together by a stone bridge, supported by 19 piers, and 630 paces in length. As this bridge was too narrow for the crowds of people that were continually passing and repassing, King Augustus in 1730, caused two walks for foot passengers to be built, one on each side, in a very wonderful manner; the one for those that go into the city, and the other for those that return back. These are bordered with iron pallisadoes of curious workmanship. This noble bridge was much injured by the French in 1813. Dresden is surrounded by fortifications; and was said to contain 45,000 inhabitants in 1811.

All the buildings of this city are constructed with square freestone, and are almost all of the same height. They have stone from the neighbourhood of Pirna, about ten miles from this city, which is readily brought down the Elbe. In general the houses are high and strong; the streets wide, straight, well paved, clean, and well illuminated in the night; and there are large squares, disposed in such a manner, that Dresden may pass for one of the handsomest cities in the world. The king's palace is a magnificent structure, and abounds in many valuable curiosities both of nature and art. The collection of pictures is reckoned one of the finest that exists, and is valued at 500,000l.

Above 700 men are here constantly employed in the porcelain manufacture, the annual expence of which is estimated at no more than 80,000 crowns; and the manufacture yields to the king 200,000 crowns yearly, besides

besides the magnificent presents which he occasionally makes, and the large quantity reserved for the use of his household.

The other most considerable article of trade is silver, of which the mines near Friburg produce every 15 days near the value of 20,000 dollars. The metal is brought into the city in ingots, where it is immediately coined and delivered to the proprietors.

The court of Dresden is one of the most remarkable in Europe for splendour and profusion. Six thousand five hundred ducats are yearly allowed for comfits and similar articles, which is near twice as much as the king of Prussia allows for the whole expence of his table. The revenues of the king of Saxony are estimated at about 900,000l.; which arise from the taxes on lands, and a capitation on all males as soon as they commence an apprenticeship or begin to work. People of a higher rank are taxed according to their class, and are liable to be called to account if they assume not an exterior appearance correspondent to the extent of their fortune. Every foreigner pays capitation after residing six months in the country. The Jews are taxed at 50, their wives at 30, and their children at 20 dollars. There is also an excise on all eatables and liquors; and 10 per cent. is levied out of the incomes of the people.

Though this city lies in a low situation, yet it hath agreeable prospects. It is supplied with a prodigious quantity of provisions, not only out of the neighbourhood, but from Bohemia, which are brought every market day, which is once a-week. E. Long. 13. 34. N. Lat. 51. 12.

DRESSING of Hemp and Flax. See *Flax-Dressing.*

Dressing of Meats, the preparing them for food by means of culinary fire.

The design of dressing is to loosen the compages or texture of the flesh, and dispose it for dissolution and digestion in the stomach. Flesh not being a proper food without dressing, is alleged as an argument that man was not intended by nature for a carnivorous animal.

The usual operations are roasting, boiling, and stewing.—In roasting, it is observed, meat will bear a much greater and longer heat than either in boiling or stewing; and in boiling, greater and longer than in stewing. The reason is, that roasting being performed in the open air, as the parts begin externally to warm, they extend and dilate, and so gradually let out part of the rarefied included air, by which means the internal succussions, on which the dissolution depends, are much weakened and abated. Boiling being performed in water, the pressure is greater, and consequently the succussions to lift up the weight are proportionably strong, by which means the coction is hastened; and even in this way there are great differences; for the greater the weight of water, the sooner is the business done.

In stewing, though the heat be infinitely short of what is employed in the other ways, the operation is much more quick, because performed in a close vessel, and full; by which means the succussions are oftener repeated, and more strongly reverberated. Hence the force of Papin's digester; and hence an illustration of the operation of digestion.

Boiling, Dr Cheyne observes, draws more of the rank strong juices from meat, and leaves it less nutritive, more diluted, lighter, and easier of digestion: roasting, on the other hand, leaves it fuller of the strong nutritive juices, harder to digest, and needing more dilution. Strong, grown, and adult animal food, therefore, should be boiled, and the younger and tenderer roasted.

Dressing, in *Surgery*, the treatment of a wound, or any disordered part. The apparatus of dressing consists of dossils, tents, plasters, compresses, bandages, bands, ligatures, and strings. See Surgery *Index*.

DREVET, Peter, the Younger, an eminent French engraver, was a member of the royal academy of painting and sculpture; and died at Paris in 1739, at 42 years of age. His portraits are neat and elegant, but laboured to the last degree. He particularly excels in representing lace, silk, fur, velvet, and other ornamental parts of dress. His father was excellent in the same art, and had instructed, but was surpassed by the son. The younger Drevet did not confine himself to portraits. We have several historical prints by him, which in point of neatness and exquisite workmanship are scarcely to be equalled. His most esteemed and best historical print is very valuable; but the first impressions of it are rarely to be met with: it is The Presentation of Christ in the Temple; a very large plate, lengthwise, from Louis de Bologna. The following deserve also to be particularized: The Meeting of Abraham's Servant with Rebecca at the Well; a large upright plate, from Ant. Coypel: and Abraham, with his son Isaac on the Altar, the same, from the same, date 1707; the first impressions of which are before the work upon the right thigh of Isaac was altered, the curved lines from the button almost down to the knee being in those impressions arched downwards, but in posterior ones arched upwards. Among his portraits, the two following are justly held in the highest estimation: M. Bossuet, bishop of Meaux; a whole length figure standing, a middling sized upright plate, from Rigaud: and Samuel Bernard; a whole length figure sitting in a chair, a large upright plate. The first impressions of the last are, before the words *Conseiller d'Etat* were inserted upon the plate.

DREUX, a town in the Isle of France, remarkable for its antiquities; and for the battle which was fought in December 1562 between the Papists and the Protestants, in which the latter were defeated. Some think it took its name from the priests of Gaul, called the *Druids*, in the times of Paganism. It consists of two parishes, St Stephen's, and Notre Dame, called the *great church*, which is pretty well built. It is seated on the river Blaise, at the foot of a mountain, on which is a ruined castle. Population 5450. E. Long. 1. 27. N. Lat. 48. 44.

DRIEPER, or Dnieper, a river of Russia, which rises in the forest of Volkonski, near the source of the Volga, about 100 miles from Smolensko. It passes by Smolensko and Mohilef, separates the Ukraine from Poland, flows by Kiof, and falls into the Black sea between Otzakof and Kinburn. By the acquisition of the province of Mohilef, its whole course is now included within the Russian territories. It begins to be navigable at a little distance above Smolensko, though in some seasons of the year it is so shallow near the town, that the goods must be transported upon rafts and small flat-bottomed boats.

DRIFT, in *Navigation*, the angle which the line of a ship's motion makes with the nearest meridian, when she drives with her side to the wind and waves, and is not governed by the power of the helm: it also implies the distance which the ship drives on that line.

A ship's way is only called *drift* in a storm; and then when it blows so vehemently as to prevent her from carrying any sail, or at least restrains her to such a portion of sail as may be necessary to keep her sufficiently inclined to one side, that she may not be dismasted by her violent labouring produced by the turbulence of the sea.

Drift, in mining, a passage cut out under the earth betwixt shaft and shaft, or turn and turn; or a passage or way wrought under the earth to the end of a meer of ground, or part of a meer.

Drift-Sail, a sail used under water, veered out right a-head by sheets, as other sails are. It serves to keep the ship's head right upon the sea in a storm, and to hinder her from driving too fast in a current.

DRILL, in *Mechanics*, a small instrument for making such holes as punches will not conveniently serve for. Drills are of various sizes, and are chiefly used by smiths and turners.

Drill, or *Drill-Box*, a name given to an instrument for sowing land in the new method of horsehoeing husbandry. See Agriculture *Index*.

Drill-Sowing, a method of sowing grain or seed of any kind, so that it may all be at a proper depth in the earth, which is necessary to its producing healthful and vigorous plants. For this purpose a variety of drill ploughs have been invented and recommended. See Agriculture *Index*.

DRILLING is popularly used for exercising soldiers. The word is derived from the French *drille*, which signifies a *raw soldier*.

DRIMYS, a genus of plants changed by Murray, in the 14th edit. of *Syst. Veget.* to Wintera; which see in Botany *Index*.

DRINK, a part of our ordinary food in a liquid form. See Dietetics, Supplement.

The general use of drink is to supply fluid; facilitate solution; in consequence of that, to expede the evacuation of the stomach, and promote the progress of the aliment through the intestines: for, by the contraction of the longitudinal fibres of the stomach, the pylorus is drawn up, and nothing but fluid can pass; which, by its bulk, makes a hurried progress through the intestines, and so determines a greater excretion by stool, as less then can be absorbed by the lacteals. Hence a large quantity of common water has been found purgative; and, *cæteris paribus*, that aliment which is accompanied with the largest proportion of drink, makes the largest evacuation by stool. Here a question has risen, about where the feculent part of the aliment is first remarkably collected. It is commonly thought to be in the great guts: but undoubtedly it often begins in the lower part of the ileum, especially when the drink is in a small proportion, and when the progress of the aliment is slow; for when the contents of the guts are very fluid, they are quickly pushed on, and reach the great guts before they deposite any feculency. Another effect of drink is, to facilitate the mixture of the lymph, refluent from every part of the system, with the chyle. In the blood-vessels, where all must be kept fluid in order to proper mixture, drink increases the fluidity, and gives tension, by its bulk, without concomitant acrimony or too much elasticity, and so strength and oscillatory motion: hence drink contributes to sanguification, as sometimes food gives too dense a nutriment to be acted upon by the solids; and hence also we can see how drink promotes the secretions. These are the effects of drink in general; but what has been said must be taken with some limitations; for the more liquid the food, it is sooner evacuated, and less nourishment is extracted. Hence drink is, in some degree, opposed to nourishment; and so, *cæteris paribus*, those who use least drink are most nourished.

All the effects of drink above mentioned are produced by simple water; and it may be said, that other liquors are fit to drink in proportion to the water they contain. Water, when used as drink, is often impregnated with vegetable and farinaceous substances; but, as drinks, these impregnations are of little consequence: they add, indeed, a little nourishment; but this is not to be regarded in a healthy state. Sometimes we impregnate water with the *fructus acido-dulces*; and then, indeed, it acquires other qualities, of considerable use in the animal economy. All drinks, however, may be reduced to two heads: first, pure water, or where the additional substances give no additional virtue; secondly, the *fermentatæ*. Of the first we have already spoken; and the latter have not only the qualities of the first, but also qualities peculiar to themselves.

Fermented liquors are more or less poignant to the taste, and better calculated to quench thirst. Thirst may be owing to various causes: First, To defect of fluid in the system, which occasions a scanty secretion in the mouth, fauces, and stomach; the dryness of the mouth and fauces will also in this case be increased, by their continual exposure to the perpetual flux and reflux of the evaporating air. Secondly, Thirst depends on a large proportion of solid viscid food. Thirdly, On an alkalescent aliment, especially if it has attained any thing of the putrefactive taint. Fourthly, On the heat of the system; but this seems to operate in the same manner as the first cause, giving a sense of dryness from its dissipation of the fluids. The fermented liquors are peculiarly adapted for obviating all these causes; stimulating the mouth, fauces, and stomach, to throw out the saliva and gastric liquor by their poignancy; by their acescency they are fitted to destroy alkalescent acrimony, to quench thirst from that cause; by their fluidity they dilute viscid food; though here, indeed, they answer no better than common water. In two ways they promote the evacuation by stool, and progress through the intestines: first, by their fluidity and bulk; secondly, by their acescency, which, uniting with the bile, forms the peculiar stimulus formerly mentioned. Carried into the blood-vessels, in so far as they retain any of the saline nature, they stimulate the excretories, and promote urine and sweat; correcting thus alkalescency, not only by mixture, but dissipation of the degenerated fluids.

Many physicians, in treating of fermented liquors, have

have only mentioned these qualities, rejecting their nutritious virtue, which certainly ought to be taken in; though by expediting the evacuation by stool they make less of the nutritious parts of the aliment to be taken up, and by stimulating the excretories make these nutritious parts to be for a shorter time in the system. All these and many more effects arise from fermented liquors. Their acescency sometimes promotes the disease of acescency, by increasing that of vegetables, acting as a ferment, and so producing flatulency, purging, cholera, &c.: so that, with vegetable aliment, as little drink is necessary, the most innocent is pure water; and it is only with animal food that fermented liquors are necessary. In warmer climates, *fermentatæ* would seem necessary to obviate alkalescency and heat. But it should be considered, that though fermented liquors contain an acid, yet they also contain alcohol; which, though it adds stimulus to the stomach, yet is extremely hurtful in the warmer climates, and wherever alkalescency prevails in the system. Nature in these climates has given men an appetite for water impregnated with acid fruits, *e.g.* sherbet: but the use of this needs caution, as in these countries they are apt to shun animal food, using too much of the vegetable, and often thus causing dangerous refrigerations, choleras, diarrhœas, &c.

Of varieties of fermented liquors. We shall only mention here the chief heads on which these varieties depend. First, They are owing to the quality of the subject, as more or less viscid; and to its capacity also of undergoing an active fermentation, although perhaps the more viscid be more nutritious. Hence the difference between ales and wines; by the first meaning fermented liquors from *farinacea*, by the second from the fruits of plants. It depends, secondly, On the acerbity, acidity, nature, and maturation, of the fruit. Thirdly, The variety depends on the conduct of the fermentation. In general, fermentation is progressive, being at first active and rapid, detaching the fixed air or *gas sylvestre*, at the same time acquiring more acid than before. These qualities of flatulency and acidity remain for some time: but as the fermentation goes on, the liquor becomes more perfect, no air is detached and alcohol is produced; so that fermented liquors differ according to the progress of the fermentation, and have different effects on the system. When fermentation is stopped before it comes to maturity, though naturally it proceeds in this way, yet by addition of new ferment it may be again renewed with a turbid intestine motion.

DRIVERS, among sportsmen, a machine for driving pheasant powts, consisting of good strong osier wands, such as the basketmakers use; these are to be set in a handle, and twisted or bound with small osiers in two or three places. With this instrument the sportsman drives whole eyes of young powts into his nets. See the next article.

DRIVING, among sportsmen, a method of taking pheasant powts. It is thus: The sportsman finds out the haunts of these birds; and having fixed his nets there, he calls them together by a pheasant call, imitating the voice of the dam; after this he makes a noise with his driver, which will make them run a little way forward in a cluster; and this he is to repeat till he has made sure of them, which an expert sportsman never fails to do, by driving them into his nets.

DRIVING, in *Metallurgy*, is said of silver, when, in the operation of refining, the lead being burnt away, the remaining copper rises upon its surface in red fiery bubbles.

DRIVING, in the sea language, is said of a ship, when an anchor being let fall will not hold her fast, nor prevent her sailing away with the wind or tide. The best help in this case is to let fall more anchors, or to veer out more cable; for the more cable she has out, the safer she rides. When a ship is a-hull or a-try, they say she drives to leeward.

DROGHEDA, by the English called *Tredah*, a town of Ireland, in the province of Leinster and county of Lowth, and situated on the bay of the same name, in W. Long. 6. 17. N. Lat. 53. 45. It was formerly very remarkable for its situation and strength. In consequence of this it was much distinguished by the old English monarchs. Edward II. granted it a market and fair; and to these were added other great privileges in succeeding ages, particularly the right of coinage. It was bravely defended against the rebels in 1641. After the cessation of arms, it was taken by the duke of Ormond and the earl of Inchiquin: but was retaken by Cromwell in 1649. At this time it suffered so much, that for a long time after it remained almost in ruins. The buildings were exceedingly shattered; and the town being taken by storm, not only the garrison, but the inhabitants, men, women, and children, were mostly put to the sword. By degrees, however, it recovered, and is at present a large place, with 15,000 inhabitants. It is a town and county; and sends one member to the imperial parliament. It has a great share of inland trade, and an advantageous commerce with England.

Drogheda is perhaps one of the strongest instances that can be mentioned of the inestimable benefit of a river in any degree navigable; for though the Boyne is not capable of carrying vessels of a greater size than barges or pretty large boats, yet the conveniency that this affords of conveying coals by water carriage through a great extent of country, produced an intercourse between this place and Whitehaven in Cumberland, to which the revival of its commerce has been in a great measure owing.

DROITWITCH, a town of Worcestershire in England, noted for excellent white salt made from the salt springs in its neighbourhood. It sends two members to parliament. Population 2079. W. Long. 2. 16. N. Lat. 52. 20.

DROMEDARY. See CAMELUS, MAMMALIA *Index*.

DROME, a department of France, on the east side of the Rhone. It contained 253,000 inhabitants in 1815, including 34,000 Protestants. It is hilly, and abounds in wood. Wine is a staple produce, and it imports corn. Valence is the chief town.

DROMORE, a town of Ireland, in the county of Down. It is a very ancient town, and the seat of a bishopric. The see was founded by St Colman in the 6th century. It was refounded by King James I. who, by his charters (now preserved in the Rolls office) granted it very great and uncommon privileges. Among other marks of royal favour, he distinguishes the bishops of this see by the style of "A. B. by Divine Providence bishop of Dromore:" whereas all other bishops in Ireland, except those of Meath and Kildare, are styled, "by Divine Permission." This see, although the least in its extent, is so complete and perfect in its endowment and jurisdiction, that it need not envy the greatest and most opulent.

DRONE, a kind of large bees which make their appearance in hives about the month of May, but never work nor prepare any honey: and are at last all killed by the rest. Under the article BEE, N° 20. *et seq.* we have given an account of the experiments of Messrs Debraw and Schirach concerning these animals: but in a Treatise upon Bees and their Management by Mr Bonner near Berwick on Tweed, who has made the management of bees his study for a great number of years, this author dissents from the opinions of the above-mentioned gentlemen for the following reasons, which we shall give in his own words. Having mentioned the opinions of Mr Debraw concerning the little drones mentioned in the article above mentioned, he proceeds thus:

"1. Can it be thought that the prying eyes of multitudes in many generations should have escaped seeing those little drones (they being, according to his account, vastly numerous) thrust their posterior parts into the cells? Yet none ever saw them do it except himself; while many have seen the queen do it, though but a single bee.

"2. It is well known the queen is very long behind the wings, wise nature having made her so, in order that she might thrust her posterior part into the cells, and yet her wings scarcely touch them, nor receive the least injury. If these imaginary little drones had to thrust their posterior parts into the cells in the same manner as the queen, certainly their wings would have been made in the same manner short, and their posterior parts long and taper, which is not the case. Whereas were a bee of any kind (the queen excepted) to thrust its hinder part into a common cell, its wings or coats would come over its head, and be antic-like, and injure both them and its body. Besides, I scarcely think they could get into the common cells that way at any rate for want of room.

"3. Mr Debraw grants, that without a queen or eggs bees will not begin to work, as well knowing they cannot propagate their species without her; and yet he says, those bees which wanted little drones began to work, and the queen laid eggs, and all went forward, till they were not impregnated, and then they gave over work, and deserted the hive. Certainly those sagacious creatures would have been as sensible that they wanted drones at the very first, when they were put into the hive, and that they could not do without them, as they are sensible when they want a queen, and that it is needless to begin work without her; and it might be added that two different kinds of drones in one hive does not appear to be probable, or serve any end.

"But I shall narrate some of my own experiments on that head, which will put it, I hope, beyond dispute: On September 1st, I had a hive breeding fast; I took out all her bees (among which were only four large drones, which I killed), and I put them in a hive that had nothing in her but empty combs: I waited ten days, when, by looking between the combs, I saw her have new sealed up maggots in her cells. I then took all her bees out, and shook them into a tub full of water, and recovered them gradually; and when recovering, I pressed every one of them, in order to see if I could find any of those little drones, but could not find one; but all and every one of them had stings: they were in number 3000. After which I searched the hive I took them out of, and cut out all her combs that had eggs in them, and found they had new laid eggs, four days old eggs, and maggots in them. I then recovered the queen and all her bees, and put in the same hive again, which had not an egg in her now, and waited other twenty days, and saw her in fine days working very well; a sure indication she was breeding again. I then turned her up, and cut out one of her brood combs, and saw in it new laid eggs, four days old eggs, and maggots and some young almost fit for emerging out of their cells.

"The very same day I made a further experiment: I had a hive which I saw had some brood combs in her, but she had not had a large drone for four weeks before in her; she had not above 500 bees in her, which favoured me, because few in number. I took the hive into a close place in my house, in order that not a single bee should escape me; I then took all the bees out of her, and immersed them in water; and when recovering, I pressed every one of them, and each bee had a sting, as in the former experiment.

"I think the above experiments may satisfy any judicious person, that there is no such thing in being as little drones, unless in Mr Debraw's brain. And if Mr Debraw, who can find 57 in a small swarm of bees, will send me the odd seven, I will send him one of my best hives for them, and he will scarcely think he is ill paid. I add, I never saw a hive in spring, however few bees in her, but she bred some, if she had a queen, though to be sure few in proportion to her bees.

"By this time the reader will be very ready, no doubt, to ask me the use of the drones. I beg to be excused on that head, as I have not the least idea of their use in a hive; they do not fecundate the qneen, for she can lay and breed too though she never see them. Their heat does not appear to me to be necessary for hatching the young, as they are mostly hatched before any are bred in a hive; and when drones are in the hive, the weather is so warm, and so many common bees in it, that they appear to have rather too much heat, by their lying out of the hives often.

"I have many times had good hives with few or no drones in them all the year; and Keys is quite wrong when he says a top swarm will not do without drones in her; for I am positive to the contrary, as in the summer 1785 I took off four swarms of mine own in one day with not a single drone in any of them, and they all throve well, and bred drones in themselves about four weeks after.

"Although I cannot say what use the drones are of to a hive (unless it be to help away with a great deal of her honey, which they are very good at), yet the best hives have them soonest in the year, they generally appearing in such about the latter end of May, and the bees put a period to their lives about Lammas, at which time I give them all the assistance I can. The way they kill them is thus: They pull and bite them with their teeth, and sting them also. I have seen great havock made of them in one day, as appeared by their lying dead before the door of the hive. But their most effectual way of killing them is their banishing them from the honeycombs; upon which the drones betake themselves to the under edges of the hives in great numbers, and to the board the hive stands on; and sometimes, though rare, I have even seen them come to the outside of the hive, and cluster there about the bulk of a man's hand. When they are banished thus, they are very dull and lifeless: and I have lifted up a hive from the board, and there they would have been sitting close on it, with scarcely three or four common bees among them; and I have trod to death 40 or more at a time.

"We may now take a view of the disadvantages attending the old, and also Mr Debraw's principles on bees, were they true; and next see how a hive of bees may be preserved from coming to ruin, according to my sentiments on them.

"1. The old principles on bees say, that without a queen or royal cell be in a hive, it will come to ruin.

"2. Mr Debraw's principles say, that without little drones be in a hive it will come to ruin.

"3. I say, if a hive have only new laid eggs in her (which may be easily got the greatest part of the year, in case she have none of her own) and common bees, she will find herself a queen, and so thrive.

"According to the old principle, it is easily seen that, in case a hive lose her queen, when there is no royal cell in her, and no queen can be got to put to her (neither of which can be expected but in June and July), she is entirely ruined.

"According to the Frenchman's scheme, there must be drones in a hive at all times of the year to fecundate the eggs, otherwise the hive is useless. Supposing his sentiments to be true (which, however, can by no means be admitted, seeing there is no such thing as little drones), how perplexed would the owner be to know when there were little drones in the hive! When he wanted to make an artificial swarm, he might bring off a queen and common bees with her; but how should he come to know whether there were any, or a sufficient quantity, of little drones among them, as they cannot be distinguished from the commons but by immersion and pressure, which would be intolerably troublesome, and next to killing the bees, and not at all practicable? All that could be done would be to hope the best, that there were little drones in her at any time of the year.

"I say, if a queen die in a hive, and that hive have some new-laid eggs in her, or some put to her, in case she have none of her own, she will nourish up some of these eggs to be a queen to herself: and also by taking out a queen and some commons out of a hive (without a single drone, large or small), and putting them in an empty hive, will make a swarm, and the old hive will breed herself a queen again, if she have eggs in her."

Drone-Fly, a two-winged insect, extremely like the common drone bee, whence also the name.

DROPS, in *Meteorology*, small spherical bodies which the particles of fluids spontaneously form themselves into when let fall from any height. The spherical figure, the Newtonian philosophers demonstrate to be the effect of corpuscular attraction; for considering that the attractive force of one single particle of a fluid is equally exerted to an equal distance, it must follow that other fluid particles are on every side drawn to it, and will therefore take their places at an equal distance from it, and consequently form a round superfices. See the articles ATTRACTION, FLUID, and RAIN.

DROPS, in *Medicine*, a liquid remedy, the dose of which is estimated by a certain number of drops.

English DROPS, (*Guttæ Anglicanæ*,) a name given to a chemical preparation esteemed of great virtue against vapours and lethargic affections, and purchased at 5000l. by King Charles II. from the inventor Dr Goddard. The medicine appeared to be only a spirit drawn by the retort from raw silk, and afterwards rectified with oil of cinnamon, or any other essential oil; and was in reality no better than the common sal volatile oleosum, or any of the volatile spirits impregnated with an essential oil, except that it was less disagreeable than any of them to the taste.

DROPSY, in *Medicine*, an unnatural collection of water in any part of the body. See MEDICINE *Index*.

DROPWORT. See FILIPENDULA, BOTANY *Index*.

*Water-*DROPWORT. See OENANTHE, BOTANY *Index*.

DROSERA, ROS SOLIS, or *Sun-Dew*. See BOTANY *Index*.

DROWNING, signifies the extinction of life by a total immersion in water.

In some respects, there seems to be a great similarity between the death occasioned by immersion in water, and that by strangulation, suffocation by fixed air, apoplexies, epilepsies, sudden faintings, violent shocks of electricity, or even violent falls and bruises. Physicians, however, are not agreed with regard to the nature of the injury done to the animal system in any or all of these accidents. It is indeed certain, that in all the cases above mentioned, particularly in drowning, there is very often such a suspension of the vital powers as to us hath the appearance of a total extinction of them; while yet they may be again set in motion, and the person restored to life, after a much longer submersion than hath been generally thought capable of producing absolute death. It were to be wished, however, that, as it is now universally allowed, that drowning is only a suspension of the action of the vital powers, physicians could as unanimously determine the means by which these powers are suspended; because on a knowledge of these means, the methods to be used for recovering drowned persons must certainly depend.

Dr de Haen, who has written a treatise on this subject, ascribes this diversity of opinion among the physicians to their being so ready to draw general conclusions from a few experiments. Some, having never found water in the lungs, have thought that it never was there; and others, from its presence, have drawn a contrary conclusion. Some have ascribed the death which happens in cases of drowning to that species of apoplexy which arises from a great fulness of the stomach. But this opinion our author rejects, because in 13 dogs which he had drowned and afterwards dissected, no signs of such a fulness appeared. Another reason is drawn from the want of the common marks

Drowning.

of apoplexy on the dissection of the brain, and from the actual presence of water in the lungs. He is of opinion, that the death of drowned persons happens in consequence of water getting into the lungs, and stopping the blood in the arteries. He then discusses the question how far the blowing of air into the lungs is useful in recovering drowned people. If their death is to be ascribed to the water entering the lungs, this practice, he observes, must be hurtful, as it will increase the pressure on the blood-vessels, or may even force the water into them; which, on the authority of Lewis's experiments, he alleges is possible. But, in spite of this reasoning, he asserts, that from experience it has been found useful. He allows, that the practice of suspending drowned people by the feet must be hurtful, by determining the blood too much to the head; but he observes, that remedies in some respects hurtful may be used when the advantages derived from them preponderate; and is of opinion, that the practice above mentioned may be used by agitating the viscera against each other, and thus renewing their motions. Cutting the larynx in order to admit air more freely to the lungs, he reckons to be of little or no use; but acknowledges, however, that it may sometimes prove beneficial on account of the irritation occasioned by the operation.

Dr Cullen, in his Letter to Lord Cathcart concerning the recovery of persons drowned and seemingly dead, tells us, that "From the dissection of drowned men, and other animals, it is known, that very often the water does not enter into the cavity of the lungs, nor even into the stomach, in any quantity to do hurt to the system; and, in general, it is known, that, in most cases, no hurt is done to the organization of the vital parts. It is therefore probable, that the death which ensues, or seems to ensue, in drowned persons, is owing to the stopping of respiration, and to the ceasing, in consequence, of the circulation of the blood, whereby the body loses its heat, and, with that, the activity of the vital principle."

In the Phil. Trans. vol. lxvi. Mr Hunter gives the following theory. The loss of motion in drowning seems to arise from the loss of respiration; and the immediate effect this has upon the other vital motions of the animal, at least this privation of breathing, appears to be the first cause of the heart's motion ceasing. It is most probable, therefore, Mr Hunter observes, that the restoration of breathing is all that is necessary to restore the heart's motion; for if a sufficiency of life still remains to produce that effect, we may suppose every part equally ready to move the very instant in which the action of the heart takes place, their actions depending so much upon it. What makes it very probable, that the principal effect depends upon throwing air into the lungs, is, that children in the birth, when too much time has been spent after the loss of that life which is peculiar to the fœtus, lose altogether the disposition for the new life. In such cases there is a total suspension of the actions of life; the child remains to all appearance dead; and would die, if air was not thrown into its lungs, and the first principle of action by that means restored. To put this in a clearer light, Mr Hunter gives the result of some experiments made on a dog in 1755.—A pair of double bellows were provided, which were so constructed, that by one action air was thrown into the lungs, and by the other the air was sucked out which had been thrown in by the former, without mixing them together. The muzzle of these bellows was fixed into the trachea of a dog, and by working them he was kept perfectly alive. While this artificial breathing was going on, the sternum was taken off, so that the heart and lungs were exposed to view. The heart then continued to act as before, only the frequency of its action was greatly increased. Mr Hunter then stopped the motion of the bellows; and observed that the contraction of the heart became gradually weaker and less frequent, till it left off moving altogether; but by renewing the operation, the motion of the heart also revived, and soon became as strong and frequent as before. This process was repeated upon the same dog ten times; sometimes stopping for five, eight, or ten minutes. Mr Hunter observed, that every time he left off working the bellows, the heart became extremely turgid with blood, and the blood in the left side became as dark as that in the right, which was not the case when the bellows were working. These situations of the animal, he observes, seem to be exactly similar to drowning.

Dr Edmund Goodwyn, in a treatise lately published on this subject, has endeavoured to ascertain the effects of submersion upon living animals in a more accurate manner than had hitherto been done. His first care was to determine the symptoms which took place before death; and to observe these, he procured a large glass bell in which the animals were to be immersed. Having inverted, and filled this with water, he put into it several cats, dogs, rabbits, and smaller animals, confining them among the water till they were apparently dead. In these experiments he observed, that immediately after submersion the pulse became weak and frequent; there was an apparent anxiety about the breast, and struggling to relieve it. In these struggles the animal rose to the top of the water, throwing out a quantity of air from the lungs. After this the anxiety increases, the pulse becomes weaker, and the struggles more violent; he rises again to the surface, throws out more air from the lungs, and in his efforts to inspire, a quantity of water commonly passes into the mouth. The skin about the face and lips then becomes blue, the pulse ceases, the sphincters are relaxed, and the animal falls down without sense or motion. On dissecting the bodies of drowned animals, our author met with the following appearances: 1. The external surface of the brain was darker, but the vessels of it were not more turgid than usual, nor was there any appearance of extravasation. 2. The pulmonary arteries and veins were filled with black blood, and the lungs themselves contained some frothy liquor. 3. Notwithstanding these symptoms, the right auricle and ventricle were still contracting and dilating; the left sinus venosus and auricle moving feebly, but the left ventricle at rest. 4. The right and left auricles of the heart, the right ventricle, and the left sinus venosus, were filled with black blood; but the last ventricle only half filled with the same, and a quantity of the same black blood was also contained in the smaller branches of the arteries proceeding from the left ventricle.

This investigation was followed by a most careful and

Drowning.

and ingenious inquiry concerning the causes of the symptoms already related. To find out whether or not the entrance of water into the lungs was the cause, or whether water really entered the lungs in these cases or not, he drowned several animals among ink; and by inspecting their bodies, found, that though water really did enter, it was in such small quantity that it could not be supposed capable of producing such violent effects. To ascertain this, however, more exactly than could be done by the ink, he drowned other animals in quicksilver; which, by reason of its not being miscible with the animal fluids, could be more accurately collected. By these it appeared that no more than five drachms of the fluid in which a cat was immersed entered her lungs in the time of drowning; and to determine whether or not this could be the occasion of the animal's death, he made the following experiment: Having confined a cat in an erect posture, he made a small opening in the trachea, by cutting one of the cartilaginous rings; and through this opening he introduced two ounces of water into the lungs. The only consequences were a difficulty of breathing and weak pulse; but these soon abated, and it lived several hours afterwards without any apparent inconvenience. On strangling it he found two ounces and a half of water in the lungs. On repeating the experiment with other fluids, he found the difficulty of breathing and alteration in the pulse somewhat greater; but in these instances also they abated in a few hours: and when the animals were strangled, the lungs were found to contain four ounces of fluid.

From all these experiments Dr Goodwyn draws the following conclusions: 1. "A small quantity of fluid usually passes into the lungs in drowning. 2. This water enters the lungs during the efforts to inspire; and mixing with the pulmonary mucus, occasions the frothy appearance mentioned by authors. 3. The whole of this fluid in the lungs is not sufficient to produce the changes that take place in drowning. And hence it follows, that the water produces all the changes that take place in drowning *indirectly*, by excluding the atmospheric air from the lungs." This naturally leads to an investigation of the uses of respiration, and the effects of the air upon the blood and lungs in that action, which our author traces with great accuracy and very convincing experiments. He begins with attempting to determine the quantity of air drawn in at each inspiration, with the proportional quantity left after expiration. The experiments by which he endeavoured to ascertain these quantities seem to be more uncertain than the others, as indeed there are not data sufficient for them. From such as he had an opportunity of making, however, the following conclusions were deduced: 1. "The lungs contain 109 cubic inches of air after a complete expiration; and this quantity receives an additional quantity of 14 cubic inches during each inspiration. 2. The dilatation of the lungs after expiration is to their dilatation after inspiration as 109 to 123. 3. The blood circulates through the pulmonary vessels in all the degrees of natural respiration. 4. The circulation through them, after respiration, is sufficiently free to keep up the health of the system."

The last part of our author's inquiry, viz. concerning the chemical changes produced in the air by respiration, and the effects of the air upon the blood itself falls naturally to be considered under the article RESPIRATION: so that here we shall only observe in general, that his experiments evidently show that the disease produced by drowning arises entirely from the exclusion of the atmospheric air or its dephlogisticated part; for which reason he recommends inflating the lungs with that kind of air in preference to any other.

Drowning.

From these different views of this matter, physicians have differed considerably in their account of the methods to be followed in attempting the recovery of drowned persons. De Haen recommends agitation of all kinds; every kind of stimulus applied to the mouth, nose, and rectum; bleeding; heat, both by warm clothes and warm water; blowing air into the trachea; stimulants, such as blisters, warm ashes, &c. applied to the head, ankles, thighs, pit of the stomach, and other parts.

Doctor Cullen's observations on this subject are as follow.—"With respect to the particular means to be employed for the recovery of drowned persons, it is to be observed, in the first place, That such as were recommended and practised, upon a supposition that the suffocation was occasioned by the quantity of water taken into the body, and therefore to be evacuated again, were very unhappily advised. The hanging up of persons by the heels, or setting them upon the crown of the head, or rolling the body upon a cask, were generally practised, upon a supposition altogether false; or upon the supposition, of a case which, if real, is apprehended to be irrecoverable. At the same time, these practices were always attended with the danger of bursting some vessels in the brain or lungs, and of rendering thereby some cases incurable that were not so from the drowning alone. All such practices, therefore, are now very properly disapproved of and forbidden.

"In those cases in which the body has not been long in the water, and in which therefore the natural heat is not entirely extinguished, nor the irritability of the moving fibres very greatly impaired, it is possible that a good deal of agitation of the body may be the only means necessary to restore the action of the vital organs; but in other cases, where the heat and irritability have ceased to a greater degree, it is to me very doubtful if much agitation can be safe, and if any degree of it can be useful, till the heat and irritability are in some measure restored. In all cases, any violent concussion cannot be safe, and, I believe, is never necessary. It may be proper here to observe also, that in transporting the body from the place where it is taken out of the water, to the place where it may be necessary for applying the proper means of its recovery, all postures exposing to any improper compression, as that of the body's being carried over a man's shoulder, are to be avoided. The body is to be kept stretched out, with the head and upper parts a little raised; and care is to be taken to avoid the neck's being bent much forward. In this manner, laid upon one side, and upon some straw in a cart, it may be most properly conveyed; and the agitation which a pretty brisk motion of the cart may occasion, will, in most cases, do no harm.

"From the account I have given above of the causes,

ses, or of the appearances, of death in drowned persons, it is evident, that the first step to be taken for their recovery is to restore the heat of the body, which is absolutely necessary to the activity of the moving fibres. For this purpose, the body, as soon as possible, is to be stripped of its wet clothes, to be well dried, and to be wrapped up in dry, and (if possible) warm, coverings: and it is to be wished, in all cases, as soon as the report of a person's being drowned is heard, that blankets should be immediately carried to the water side; so that as soon as the body is got out of the water, the change of covering just now mentioned may be instantly made; or, if the body has been naked when drowned, that it may be immediately dried and defended against the cold of the air. Besides covering the body with blankets, it will be further of advantage, if it can be done without loss of time, to cover the drowned body with a warm shirt or waistcoat immediately taken from a living person.

"When, at the time of a person's being drowned, it happens that the sun shines out very hot, I think there can be no better means of recovering the heat, than by exposing the naked body, in every part, to the heat of the sun; while, at the same time, all other means necessary or useful for the recovery of life are also employed.

"When the heat of the sun cannot be employed, the body should be immediately transported to the nearest house that can be got convenient for the purpose: the fittest will be one that has got a tolerably large chamber, in which a fire is ready, or can be made; and if possible, the house should afford another chamber, in which also a fire can be provided.

"When the drowned body is brought into such house, and care is at the same time taken that no more people are admitted than are absolutely necessary to the service of the drowned person, every endeavour must be immediately employed for recovering the heat of the body, and that by different measures, as circumstances shall direct.

"If, in the neighbourhood of the place, there be any brewery, distillery, dyery, or fabric which gives an opportunity of immediately obtaining a quantity of warm water and a convenient vessel, there is nothing more proper than immersing the body in a warm bath. Even where a sufficient quantity of warm water cannot be had at once, the bath may be still practised, if the accident has happened in or very near a town or village, where a great many fires may be at once employed in heating small quantities of water; for in this way the necessary quantity may be soon obtained. To encourage this practice, it is to be observed, that one part of boiling water is more than sufficient to give the necessary heat to two parts of spring or sea water, as it is not proper to apply the bath at first very warm, nor even of the ordinary heat of the human body, but somewhat under it; and, by the addition of warm water, to bring it gradually to a heat very little above it.

"If the drowned body be of no great bulk, it may be conveniently warmed by a person's lying down in bed with it, and taking it near to their naked body, changing the position of it frequently, and at the same time chafing and rubbing with warm cloths the parts which are not immediately applied to their warm body.

"If none of these measures can be conveniently practised, the body is to be laid upon a bed before a moderate fire, and frequently turned, to expose the different parts of it; and thus, by the heat of the fire gradually employed, and by rubbing the body well with coarse towels, or other cloths well warmed, pains are to be taken for restoring its heat. This will be promoted by warm cloths applied and frequently renewed under the hams and armpits; and by hot bricks, or bottles of warm water, laid to the feet.

"In the practice of rubbing, it has been proposed to moisten the cloths applied with camphorated spirits, or other such stimulating substances; but I think this must prove an impediment to the rubbing; and I would not recommend any practice of this kind, except, perhaps, the application of the vinous spirits of sal ammoniac to the wrists and ankles only.

"For recovering the heat of the body, it has been proposed to cover it all over with warm grains, ashes, sand, or salt; and where these, sufficiently warm, are ready at hand, they may be employed; but it is very seldom they can be obtained, and the application might often interfere with other measures that may be necessary. All therefore that I can propose with respect to the use of these, is to observe, that bags of warm and dry salt may be amongst the most convenient applications to the feet and hands of drowned persons; and the quantity necessary for this purpose may be got pretty quickly by heating the salt in a frying pan over a common fire.

"While these measures are taking for recovering the heat, means are at the same time to be employed for restoring the action of the moving fibres. It is well known, that the intestines are the parts of the body which, both from their internal situation and peculiar constitution, retain the longest their irritability; and therefore, that, in drowned persons, stimulants applied may have more effect upon the intestines than upon other parts. The action, therefore, of the intestines is to be supported or renewed as soon as possible; as the restoring and supporting the action of such a considerable portion of moving fibres as those of the intestines, must contribute greatly to restore the activity of the whole system.

"For exciting the action of the intestines, the most proper mean is, the application of their ordinary stimulus of dilatation; and this is most effectually applied, by forcing a quantity of the air into them by the fundament. Even the throwing in cold air has been found useful: but it will certainly be better if heated air can be employed; and further, if that air can be impregnated with something which, by its acrimony also may be powerful in stimulating the intestines.

"From all these considerations, the smoke of burning tobacco has been most commonly applied, and has upon many occasions proved very effectual. This will be most properly thrown in by a particular apparatus, which, for other purposes as well as this, should be in the hands of every surgeon; or at least should, at the public expence, be at hand in every part of the country where drownings are likely to happen. With regard to the use of it, I have to observe, that till the

the tobacco is kindled in a considerable quantity, a great deal of cold air is blown through the box and tube; and as that, as hinted above, is not so proper, care should be taken to have the tobacco very well kindled, and to blow through it very gently, till the heated smoke only passes through. If upon certain occasions, the apparatus referred to should not be at hand, the measure however may be executed by a common tobacco pipe, in the following manner: A common glyster pipe, that has a bag mounted upon it, is to be introduced into the fundament, and the mouth of the bag is to be applied round the small end of a tobacco pipe. In the bowl of this, tobacco is to be kindled; and, either by a playing card made into a tube and applied round the mouth of the bowl, or by applying upon this the bowl of another pipe that is empty, and blowing through it, the smoke may be thus forced into the intestines, and, in a little time, in a considerable quantity.

"If none of these means for throwing in the smoke can be employed, it may be useful to inject warm water to the quantity of three or four English pints. This may be done by a common glyster bag and pipe, but better by a large syringe; and it may be useful to dissolve in the water some common salt, in the proportion of half an ounce to an English pint; and also to add to it some wine or brandy.

"While these measures for recovering the heat of the body and activity of the moving fibres are employed, and especially after they have been employed for some time, pains are to be taken to complete and finish the business, by restoring the action of the lungs and heart.

"On this subject, I am obliged to my learned and ingenious colleague Dr Monro, who has made some experiments for ascertaining the best manner of inflating the lungs of drowned persons. By these experiments he finds it may be more conveniently done by blowing into one of the nostrils, than by blowing into the mouth. For blowing into the nostril, it is necessary to be provided with a wooden pipe, fitted at one extremity for filling the nostril, and at the other for being blown into by a person's mouth, or for receiving the pipe of a pair of bellows, to be employed for the same purpose. Dr Monro finds, that a person of ordinary strength can blow into such a pipe, with a sufficient force to inflate the lungs to a considerable degree; and thinks the warm air from the lungs of a living person will be most conveniently employed at first; but when it is not soon effectual in restoring the respiration of the drowned person, and that a longer continuance of the inflation is necessary, it may be proper to employ a pair of bellows, large enough at once to contain the quantity of air necessary to inflate the lungs to a due degree.

"Whether the blowing in is done by a person's mouth, or by bellows, Dr Monro observes, that the air is ready to pass by the gullet into the stomach; but that this may be prevented, by pressing the lower part of the larynx backwards upon the gullet. To persons of a little knowledge in anatomy, it is to be observed, that the pressure should be only upon the cricoid cartilage, by which the gullet may be straitened, while the passage through the larynx is not interrupted.

"When, by blowing thus into the nostrils, it can be perceived, by the raising of the chest or belly, that the lungs are filled with air, the blowing in should cease; and by pressing the breast and belly, the air received into the lungs should be again expelled; then the blowing and expulsion should be again repeated; and thus the practice is to be continued, so as to imitate, as exactly as possible, the alternate motions of natural respiration.

"It is hardly necessary to observe, that when the blowing into the nostril is practised, the other nostril and the mouth should be accurately closed.

"If it should happen, that in this practice the air does not seem to pass readily into the lungs, Dr Monro informs me it is very practicable to introduce directly into the glottis and trachea a crooked tube, such as the catheter used for a male adult. For this he offers the following directions: The surgeon should place himself on the right side of the patient; and, introducing the fore finger of his left hand at the right corner of the patient's mouth, he should push the point of it behind the epiglottis; and using this as a directory, he may enter the catheter, which he holds in his right hand, at the left corner of the patient's mouth, till the end of it is passed beyond the point of his fore finger; and it is then to be let fall, rather than pushed into the glottis; and through this tube, by a proper syringe applied to it, air may be with certainty blown into the lungs. I observe, that some such measure had been proposed by Mons. le Cat in France; but I have not learned that it has ever been put in practice, and I am afraid it may be attended with several difficulties, and must be left to the discretion of surgeons who may be properly provided and instructed for this purpose.

"For throwing air with more certainty into the lungs, it has been proposed to open the windpipe in the same manner as is done in the operation which the surgeons call *bronchotomy*, and by this opening to blow into the lungs; and when the blowing into the nostril does not seem to succeed, and a skilful operator is at hand, I allow that the measure may be tried; but I can hardly suppose that it will be of any advantage when the blowing in by the nostril has entirely failed.

"It is to be hoped, that by blowing into the lungs one way or other, even a quantity of water which had been taken into the lungs may be again washed out; and the same seems to be the only effectual means of washing out that frothy matter which is found to fill the lungs of drowned persons, and which proves, if I mistake not, the most common cause of their mortal suffocation. This practice, therefore, is to be immediately entered upon, and very assiduously continued for an hour or two together.

"I have now mentioned the measures chiefly to be pursued and depended upon for the recovery of drowned persons; but must still mention some others that may prove considerable helps to it.

"One of these is, the opening the jugular veins, to relieve the congestion which almost constantly occurs in the veins of the head, and is probably a frequent cause of the death of drowned persons. For relieving this congestion, the drawing some blood from the jugulars, very early, may certainly be of service; and it will be particularly indicated by the livid and purple colour of the face. It may even be repeated, according to the effect it seems to have in taking off that suffusion; but when the drowned person is in some measure recovered, and some motion of the blood is restored, it will be proper to be very cautious in making this evacuation, and at least to take care not to push it so as to weaken too much the recovering, but still weak, powers of life.

"Another measure for recovering the activity of the vital principle, is the application of certain stimulants to the more sensible parts of the body, such as holding the quicklime spirit of sal ammoniac to the nose, or putting a little of it upon a rag into the nostrils. It has been usual to pour some liquids into the mouth; but it is dangerous to pour in a quantity of liquid, till it appear that the power of swallowing is in some measure restored.

"When a surgeon is at hand, and is provided with proper apparatus, a crooked pipe may be introduced into the gullet; and by this a gill or two of warm wine may be poured down into the stomach, and probably with advantage. But when no such apparatus is at hand or surgeon to employ it, and the power of swallowing is still doubtful, the trial of pouring liquids into the mouth should be made by a small quantity of warm water alone; and when, from such trial, the power of swallowing shall appear to be recovered, it may then be allowable to favour the further recovery of the person, by pouring in some wine or brandy.—In short, till some marks of the recovery of swallowing and respiration appear, it will not be safe to apply any stimulants to the mouth; excepting that of a few drops of some acrid substance to the tongue, and which are not of bulk enough to slide back upon the glottis: I can think of no stimulant more conveniently and safely to be applied to the mouth and nostrils, than a moderate quantity of tobacco smoke blown into them.

"Though I do not imagine that drowned persons are ever hurt by the quantity of water taken into their stomach, yet, as a stimulus applied to the stomach, and particularly as the action of vomiting proves a stimulus to the whole system, I can have no objection to the French practice of throwing in an emetic as soon as any swallowing is restored. For this purpose, I would successively throw in some tea-spoonfuls of the ipecacuanha wine; and when it does not interfere with other necessary measures, the fauces may be gently irritated by an oiled feather thrust into them.

"With regard to the stimulants, I must conclude with observing, That when a body has lain but for a short time in the water, and that therefore its heat and irritability are but little impaired, the application of stimulants alone has been often found effectual for the recovery: but on the contrary, when the body has lain long in the water, and the heat of it is very much extinguished, the application of any other stimulants than that of tobacco smoke to the intestines can be of very little service; and the application of others ought never to interfere with the measures for recovering heat and the motion of respiration.

"With respect to the whole of these practices, I expect, from the principles upon which they are in general recommended, it will be understood that they are not to be soon discontinued, though their effects do not immediately appear. It is obvious, that, in many cases, it may be long before the heat of the body, and the activity of the vital principle, can be restored, although in a longer time it may very possibly be accomplished. In fact, it has often happened, that though means employed for one hour have not succeeded, the same continued for two or more hours, have at length had the wished-for effects. It should therefore be a constant rule, in this business, that the proper means should be employed for several hours together; unless it happen that, while no symptoms of returning life appear, the symptoms of death shall, at the same time, go on constantly increasing.

"In the whole of the above I have kept in view chiefly the case of drowned persons; but it will be obvious, that many of the measures proposed will be equally proper and applicable in other cases of suffocation; as those from strangling, the damps of mines, the fumes of charcoal, &c.; and a little attention to the difference of circumstances will lead to the measures most proper to be employed."

Mr Hunter, in the before-mentioned paper, differs pretty considerably from De Haen and Dr Cullen. He observes, that when assistance is soon called after immersion, blowing air into the lungs will in some cases effect a recovery; but when any considerable time has been lost, he advises stimulant medicines, such as the vapour of volatile alkali, to be mixed with the air; which may easily be done, by holding spirits of hartshorn in a cup under the receiver of the bellows. And, as applications of this kind to the olfactory nerves tend greatly to rouse the living principle, and put the muscles of respiration into action, it may probably, therefore, be most proper to have air impregnated in that manner thrown in by the nose. To prevent the stomach and intestines from being too much distended by the air so injected, the larynx is directed to be gently pressed against the œsophagus and spine.

While this business is going on, an assistant should prepare bed clothes, carefully brought to a proper degree of heat. Heat our author considers as congenial with the living principle; increasing the necessity of action, it increases action: cold, on the other hand, lessens the necessity, and of course the action is diminished: to a due degree of heat, therefore, the living principle, he thinks, owes its vigour. From experiments, he says, it appears to be a law in animal bodies, that the degree of heat should bear a proportion to the quantity of life; as life is weakened, this proportion requires great accuracy, while greater powers of life allow it greater latitudes.

After these and several other observations on the same subject, our author proceeds to more particular directions for the management of drowned people.

If bed clothes are put over the person, so as scarce to touch him, steams of volatile alkali, or of warm balsams, may be thrown in, so as to come in contact with many parts of the body. And it might probably be advantageous, Mr Hunter observes, to have steams of the same kind conveyed into the stomach. This, we are told, may be done by a hollow bougie and a syringe: but the operation should be very speedily performed,

formed, as the instrument, by continuing long in the mouth, might produce sickness, which our author says he would always wish to avoid.

Some of the warm stimulating substances, such as juice of horseradish, peppermint water, and spirits of hartshorn, are directed to be thrown into the stomach in a fluid state, as also to be injected by the anus. Motion possibly may be of service; it may at least be tried: but as it hath less effect than any other of the usually prescribed stimuli, it is directed to be the last part of the process.

The same care in the operator, in regulating the proportion of every one of these means, is here directed, as was formerly given for the application of heat. For every one of them, our author observes, may possibly have the same property of destroying entirely the feeble action which they have excited, if administered in too great a quantity: instead, therefore, of increasing and hastening the operations on the first signs of returning life being observed, as is usually done, he desires they may be lessened; and advises their increase to be afterwards proportioned, as nearly as possible, to the quantity of powers as they arise.

When the heart begins to move, the application of air to the lungs should be lessened, that, when the muscles of respiration begin to act, a good deal may be left for them to do.

Mr Hunter absolutely forbids bloodletting in all such cases; for as it not only weakens the animal principle, but lessons life itself, it must consequently, he observes, lessen both the powers and dispositions to action. For the same reason, he is against introducing any thing into the stomach that might produce sickness or vomiting; and, on the same principle, he says, we should avoid throwing tobacco fumes, or any other such articles, up by the anus, as might tend to an evacuation that way.

The following is a description of instruments recommended for such operations by our author.

First, A pair of bellows, so contrived, with two separate cavities, that, by opening them when applied to the nostrils or mouth of a patient, one cavity will be filled with common air, and the other with air sucked out from the lungs, and by shutting them again, the common air will be thrown into the lungs, and that sucked out of the lungs discharged into the room. The pipe of these should be flexible; in length a foot, or a foot and a half; and, at least, three eighths of an inch in width. By this the artificial breathing may be continued, while the other operations, the application of the stimuli to the stomach excepted, are going on, which could not be conveniently done, if the muzzle of the bellows were introduced into the nose. The end next the nose should be double, and applied to both nostrils. Secondly, A syringe, with a hollow bougie, or flexible catheter, of sufficient length to go into the stomach, and convey any stimulating matter into it, without affecting the lungs. Thirdly, A pair of small bellows, such as are commonly used in throwing fumes of tobacco up by the anus.

Notwithstanding the differences in theory, however, between the physicians above mentioned, it is certain, that within these few years great numbers of drowned people have been restored to life by a proper use of the remedies we have enumerated, and societies for the recovery of drowned persons have been instituted in different places. The first society of this kind was instituted in Holland, where from the great abundance of canals and inland seas, the inhabitants are particularly exposed to accidents by water. In a very few years 150 persons were saved from death by this society; and many of these had continued upwards of an hour without any signs of life, after they had been taken out of the water. The society was instituted at Amsterdam in 1767: and, by an advertisement, informed the inhabitants of the United Provinces of the methods proper to be used on such occasions; offering rewards at the same time to those who should, with or without success, use those methods for recovering persons drowned and seemingly dead. The laudable and humane example of the Dutch, was followed in the year 1768 by the magistrates of health in Milan and Venice; afterwards by the magistrates of Hamburg in the year 1771, by those of Paris in the year 1772, and by the magistrates of London in 1774.

The following directions are given for the recovery of drowned persons by the society at London.

I. As soon as the patient is taken out of the water, the wet clothes, if the person is not naked at the time of the accident, should be taken off with all possible expedition on the spot (unless some convenient house be very near), and a great coat or two, or some blankets if convenient, should be wrapped round the body.

II. The patient is to be thus carefully conveyed in the arms of three or four men, or on a bier, to the nearest public or other house, where a good fire, if in the winter season, and a warm bed, can be made ready for its reception. As the body is conveying to this place, a great attention is to be paid to the position of the head; it must be kept supported in a natural and easy posture, not suffered to hang down.

III. In cold or moist weather, the patient is to be laid on a mattress or bed before the fire, but not too near, or in a moderately heated room; in warm and sultry weather, on a bed only. The body is then to be wrapped as expeditiously as possible with a blanket, and thoroughly dried with warm coarse cloths or flannels.

IV. In summer or sultry weather too much air cannot be admitted. For this reason it will be necessary to set open the windows and doors, as cool refreshing air is of the greatest importance in the process of resuscitation.

V. Not more than six persons are to be present to apply the proper means; a greater number will be useless, and may retard, or totally prevent, the restoration of life, by rendering the air of the apartment unwholesome. It will be necessary, therefore, to request the absence of those who attend merely from motives of curiosity.

VI. It will be proper for one of the assistants, with a pair of bellows of the common size, applying the pipe a little way up one nostril, to blow with some force, in order to introduce air into the lungs: at the same time the other nostril and the mouth are to be closed by another assistant, whilst a third person gently presses the chest with his hands, after the lungs are observed to be inflated. By pursuing this process, the noxious and stagnant vapours will be expelled, and natural breathing imitated. If the pipe of the bellows be too large,

the

the air may be blown in at the mouth, the nostrils at the same time being closed, so that it may not escape that way: but the lungs are more easily filled, and natural breathing better imitated, by blowing up the nostril.

VII. Let the body be gently rubbed with common salt, or with flannels, sprinkled with spirits, as rum or geneva (A). A warming pan heated (the body being surrounded with flannel) may be lightly moved up and down the back. Fomentations of hot brandy are to be applied to the pit of the stomach, loins, &c. and often renewed. Bottles filled with hot water, heated tiles covered with flannel, or hot bricks, may be efficaciously applied to the soles of the feet, palms of the hands, and other parts of the body. The temples may be rubbed with spirits of hartshorn, and the nostrils now and then tickled with a feather; and snuff, or *eau de luce*, should be occasionally applied.

VIII. Tobacco fumes should be thrown up the fundament: if a fumigator be not at hand, the common pipe may answer the purpose. The operation should be frequently performed, as it is of importance; for the good effects of this process have been experienced in a variety of instances of suspended animation. But should the application of tobacco smoke in this way not be immediately convenient, or other impediments arise, clysters of this herb, or other acrid infusions with salt, &c. may be thrown up with advantage.

IX. When these means have been employed a considerable time without success, and any brewhouse or warm bath can be readily obtained, the body should be carefully conveyed to such a place, and remain in the bath, or surrounded with warm grains, for three or four hours.

If a child has been drowned, its body should be wiped perfectly dry, and immediately placed in bed between two healthy persons. The salutary effects of the natural vital warmth, conveyed in this manner, have been proved in a variety of successful cases.

X. While the various methods of treatment are employed, the body is to be well shaken every ten minutes, in order to render the process of animation more certainly successful; and children, in particular, are to be much agitated, by taking hold of their legs and arms, frequently and for a continuance of time. In various instances agitation has forwarded the recovery of boys who have been drowned, and continued for a considerable time apparently dead.

XI. If there be any signs of returning life, such as sighing, gasping, or convulsive motions, a spoonful of any warm liquid may be administered; and if the act of swallowing is returned, then a cordial of warm brandy or wine may be given in small quantities, and frequently repeated.

XII. Electricity may be tried by the judicious and skilful, as its application neither prevents nor retards the various modes of recovery already recommended; but on the other hand, will most probably tend to render the other means employed more certainly and more expeditiously efficacious. This stimulus bids fair to prove an important auxiliary in cases of suspended animation; and therefore deserves the serious regard and attention of the faculty.

The methods which have been fully described, are to be employed with vigour for three hours or upwards, although no favourable circumstances should arise; for it is a vulgar and dangerous opinion to suppose that persons are irrecoverable, because life does not soon make its appearance; an opinion that has consigned to the grave an immense number of the seemingly dead, who might have been restored to life by resolution and perseverance.

Bleeding is never to be employed in such cases, unless by the direction of one of the medical assistants, or some other gentleman of the faculty who has paid attention to the resuscitating art.

DRUG, a general term for goods of the druggist and grocery kinds, especially those used in medicine and dyeing. See MATERIA MEDICA, PHARMACY, and DYEING.

DRUGGET, in commerce, a stuff sometimes all wool, and sometimes half wool half thread, sometimes corded, but usually plain. Those that have the woof of wool, and the warp of thread, are called *threaded druggets*; and those wrought with the shuttle on a loom of four marches, as the serges of Moui, Beauvois, and other like stuffs corded, are called *corded druggets*. As to the plain, they are wrought on a loom of two marches, with the shuttle, in the same manner as cloth, camblets, and other like stuffs not corded.

DRUIDÆ, or DROIUM, in *Ancient Geography*, a very ancient town, the principal place of the Druides or Druidæ in Gaul, as they are called (Cæsar, Cicero). Now *Dreux* in the Orleannois. Here they met every year in a consecrated grove, according to Cæsar. The town was also called *Durocâses*. W. Long. 1. 21. N. Lat. 48. 45.

DRUIDS, DRUIDES, or DRUIDÆ, the priests or ministers of religion among the ancient Celtæ or Gauls, Britons, and Germans.

Some authors derive the word from the Hebrew דרושים *derussim*, or *drussim*, which they translate *contemplatores*. Picard, Celtopæd. lib. ii. p. 58. believes the druids to have been thus called from *Druis*, or *Dryius*, their leader, the fourth or fifth king of the Gauls, and father of Saron or Naumes. Pliny, Salmasius, Vigenere, &c. derive the name from δρυς, *oak*; on account of their inhabiting, or at least frequenting, and teaching in forests; or perhaps because, as Pliny says, they never sacrificed but under the oak. But it is hard to imagine how the druids should come to speak Greek. Menage derived the word from the old British *drus*, "dæmon, magician." Borel, from the Saxon *dry*, "magician;" or rather from the old British *dru*, or *derw*, "oak," whence he takes δρυς to be derived; which is the most probable supposition. Gorop. Becanus, lib. i. takes *druis* to be an old Celtic and German word, formed from *trowis* or *truwis*, "a doctor of the

---

(A) Dr Fothergill of Bath, in a letter to the Register, advises as a potent and active stimulus the patent mustard moistened with spirits.

ruids.

the truth and the faith;" which etymology Vossius acquiesces in.

I
eral
out of
t Druids.

The druids were the first and most distinguished order among the Gauls and Britons; they were chosen out of the best families; and the honours of their birth, joined with those of their function, procured them the highest veneration among the people. They were versed in astrology, geometry, natural philosophy, politics, and geography; they were the interpreters of religion, and the judges of all affairs indifferently. Whoever refused obedience to them was declared impious and accursed. We know but little as to their peculiar doctrines; only that they believed the immortality of the soul, and, as is generally also supposed, the metempsychosis; though a late author makes it appear highly probable they did not believe this last, at least not in the sense of the Pythagoreans.

The chief settlement of the druids in Britain was in the isle of Anglesey, the ancient *Mona*, which they might choose for this purpose, as it is well stored with spacious groves of their favourite oak. They were divided into several classes or branches, viz. the *vacerri*, *bardi*, *eubages*, *symnothii* or *semnothei*, and *saronidæ*. The *vacerri* are held to have been the priests; the *bardi*, the poets; the *eubages*, the augurs; and the *saronidæ*, the civil judges and instructors of youth. As to the *semnothei*, who are said to have been immediately devoted to the service of religion, it is probable they were the same with the *vacerri*. Strabo, however, (lib. iv. p. 147.) and Picard after him in his Celtopædia, do not comprehend all these different orders under the denomination of druids, as species under their genus, or parts under the whole; but make them quite different conditions or orders. Strabo, in effect, only distinguishes three kinds; *bardi*, *vates*, and *druids*. The *bardi* were the poets; the *vates*, ȣατεις, (apparently the same with the *vacerri*), were the priests and naturalists; and the *druids*, beside the study of nature, applied themselves likewise to morality.

Diogenes Laertius assures us, in his prologue, that the druids were the same among the ancient Britons with the sophi or philosophers among the Greeks; the magi among the Persians; the gymnosophists among the Indians; and the Chaldeans among the Assyrians.

Their garments were remarkably long; and, when employed in religious ceremonies, they always wore a white surplice. They generally carried a wand in their hands; and wore a kind of ornament enchased in gold about their necks, called the *druid's egg*. Their necks were likewise decorated with gold chains, and their hands and arms with bracelets: they wore their hair very short, and their beards remarkably long.

The druids had one chief, or arch-druid, in every nation, who acted as high priest, or *pontifex maximus*. He had absolute authority over the rest; and commanded, decreed, punished, &c. at pleasure. At his death he was succeeded by the most considerable among his survivors; and, if there were several pretenders, the matter was ended by an election, or else put to the decision of arms.

The druids, we have observed, were in the highest esteem. They presided at sacrifices, and other ceremonies; and had the direction of every thing relating to religion. The British and Gaulish youth flocked to them in crowds to be instructed by them. The children of the nobility, Mela tells us, they retired with into caves, or the most desolate parts of forests, and kept them there sometimes for twenty years under their discipline. Besides the immortality and metempsychosis, they were here instructed in the motion of the heavens, and the course of the stars; the magnitude of the heavens and the earth; the nature of things; the power and wisdom of the gods, &c. They preserved the memory and actions of great men in their verses, which they never allowed to be wrote down, but made their pupils get them by heart. In their common course of learning, they are said to have taught them twenty-four thousand such verses. By this means their doctrines appeared more mysterious by being unknown to all but themselves; and having no books to recur to, they were the more careful to fix them in their memory.

Druids.

They worshipped the Supreme Being under the name of *Esus*, or *Hesus*, and the symbol of the oak; and had no other temple than a wood or a grove, where all their religious rites were performed. Nor was any person admitted to enter that sacred recess, unless he carried with him a chain, in token of his absolute dependence on the Deity. Indeed, their whole religion originally consisted in acknowledging, that the Supreme Being, who made his abode in these sacred groves, governed the universe; and that every creature ought to obey his laws, and pay him divine homage.

They considered the oak as the emblem, or rather the peculiar residence, of the Almighty; and accordingly chaplets of it were worn both by the druids and people in their religious ceremonies, the altars were strewed with its leaves, and encircled with its branches. The fruit of it, especially the misletoe, was thought to contain a divine virtue, and to be the peculiar gift of heaven. It was therefore sought for on the sixth day of the moon with the greatest earnestness and anxiety; and when found was hailed with such raptures of joy, as almost exceeds imagination to conceive. As soon as the druids were informed of this fortunate discovery, they prepared every thing ready for the sacrifice under the oak, to which they fastened two white bulls by the horns; then the arch-druid, attended by a prodigious number of people, ascended the tree, dressed in white; and with a consecrated golden knife, or pruning-hook, cropped the misletoe, which he received in his sagum or robe, amidst the rapturous exclamations of the people. Having secured this sacred plant, he descended the tree; the bulls were sacrificed; and the Deity invoked to bless his own gift, and render it efficacious in those distempers in which it should be administered.

The consecrated groves, in which they performed their religious rites, were fenced round with stones, to prevent any person's entering between the trees, except through the passages left open for that purpose, and which were guarded by some inferior druids, to prevent any stranger from intruding into their mysteries. These groves were of different forms; some quite circular, others oblong, and more or less capacious as the votaries in the districts to which they belonged were more or less numerous. The area in the centre of the grove was encompassed with several rows of large oaks set very close together. Within this large circle were several smaller ones surrounded with large stones; and near the centre of these smaller circles were stones of a prodigious size and convenient height, on which the victims were slain and offered. Each of these being a kind of altar, was surrounded with another row of stones, the use of which cannot now be known, unless they were intended as cinctures to keep the people at a convenient distance from the officiating priest.

Suetonius, in his life of Claudius, assures us the druids sacrificed men; and Mercury is said to be the god to whom they offered these victims. Diod. Siculus, lib. vi. observes it was only upon extraordinary occasions they made such offerings; as, to consult what measures to take, to learn what should befal them, &c. by the fall of the victim, the tearing of his members, and the manner of his blood gushing out. Augustus condemned the custom, and Tiberius and Claudius punished and abolished it.

We learn from Cæsar, that the druids were the judges and arbiters of all differences and disputes, both public and private: they took cognizance of murders, inheritances, boundaries, and limits; and decreed rewards and punishments. Such as disobeyed their decisions they excommunicated, which was their principal punishment; the criminal being hereby excluded from all public assemblies, and avoided by all the world; so that nobody durst speak to him for fear of being polluted. Strabo observes, they had sometimes interest and authority enough to stop armies upon the point of engaging, and accommodate their differences.

2
Their opinions and philosophy whence derived.

It hath been disputed, whether the druids were themselves the inventors of their opinions and systems of religion and philosophy, or received them from others. Some have imagined, that the colony of Phocians which left Greece and built Marseilles in Gaul about the 57th Olympiad, imported the first principles of learning and philosophy, and communicated them to the Gauls and other nations in the west of Europe. It appears, indeed, that this famous colony contributed not a little to the improvement of that part of Gaul where it settled, and to the civilization of its inhabitants. "The Greek colony of Marseilles (says Justin) civilized the Gauls, and taught them to live under laws; to build cities and enclose them with walls; to cultivate the vine and olive; and, in a word, made so great a change both in the face of the country and the manners of its inhabitants, that Gaul seemed to be translated into Greece, rather than a few Greeks transplanted into Gaul." But though we may allow that the druids of Gaul and Britain borrowed some hints and embellishments of their philosophy from this Greek colony, and perhaps from other quarters, we have reason to believe that the substance of it was their own. Others have suggested, that the druids derived their philosophy from Pythagoras, who published his doctrines at Crotona in Italy; where he lived in the highest reputation for his virtue, wisdom, and learning, above 20 years. This conjecture is very much confirmed by this remarkable expression of Ammianus Marcellinus, "That the druids were formed into fraternities, as the authority of Pythagoras decreed." It hath been also observed, that the philosophy of the druids bore a much greater resemblance to that of Pythagoras than to that of any of the other sages of antiquity. But it seems probable, that Ammianus meant no more by the above expression than to illustrate the nature of the druidical fraternities, by comparing them to those of the Pythagoreans, which were well known to the Romans; and the resemblance between the Pythagorean and druidical philosophy may perhaps be best accounted for, by supposing, that Pythagoras learned and adopted some of the opinions of the druids, as well as imparted to them some of his discoveries. It is well known, that this philosopher, animated by the most ardent love of knowledge, travelled into many countries in pursuit of it, and got himself admitted into every society that was famous for its learning. It is therefore highly probable in itself, as well as directly asserted by several authors, that Pythagoras heard the druids of Gaul, and was initiated into their philosophy.

3
More particular account of the learning of the druids.

From the concurring testimonies of several authors, it appears that physiology, or natural philosophy, was the favourite study of the druids of Gaul and Britain. Cicero tells us, that he was personally acquainted with one of the Gaulish druids, Divitiacus the Æduan, a man of quality in his country, who professed to have a thorough knowledge of the laws of nature, or that science which the Greeks call *physics* or *physiology*. According to Diodorus Siculus, Strabo, Cæsar, Mela, Ammianus Marcellinus, and others, they entered into many disquisitions and disputations in their schools, concerning the form and magnitude of the universe in general, and of this earth in particular, and even concerning the most sublime and hidden secrets of nature. On these and the like subjects they formed a variety of systems and hypotheses; which they delivered to their disciples in verse, that they might the more easily retain them in their memories, since they were not allowed to commit them to writing. Strabo hath preserved one of the physiological opinions of the druids concerning the universe; viz. that it was never to be entirely destroyed or annihilated; but was to undergo a succession of great changes and revolutions, which were to be produced sometimes by the power and predominancy of water, and sometimes by that of fire. This opinion, he intimates, was not peculiar to them, but was entertained also by the philosophers of other nations; and Cicero speaks of it as a truth universally acknowledged and undeniable. "It is impossible for us (says he) to attain a glory that is eternal, or even of very long duration, on account of these deluges and conflagrations of the earth which must necessarily happen at certain periods." This opinion, which was entertained by the most ancient philosophers of many different and very distant nations, was probably neither the result of rational inquiry in all these nations, nor communicated from one of them to others; but descended to them all from their common ancestors of the family of Noah by tradition, but corrupted and misunderstood through length of time. The agreement of the druids with the philosophers of so many other nations in this opinion about the alternate dissolution and renovation of the world, gives us reason to believe, that they agreed with them also in their opinion of its origin from two distinct principles; the one intelligent and omnipotent, which

4
Physics, o natural philosophy

which was God; the other inanimate and inactive, which was matter. We are told, by Cæsar, that they had many disquisitions about the power of God; and, no doubt, amongst other particulars, about his creating power. But whether they believed with some that matter was eternal, or with others that it was created; and in what manner they endeavoured to account for the disposition of it into the present form of the universe, we are entirely ignorant, though they certainly had their speculations on these subjects. We are only informed, that they did not express their sentiments on these and like heads in a plain and natural, but in a dark, figurative, and enigmatical manner. This might incline us to suspect, that Pythagoras had borrowed from them his doctrine about numbers, to whose mystical energy he ascribes the formation of all things; for nothing can be more dark and enigmatical than that doctrine. The druids disputed likewise about the magnitude and form of the world in general, and of the earth in particular, of which things they pretended to have a perfect knowledge. We know not what their opinions were about the dimensions of the universe or of the earth, but we have several reasons to make us imagine that they believed both to be of a spherical form. This is visibly the shape and form of the sun, moon and stars, the most conspicuous parts of the universe; from whence it was natural and easy to infer, that this was the form of the world and of the earth. Accordingly this seems to have been the opinion of the philosophers of all nations; and the circle was the favourite figure of the druids, as appears from the form both of their houses and places of worship. Besides these general speculations about the origin, dissolution, magnitude, and form of the world and of the earth, the druids engaged in particular inquiries into the natures and properties of the different kind of substances. But all their discoveries in this most useful and extensive branch of natural philosophy, whatever they were, are entirely lost.

Astronomy.

Astronomy also appears to have been one of the chief studies of the druids of Gaul and Britain. "The druids (says Cæsar) have many disquisitions concerning the heavenly bodies and their motions, in which they instruct their disciples." Mela, speaking of the same philosophers, observes, "That they profess to have great knowledge of the motions of the heavens and of the stars." Some knowledge of this science indeed was not only necessary for measuring time in general, marking the duration of the different seasons, regulating the operations of the husbandman, directing the course of the mariner, and for many other persons in civil life; but it was especially necessary for fixing the times and regular returns of their religious solemnities, of which the druids had the sole direction. Some of these solemnities were monthly, and others annual. It was therefore necessary for them to know, with some tolerable degree of exactness, the number of days in which the sun and moon performed their revolutions, that these solemnities might be observed at their proper seasons. This was the more necessary, as some of these solemnities were attended by persons from different and very distant countries, who were all to meet at one place on one day; who must have had some rule to discover the annual return of that day.

6
Their method of computing time.

The most perceptible division of time by the two great luminaries is into day and night; the former occasioned by the presence of the sun above the horizon, the latter by his absence, which is in some measure supplied by the moon and stars. The druids computed their time by nights, and not by days; a custom which they had received from their most remote ancestors by tradition, and in which they were confirmed by their measuring their time very much by the moon, the mistress and queen of night. As the changes in the aspect of that luminary are most conspicuous, they engaged the attention of the most ancient astronomers of all countries, and particularly of the druids, who regulated all their great solemnities, both sacred and civil, by the age and aspect of the moon. "When no unexpected accident prevents it, they assemble upon stated days, either at the time of the new or full moon; for they believe these to be the most auspicious times for transacting all affairs of importance." Their most august ceremony of cutting the misletoe from the oak by the arch-druid, was always performed on the sixth day of the moon. Nay, they even regulated their military operations very much by this luminary, and avoided, as much as possible, to engage in battle while the moon was on the wane. As the attention of the druids was so much fixed on this planet, it could not be very long before they discovered that she passed through all her various aspects in about thirty days; and by degrees, and more accurate observations, they would find, that the real time of her performing an entire revolution was very nearly 29½ days. This furnished them with the division of their time into months, or revolutions of the moon; of which we know with certainty they were possessed. But this period, though of great use, was evidently too short for many purposes, and particularly for measuring the seasons; which they could not fail to perceive depended on the influences of the sun. By continued observation they discovered, that about 12 revolutions of the moon included all the variety of seasons, which begun again, and revolved every 12 months. This suggested to them that larger division of time called a year, consisting of 12 lunations, or 354 days, which was the most ancient measure of the year in almost all nations. That this was for some time at least the form of the druidical year, is both probable in itself, and from the following expression of Pliny: "That they began both their months and years, not from the change, but from the sixth day of the moon." This is even a demonstration that their years consisted of a certain number of lunar revolutions, as they always commenced on the same day of the moon. But as this year of 12 lunar months falls 11 days and nearly one-fourth of a day short of a real revolution of the sun, this error would soon be perceived, and call for reformation; though we are not informed of the particular manner in which it was rectified. Various arguments might be collected to make it very probable that the Britons were acquainted with a year exact enough for every purpose of life, when they were first invaded by the Romans; but it will be sufficient to mention one, which is taken from the time and circumstances of that invasion. The learned Dr Halley hath demonstrated that Cæsar arrived in Britain, in his first year's expedition, on the 26th day of August:

gust: and Cæsar himself informs us, that at his arrival the harvest was finished, except in one field, which by some means or other was more backward than the rest of the country. This is a proof that the British husbandmen knew and used the most proper seasons for ploughing, sowing, and reaping. The druids, as we are told by Pliny, had also a cycle or period of 30 years, which they called an age, and which commenced likewise on the sixth day of the moon: but that author hath not acquainted us on what principle this cycle was formed, nor to what purpose it was applied. We can hardly suppose that this was the cycle of the sun, which consists of 28 years, and regulates the dominical letters. It is more probable, that while the druids made use of the year of 12 lunar months, and had not invented a method of adjusting it to the real revolution of the sun, they observed that the beginning of this year had passed through all the seasons, and returned to the point from whence it set out, in a course of about 33 years; which they might therefore call an age. Others may perhaps be of opinion, that this 30 years cycle of the druids is the same with the great year of the Pythagoreans, or a revolution of Saturn. Some have imagined that the druids were also acquainted with the cycle of 19 years, which is commonly called the cycle of the moon. But the evidence of this depends entirely on the truth of that supposition, that the Hyperborean island, which is described by Diodorus Siculus, was Britain, or some of the British isles. Among many other surprising things, that author says, concerning the Hyperborean island, "That its inhabitants believed that Apollo descended into their island at the end of every 19 years; in which period of time the sun and moon, having performed their various revolutions, return to the same point, and begin to repeat the same revolutions. This is called by the Greeks the great year, or the cycle of Meton."

7
Their knowledge of the stars.

We are told both by Cæsar and Mela, that the druids studied the stars as well as the sun and moon; and that they professed to know, and taught their disciples, many things concerning the motions of these heavenly bodies. From these testimonies we may conclude that the druids were acquainted with the planets, distinguished them from the fixed stars, and carefully observed their motions and revolutions. If this discovery was the result of their own observations, it would be gradual, and it would be a long time before they found out all the planets. They might perhaps have received some assistance and information from Pythagoras, or from some other quarter. But whether this discovery of the planets was their own, or communicated to them by others, it is highly probable that they were acquainted with the precise number of these wandering stars. Dio Cassius says, that the custom of giving the name of one of the planets to each of the seven days of the week was an invention of the Egyptians, and from them was gradually communicated to all the other nations of the world; and that in his time this custom was so firmly established, not only among the Romans, but among all the rest of mankind, that in every country it appeared to be a native institution. The knowledge of the planets, and perhaps the custom of giving their names to the days of the week, was brought out of Egypt into Italy by Pythagoras, more than 500 years before the beginning of the Christian era; and from thence it could not be very long before it reached Gaul and Britain. But though we have little or no reason to doubt that the druids knew the number and observed the motion of the planets, yet it may be questioned whether they had discovered the times in which they performed their several revolutions. Some of these stars, as Jupiter and Saturn, take so great a number of years in revolving, that it required a very extraordinary degree of patience and attention to discover the precise periods of their revolutions. If we could be certain that the island in which the ancients imagined Saturn lay asleep, was one of the British isles, as Plutarch intimates it was, we might be inclined to think that the British druids were not ignorant of the length of the period in which the planet Saturn performs a revolution. For that same author, in another treatise, tells us, "That the inhabitants of that island kept every thirtieth year a solemn festival in honour of Saturn, when his star entered into the sign of Taurus."

If we could depend upon the above testimony of Plutarch, we should have one positive proof that the druids of the British isles were acquainted with the constellations, and even with the signs of the zodiac; and that they measured the revolutions of the sun and planets, by observing the length of time between their departure from and return to one of these signs. But we have no direct evidence of this remaining in history.

The druids of Gaul and Britain, as well as the ancient philosophers of other countries, had a general plan or system of the universe, and of the disposition and arrangement of its various parts, in which they instructed their disciples. This is both probable in itself, and is plainly intimated by several authors of the greatest authority. But we cannot be certain whether this druidical system of the world was of their own invention, or was borrowed from others. If it was borrowed, it was most probably from the Pythagoreans, to whom they were the nearest neighbours; and with whom they had the greatest intercourse.

It hath been imagined, that the druids had instruments of some kind or other, which answered the same purposes with our telescopes, in making observations on the heavenly bodies. The only foundation of this very improbable conjecture is an expression of Diodorus Siculus, in his description of the famous Hyperborean island. "They say further, that the moon is seen from that island, as if she was but at a little distance from the earth, and having hills or mountains like ours on her surface." But no such inference can be reasonably drawn from this expression, which in reality merits little more regard than what Strabo reports was said of some of the inhabitants of Spain: "That they heard the hissing noise of the sun every evening when he fell into the western ocean."

The application of the druids to the study of philosophy and astronomy amounts almost to a demonstration that they applied also to the study of arithmetic and geometry. For some knowledge of both these sciences is indispensably necessary to the physiologist and astronomer, as well as of great and daily use in the common affairs of life.

If we were certain that **Abaris**, the famous Hyperborean philosopher, the friend and scholar of Pythagoras, Druids.

thagoras, was really a British druid, as some have imagined, we should be able to produce direct historical evidence of their arithmetical knowledge. For Iamblicus, in the life of Pythagoras, says, "that he taught Abaris to find out all truth by the science of arithmetic." It may be thought improbable that the druids had made any considerable progress in arithmetic, as this may seem to be impossible by the mere strength of memory without the assistance of figures and of written rules. But it is very difficult to ascertain what may be done by memory alone, when it hath been long exercised in this way. We have had an example in our own age, of a person * who could perform some of the most tedious and difficult operations in arithmetic by the mere strength of his memory. The want of written rules could be no great disadvantage to the druids, as the precepts of this, as well as of the other sciences, were couched in verse, which would be easily got by heart and long remembered. Though the druids were unacquainted with the Arabic characters, which are now in use, we have no reason to suppose that they were destitute of marks or characters of some other kind, which, in some measure, answered the same purposes, both in making and recording their calculations. In particular, we have reason to think, that they made use of the letters of the Greek alphabet for both these purposes. This seems to be plainly intimated by Cæsar in the following expression concerning the druids of Gaul: "In almost all other public transactions and private accounts or computations, they make use of the Greek letters." This is further confirmed by what the same author says of the Helvetii; a people of the same origin, language, and manners, with the Gauls and Britons. "Tables were found in the camp of the Helvetii written in Greek letters, containing an account of all the men capable of bearing arms, who had left their native country, and also separate accounts of the boys, old men, and women." There is historical evidence of the druids being also well acquainted with geometry. "When any disputes arise (says Cæsar) about their inheritances, or any controversies about the limits of their fields, they are entirely referred to the decision of their druids." But besides the knowledge of mensuration which this implies, both Cæsar and Mela plainly intimate that the druids were conversant in the most sublime speculations of geometry; "in measuring the magnitude of the earth, and even of the world."

Ski n mecha cs.

There are still many monuments remaining in Britain and the adjacent isles, which cannot so reasonably be ascribed to any as to the ancient Britons, and which give us cause to think, that they had made great progress in this useful part of learning, and could apply the mechanical powers so as to produce very astonishing effects. As these monuments appear to have been designed for religious purposes, we may be certain that they were erected under the direction of the druids. How many obelisks or pillars, of one rough unpolished stone each, are still to be seen in Britain and its isles! Some of these pillars are both very thick and lofty, erected on the summits of barrows and of mountains; and some of them (as at Stonehenge) have ponderous blocks of stone raised aloft, and resting on the tops of the upright pillars. We can hardly suppose that it was possible to cut these prodigious masses of stone (some of them above 40 tons in weight) without wedges, or to raise them out of the quarry without levers. But it certainly required still greater knowledge of the mechanical powers, and of the method of applying them, to transport those huge stones from the quarry to the places of their destination; to erect the perpendicular pillars, and to elevate the imposts to the tops of these pillars. If that prodigious stone in the parish of Constantine, Cornwall, was really removed by art from its original place, and fixed where it now stands (as one of our most learned and diligent antiquaries thinks it was *). it is a demonstration, that the druids could perform the most astonishing feats by their skill in mechanics. That the British druids were acquainted with the principles and use of the balance, we have good reason to believe, not only from the great antiquity of that discovery in other parts of the world, but also from some druidical monuments which are still remaining in this island. These monuments are called *Logan Stones*, or rocking stones; and each of them consists of one prodigious block of stone, resting upon an upright stone or rock, and so equally balanced, that a very small force, sometimes even that of a child, can move it up and down, though hardly any force is sufficient to remove it from its station. Some of these stones may have fallen into this position by accident, but others of them evidently appear to have been placed in it by art. That the ancient Britons understood the construction and use of wheels, the great number of their war-chariots and other wheel-carriages is a sufficient proof; and that they knew how to combine them together and with the other mechanical powers, so as to form machines capable of raising and transporting very heavy weights, we have good reason to believe. In a word, if the British druids were wholly ignorant of the principles and use of any of the mechanical powers, it was most probably of the screw, though even of this we cannot be certain.

10 Medicine.

In Germany and in the northern nations of Europe, the healing art was chiefly committed to the old women of every state; but in Gaul and Britain it was entrusted to the druids, who were the physicians as well as the priests of these countries. Pliny says expressly, "That Tiberius Cæsar destroyed the druids of the Gauls, who were the poets and physicians of that nation;" and he might have added of the Britons. The people of Gaul and Britain were probably induced to devolve the care of their health on the druids, and to apply to these priests for the cure of their diseases, not only by the high esteem they had of their wisdom and learning, but also by the opinion which they entertained, that a very intimate connection subsisted between the arts of healing and the rites of religion, and that the former were most effectual when they were accompanied by the latter. It appears indeed to have been the prevailing opinion of all the nations of antiquity, that all internal diseases proceeded immediately from the anger of the gods; and that the only way of obtaining relief from these diseases was by applying to their priests to appease their anger by religious rites and sacrifices. This was evidently the opinion and practice of the Gauls and Britons, who in some dangerous cases sacrificed one man as the most effectual means of curing

---

ee Bux- y (Je- iah).

* *Dr Borlase's Antiq. Cornwall*, p. 174, 175.

another. "They are much addicted (says Cæsar) to superstition; and for this cause, those who are afflicted with a dangerous disease sacrifice a man, or promise that they will sacrifice one for their recovery. For this purpose they make use of the ministry of the druids; because they have declared, that the anger of the immortal gods cannot be appeased, so as to spare the life of one man, but by the life of another." This way of thinking gave rise also to that great number of magical rites and incantations with which the medical practices of the druids, and indeed of all the physicians of antiquity, were attended. "Nobody doubts (says Pliny) that magic derived its origin from medicine, and that, by its flattering but delusive promises, it came to be esteemed the most sublime and sacred part of the art of healing."

11 Botany. That the druids made great use of herbs for medicinal purposes, we have sufficient evidence. They not only had a most superstitious veneration for the misletoe of the oak, on a religious account, but they also entertained a very high opinion of its medical virtues, and esteemed it a kind of panacea or remedy for all diseases. "They call it (says Pliny) by a name which in their language signifies *All-heal*, because they have an opinion that it cureth all diseases. They believed it to be in particular a specific against barrenness, and a sovereign antidote against the fatal effects of poisons of all kinds. It was esteemed also an excellent emollient and discutient for softening and discussing hard tumours; good for drying up scrophulous sores; for curing ulcers and wounds; and (provided it was not suffered to touch the earth after it was cut) it was thought to be a very efficacious medicine in the epilepsy or falling sickness. It hath been thought useful in this last calamitous disease by some modern physicians. The pompous ceremonies with which the misletoe was gathered by the druids have been already described. The selago, a kind of hedge hyssop resembling savin, was another plant much admired by the druids of Gaul and Britain for its supposed medicinal virtues, particularly in all diseases of the eyes. But its efficacy, according to them, depended very much upon its being gathered exactly in the following manner: The person who gathered it was to be clothed in a white robe; to have his feet bare, and washed in pure water; to offer a sacrifice of bread and wine before he proceeded to cut it; which he was to do with his right hand covered with the skirt of his garment, and with a hook of some more precious metal than iron. When it was cut, it was to be received into, and kept in a new and very clean cloth. When it was gathered exactly according to this whimsical ritual, they affirmed that it was not only an excellent medicine, but also a powerful charm and preservative from misfortunes and unhappy accidents of all kinds. They entertained a high opinion also of the herb samolus or marshwort, for its sanative qualities; and gave many directions for the gathering it no less fanciful than those above mentioned. The person who was to perform that office was to do it fasting, and with his left hand; he was on no account to look behind him, nor to turn his face from the herbs he was gathering. It would be tedious to relate the extravagant notions they entertained of the many virtues of the vervain, and to recount the ridiculous mummeries which they practised in gathering and preparing it, both for the purposes of divination and physic. These things may be seen in Plin. Hist. Nat. l. 25. c. 9. from whence we have received all these anecdotes of the botany of the druids. It is easy to see that his information was very imperfect; and that, like many of the other Greek and Roman writers, he designedly represents the philosophers of Gaul and Britain in an unfavourable light. The herb which was called *Britannica* by the ancients, which some think was the great water-dock, and others the cochlearia or scurvy-grass, was probably much used in this island for medicinal purposes; as it derived its name from hence, and was from hence exported to Rome and other parts. Though these few imperfect hints are all that we can now collect of the botany of the British druids, yet we have some reason to think that they were not contemptible botanists. Their circumstances were peculiarly favourable for the acquisition of this kind of knowledge. For as they spent most of their time in the recesses of mountains, groves, and woods, the spontaneous vegetable productions of the earth constantly presented themselves to their view, and courted their attention.

The opinions which, it is said, the druids of Gaul and Britain entertained of their anguinum or serpents egg, both as a charm and as a medicine, are romantic and extravagant in a very high degree. This extraordinary egg was formed, as they pretended, by a great number of serpents, interwoven and twined together; and when it was formed, it was raised up in the air by the hissing of these serpents, and was to be catched in a clean white cloth before it fell to the ground. The person who catched it was obliged to mount a swift horse, and to ride away at full speed to escape from the serpents, who pursued him with great rage, until they were stopped by some river. The way of making trial of the genuineness of the egg was no less extraordinary. It was to be enchased in gold, and thrown into a river, and if it was genuine it would swim against the stream. "I have seen (says Pliny) that egg; it is about the bigness of a moderate apple, its shell is a cartilaginous incrustation, full of little cavities, such as are on the legs of the polypus; it is the insignia or badge of distinction of the druids." The virtues which they ascribed to this egg were many and wonderful. It was particularly efficacious to render those who carried it about with them superior to their adversaries in all disputes, and to procure them the favour and friendship of great men. Some have thought that this whole affair of the serpents egg was a mere fraud, contrived by the druids, to excite the admiration and pick the pockets of credulous people, who purchased these wonder-working eggs from them at a high price. Others have imagined that this story of the anguinum (of which there is an ancient monument in the cathedral at Paris) was an emblematical representation of the doctrine of the druids concerning the creation of the world. The serpents, say they, represent the Divine wisdom forming the universe, and the egg is the emblem of the world formed by that wisdom. It may be added, that the virtue ascribed to the anguinum, of giving those who possessed it a superiority over others, and endearing them to great men, may perhaps be intended to represent the natural effects of learning and philosophy. But in so doubtful a matter every one is at full liberty to form what judgment he thinks proper.

12 toric. As the influence and authority of the druids in their country, depended very much upon the reputation of their superior wisdom and learning, they wisely applied to the study of those sciences which most directly contributed to the support and advancement of that reputation. In this number, besides those already mentioned, we may justly reckon rhetoric, which was diligently studied and taught by the druids of Gaul and Britain; who to the charms of their eloquence were indebted for much of the admiration and authority which they enjoyed. They had indeed many calls and opportunities to display their eloquence, and to discover its great power and efficacy; as when they were teaching their pupils in their schools; when they discoursed in public to the people on religious and moral subjects; when they pleaded causes in the courts of justice; and when they harangued in the great councils of the nation, and at the heads of armies ready to engage in battle, sometimes with a view to inflame their courage, and at other times with a design to allay their fury, and dispose them to make peace. Though this last was certainly a difficult task among fierce and warlike nations, yet such was the authority and eloquence of the druids, that they frequently succeeded in it. "They pay a great regard (says Diodorus Siculus) to their exhortations, not only in the affairs of peace, but even of war, and these are respected both by their friends and enemies. They sometimes step in between two hostile armies, who are standing with their swords drawn and their spears extended, ready to engage; and by their eloquence, as by an irresistible enchantment, they prevent the effusion of blood, and prevail upon them to sheath their swords. So great are the charms of eloquence and the power of wisdom even amongst the most fierce barbarians. The British kings and chieftains, who were educated by the druids, were famous for their eloquence. This is evident from the many noble speeches which are ascribed to them by the Greek and Roman writers. For though these speeches may not be genuine, yet they are a proof that it was a well known fact, that these princes were accustomed to make harangues on these and the like occasions. This we are expressly told by Tacitus:—"The British chieftains, before a battle, fly from rank to rank, and address their men with animating speeches, tending to inflame their courage, increase their hopes, and dispel their fears." These harangues were called, in the ancient language of Britain, *Brosnichty Kah*, which is literally translated by Tacitus, *Incitamenta Belli*, "incentives to war." The genuine posterity of the ancient Britons long retained their taste for eloquence, and their high esteem for those who excelled in that art. "Orators (says Mr Martin) were in high esteem, both in these islands (the Æbudæ) and the continent, until within these forty years. They sat always among the nobles or chiefs of families in the streah or circle. Their houses and little villages were sanctuaries, as well as churches, and they took place before doctors of physic. The orators, after the druids were extinct, were brought in to preserve the genealogy of families, and to repeat the same at every succession of a chief; and upon the occasion of marriages and births, they made epithalamiums and panegyrics, which the poet or bard pronounced. The orators, by the force of their eloquence, had a powerful ascendant over the greatest men in their time. For if any orator did but ask the habit, arms, horse, or any other thing belonging to the greatest man in these islands, it was readily granted him; sometimes out of respect, and sometimes for fear of being exclaimed against by a satire, which in those days was reckoned a great dishonour."

13 Magic and divination. If the British druids, considering the times in which they lived, had made no contemptible proficiency in several parts of real and useful learning, it cannot be denied that they were also great pretenders to superior knowledge in certain vain fallacious sciences, by which they excited the admiration, and took advantage of the ignorance and credulity of mankind. These were the sciences (if they may be so called) of magic and divination; by which they pretended to work a kind of miracles, and exhibit astonishing appearances in nature; to penetrate into the counsels of heaven; to foretel future events, and to discover the success or miscarriage of public or private undertakings. Their own countrymen not only believed that the Druids of Gaul and Britain were possessed of these powers, but they were celebrated on this account by the philosophers of Greece and Rome. "In Britain (says Pliny) the magic arts are cultivated with such astonishing success, and so many ceremonies, at this day, that the Britons seem to be capable of instructing even the Persians themselves in these arts. They pretend to discover the designs and purposes of the gods. The Eubates or Vates in particular investigate and display the most sublime secrets of nature; and, by auspices and sacrifices, they foretel future events." They were so famous for the supposed veracity of their predictions, that they were not only consulted on all important occasions by their own princes and great men, but even sometimes by the Roman emperors. Nor is it very difficult to account for all this. The druids finding that the reputation of their magical and prophetical powers contributed not a little to the advancement of their wealth and influence, they endeavoured, no doubt, to strengthen and establish it by all their art and cunning. Their knowledge of natural philosophy and mechanics enabled them to execute such works, and to exhibit such appearances, or to make the world believe that they did exhibit them, as were sufficient to gain them the character of great magicians. The truth is, that nothing is more easy than to acquire this character in a dark age, and among an unenlightened people. When the minds of men are haunted with dreams of charms and enchantments, they are apt to fancy that the most common occurrences in nature are the effects of magical arts. The following strange story, which we meet with in Plutarch's Treatise of the Cessation of Oracles, was probably occasioned by something of this kind. "There are many islands which lie scattered about the isle of Britain after the manner of our Sporades. They are generally unpeopled, and some of them are called the *Islands of the Heroes*. One Demetrius was sent by the emperor (perhaps Claudius) to discover those parts. He arrived at one of these islands (supposed by some to be Anglesey, but more probably one of the Æbudæ) next adjoining to the isle of Britain before mentioned, which

which was inhabited by a few Britons, who were esteemed sacred and inviolable by their countrymen. Immediately after his arrival the air grew black and troubled, and strange apparitions were seen; the winds arose to a tempest, and fiery spouts and whirlwinds appeared dancing towards the earth." This was probably no more than a storm of wind, accompanied with rain, and lightning; a thing neither unnatural nor uncommon: but Demetrius and his companions having heard that the British druids, by whom this isle was chiefly inhabited, were great magicians, they imagined that it was raised by them; and fancied that they saw many strange and unnatural sights. The druids did not think proper to undeceive them; for when they inquired at them about the cause of this storm, they told them it was occasioned by the death of one of those invisible beings or genii who frequented their isle. A wonderful and artful tale, very well calculated to increase the superstitious terrors of Demetrius and his crew; and to determine them to abandon this enchanted isle, with a resolution never to return. Stonehenge, and several other works of the druids, were believed to have been executed by the arts of magic and enchantment, for many ages after the destruction of their whole order; nor is it improbable that they persuaded the vulgar in their own times to entertain the same opinion of these works, by concealing from them the real arts by which they are performed. The natural and acquired sagacity of the druids, their long experience, and great concern in the conduct of affairs, enabled them to form very probable conjectures about the event of enterprises. These conjectures they pronounced as oracles, when they were consulted; and they pretended to derive them from the inspection of the entrails of victims, the observation of the flight and feeding of certain birds, and many other mummeries. By these, and the like arts, they obtained and preserved the reputation of prophetic foresight among an ignorant and credulous people. But these pretensions of the druids to magic and divination, which contributed so much to the advancement of their fame and fortune in their own times, have brought very heavy reproaches upon their memory, and have made some learned moderns declare that they ought to be expunged out of the catalogue of philosophers, and esteemed no better than mere cheats and jugglers. This censure is evidently too severe, and might have been pronounced with equal justice upon all the ancient philosophers of Egypt, Assyria, Persia, Greece, and Rome; who were great pretenders to magic and divination, as well as our druids. "I know of no nation in the world (says Cicero) either so polite and learned, or so savage and barbarous, as not to believe that future events are presignified to us, and may by some men be discovered and foretold." The only conclusion therefore that can be fairly drawn, from the successful pretensions of the British druids to the arts of magic and divination, is this—That they had more knowledge than their countrymen and contemporaries; but had not so much virtue as to resist the temptation of imposing upon their ignorance to their own advantage.

DRUM, is a martial musical instrument in form of a cylinder, hollow within, and covered at the two ends with vellum, which is stretched or slackened at pleasure by the means of small cords or sliding knots. It is beat upon with sticks. Drums are sometimes made of brass, but most commonly they are of wood.—The drum is by Le Clerc said to have been an oriental invention, and to have been brought by the Arabians, or perhaps rather the Moors, into Spain.

Kettle DRUMS, are two sorts of large basons of copper or brass, rounded in the bottom, and covered with vellum or goat skin, which is kept fast by a circle of iron round the body of the drum, with a number of screws to screw up and down. They are much used among the horse; as also in operas, oratorios, concerts, &c.

DRUM, or *Drummer*, he that beats the drum; of whom each company of foot has one, and sometimes two. Every regiment has a drum major, who has the command over the other drums. They are distinguished from the soldiers by clothes of a different fashion: their post, when a battalion is drawn up, is on the flanks, and on a march it is betwixt the divisions.

DRUM *of the Ear*, the same with the *tympanum*. See ANATOMY *Index*.

DRUMMOND, WILLIAM, a Scottish poet, was born in 1585, and was the son of Sir John Drummond, who for ten or twelve years was usher and afterwards knight of the black rod to James VI. His family became first distinguished by the marriage of Robert III. whose queen was sister to William Drummond of Carnock their ancestor; as appears by the patent of that king and James I. the one calling him "our brother," the other "our uncle."

Drummond was educated at Edinburgh, where he took the degree of A. M. In 1606 he was sent by his father to study civil law at Bourges in France: but having no taste for the profession of a lawyer, he returned to Scotland, and retired to his agreeable seat at Hawthornden; where he applied himself with great assiduity to classical learning and poetry, and presented to the world several fine productions. Here he wrote, after a dangerous fit of sickness, his Cypress Grove, a piece of excellent prose; and about the same time his Flowers of Sion in verse. But an accident befel him, which obliged him to quit his retirement; and that was the death of an amiable lady to whom he was just going to be married. This affected him so deeply, that he went to Paris and Rome, between which two places he resided eight years. He travelled also through Germany, France, and Italy: where he visited universities; conversed with learned men; and made a choice collection of the ancient Greek and of the modern Spanish, French, and Italian books. He then returned to his native country; and some time thereafter married Margaret Logan, a grand-daughter of Sir Robert Logan. Upon the appearance of a civil war, he retired again; and in his retirement is supposed to have written his history of the Five James's, successively kings of Scotland, which was not published till after his death. Having been grafted as it were on the royal family of Scotland, and upheld by them, he was steadily attached to Charles I.; but does not appear ever to have armed for him. As he had always been a laborious student, and had applied himself equally to history and politics as to classical learning, his services were better rendered by occasional publications, in which

Drummond.

which he several times distinguished himself. In a piece called *Irene*, he harangues the king, nobility, and clergy, about their mutual mistakes, fears, and jealousies; and lays before them the consequences of a civil war, from indisputable arguments and the histories of past times. The great marquis of Montrose wrote a letter to him, desiring him to print this Irene, as the best means to quiet the minds of a distracted people: he likewise sent him a protection, dated August 1645, immediately after the battle of Kilsyth, with a letter, in which he commends Mr Drummond's learning and loyalty. Mr Drummond wrote other things also with the same view of promoting peace and union, of calming the disturbed minds of the people, of reasoning the better sort into moderation, and checking the growing evils which would be the consequence of their obstinacy. But his efforts were fruitless; and his attachment to the king and his cause was so strong, that when he heard of the sentence being executed on him, he was overwhelmed with grief, and lifted his head no more. He died in the year 1649, leaving behind him several children: the eldest of whom, William, was knighted by Charles II. He had a great intimacy and correspondence with the two famous English poets, Michael Drayton and Ben Johnson; the latter of whom, at the age of 45, travelled from London on foot to visit him at Hawthornden. An edition of his works, with his life prefixed, was printed in folio at Edinburgh, 1711.

Among all the writers at the beginning of the 17th century, who flourished after the death of Shakespeare, an ingenious critic * observes, there is not one whom a general reader of the English poetry of that age will regard with so much and so deserved attention as William Drummond. In a survey of his poetry, two considerations must be had, viz. the nation of which he was, and the time when he wrote. Yet will these be found not offered to extenuate faults, but to increase admiration. His thoughts are often, nay generally, bold and highly poetical: he follows nature, and his verses are delicately harmonious. As his poems are not easily met with, and have perhaps by many readers never been heard of, a few extracts may be excused.

On the death of Henry prince of Wales in 1612, Drummond wrote an elegy, entitled Tears on the Death of Moeliades; a name which that prince had used in all his challenges of martial sport, as the anagram of *Miles a Deo*. In this poem are lines, according to Denham's terms, as strong, as deep, as gentle, and as full, as any of his or Waller's. The poet laments the fate of the prince, that he died not in some glorious cause of war: "Against the Turk (says he) thou hadst ended thy life and the Christian war together:"

> Or, as brave Bourbon, thou hadst made old Rome,
> Queen of the world, thy triumph and thy tombe.

Of the lamentation of the river Forth:

> And as she rushed her Cyclades among,
> She seem'd to plain that Heav'n had done her wrong.

Further:

> Tagus did court his love with golden streams,
> Rhine with her towns, fair Seine with all she claims:
> But ah, poor lovers! death did them betray;
> And unsuspected, made their hopes his prey.

And concludes:

> The virgins to thy tomb will garlands bear
> Of flowers, and with each flower let fall a tear.
> Moeliades sweet courtly nymphs deplore,
> From Thulé to Hydaspes' pearly shore.

Perhaps there are no lines of Pope of which the easy flow may be more justly admired than of those in his third pastoral;

> Not bubbling fountains to the thirsty swain,
> Not balmy sleep to lab'rers faint with pain,
> Not showers to larks, or sunshine to the bee,
> Are half so charming as thy sight to me.

When King James I. after his accession to the English throne, returned to Scotland in 1617, his arrival was celebrated by every effort of poetical congratulation. Upon this occasion Drummond composed a panegyric entitled The Wandering Muses, or the River Forth feasting; in which are found four lines apparently imitated by Pope in the above passage, and which do not in point of harmony fall much short of that imitation. He says,

> To virgins, flow'rs; to sun-burnt earth, the rain;
> To mariners, fair winds amidst the main;
> Cool shades, to pilgrims whom hot glances burn;
> Are not so pleasing as thy blest return.

Of these two poems of Drummond, it is observable, that the first was written in 1612, the last in 1617. The earliest piece of Waller is that to the king on his navy in 1625. The piece in which Sir John Denham's greatest force lies, Cooper's Hill, was not written till 1640. The harmony of Drummond, therefore, at a time when those who are usually called the first introducers of a smooth and polished versification had not yet begun to write, is an honour to him that should never be forgotten. Nor is his excellence half enough praised or acknowledged.

Drummond and Petrarch had this in common, that each lamented, first the cruelty, and then the loss of his mistress; so that their sonnets are alike naturally divided into two parts, those before and those after their several mistresses deaths. It may justly be doubted, that among all the sonneteers in the English language any one is to be preferred to Drummond. He has shown in some of those compositions nearly the spirit of Petrarch himself. Of each period one is here inserted; the first, before the death of his mistress:

> Ah me, and am I now the man, whose muse
> In happier times was wont to laugh at love,
> In those who suffered that blind boy abuse
> The noble gifts were giv'n them from above!
> What metamorphose strange is this I prove?
> Myself I scarce now find myself to be;
> And think no fable Circe's tyrannie,
> And all the tales are told of changed Jove.
> Virtue hath taught, with her philosophy
> My mind into a better course to move.
> Reason may chide her full, and oft reprove
> Affection's power; but what is that to me,
> Who ever think, and never think on aught
> But that bright cherubim which thralls my thought!

From

---

* Cursory Remarks on some of the English Poets, 8vo 1789.

Drummond, Drunkenness.

From Part II. after her death, (Sonnet I.)

Of mortal glory, O soon darken'd ray!
O winged joys of man, more swift than wind!
O fond desires which in our fancies stray!
O traitorous hope which do our judgments blind!

Lo, in a flash that light is gone away,
Which dazzle did each eye, delight each mind;
And with that sun from whence it came combin'd,
Now makes more radiant heaven's eternal day.

Let Beauty now bedew her cheeks with tears;
Let widow'd Music only roar and groan;
Poor Virtue, get thee wings and mount the spheres,
For dwelling place on earth for thee is none:
Death hath thy temple raz'd, Love's empire soil'd,
The world of honour, worth, and sweetness spoil'd.

The seventh sonnet of the first part has much resemblance to Sir Henry Wotton's elegant little poem on the queen of Bohemia, "Ye meaner beauties," &c. Among Drummond's Flowers of Sion, the poem which begins "Amidst the azure clear—of Jordan's sacred streams," eminently distinguishes him, whether he be considered as a philosopher or a poet.

DRUNKENNESS, a well-known disorder in the brain, occasioned by drinking too freely of spirituous liquors. Drunkenness appears in different shapes in different constitutions: some it makes gay, some sullen, and some furious. The mischief of drunkenness consists in the following bad effects: 1. It betrays most constitutions either into extravagancies of anger, or sins of lewdness. 2. It disqualifies men for the duties of their station, both by the temporary disorder of their faculties, and at length by a constant incapacity and stupefaction. 3. It is attended with expences, which can often be ill spared. 4. It is sure to occasion uneasiness to the family of the drunkard. 5. It shortens life. To these consequences of drunkenness must be added the peculiar danger and mischief of the example. "Drunkenness (Mr Paley observes) is a social festive vice. The drinker collects his circle; the circle naturally spreads; of those who are drawn within it, many become the corrupters and centres of sets and circles of their own; every one countenancing, and perhaps emulating, the rest, till a whole neighbourhood be infected from the contagion of a single example. With this observation upon the spreading quality of drunkenness, may be connected a remark which belongs to the several evil effects above recited. The consequences of a vice, like the symptoms of a disease, though they be all enumerated in the description, seldom all meet in the same subject. In the instance under consideration, the age and temperature of one drunkard may have little to fear from inflammations of lust or anger; the fortune of a second may not be injured by the expence: a third may have no family to be disquieted by his irregularities; and a fourth may possess a constitution fortified against the poison of strong liquors. But if, as we always ought to do, we comprehend within the consequences of our conduct the mischief and tendency of the example, the above circumstances, however fortunate for the individual, will be found to vary the guilt of his intemperance less, probably, than he supposes. Although the waste of time and money may be of small importance to you, it may be of the utmost to some one or other whom your society corrupts. Repeated or long-continued excesses, which hurt not your health, may be fatal to your companion. Although you have neither wife nor child, nor parent, to lament your absence from home, or expect your return to it with terror; other families, whose husbands and fathers have been invited to share in your ebriety, or encouraged to imitate it, may justly lay their misery or ruin at your door. This will hold good, whether the person seduced be seduced immediately by you, or the vice be propagated from you to him through several intermediate examples."

Drunkenness.

The ancient Lacedæmonians used to make their slaves frequently drunk, to give their children an aversion and horror for the same. The Indians hold drunkenness a species of madness; and in their language, the same term (*ramgam*), that signifies "drunkard," signifies also "a phrenetic."

Drunkenness is repeatedly forbidden by St Paul: "Be not drunk with wine, wherein is excess." "Let us walk honestly as in the day, not in rioting and drunkenness: "Be not deceived: neither fornicators, nor drunkards, nor revilers, nor extortioners, shall inherit the kingdom of God," Eph. vi. 18. Rom. xiii. 13. 1 Cor. vi. 9, 10. The same apostle likewise condemns drunkenness, as peculiarly inconsistent with the Christian profession: "They that be drunken, are drunken in the night; but let us, who are of the day, be sober." 1 Thess. v. 7, 8.

Drunkenness, by our laws, is looked upon as an aggravation rather than an excuse for any criminal behaviour. A drunkard, says Sir Edward Coke, who is *voluntarius dæmon*, hath no privilege thereby: but what hurt or ill soever he doth, his drunkenness doth aggravate it: *nam omne crimen ebrietas et incendit et detergit*. It hath been observed that the real use of strong liquors, and the abuse of them by drinking to excess, depend much upon the temperature of the climate in which we live. The same indulgence which may be necessary to make the blood move in Norway, would make an Italian mad. A German, therefore, says the president Montesquieu, drinks through custom founded upon constitutional necessity; a Spaniard drinks through choice, or out of the mere wantonness of luxury; and drunkenness, he adds, ought to be more severely punished where it makes men mischievous and mad, as in Spain and Italy, than where it only renders them stupid and heavy, as in Germany, and more northern countries. And accordingly, in the warmer climate of Greece, a law of Pittacus enacted, "that he who committed a crime when drunk should receive a double punishment;" one for the crime itself, and the other for the ebriety which prompted him to commit it. The Roman law indeed made great allowances for this vice: *per vinum delapsis capitalis pœna remittitur*. But the law of England, considering how easy it is to counterfeit this excuse, and how weak an excuse it is (though real), will not suffer any man thus to privilege one crime by another.

For the offence of drunkenness a man may be punished in the ecclesiastical court, as well as by justices of peace by statute. And by 4 Jac. I. c. 5. and 21 Jac. I. c. 7. if any person shall be convicted of drunkenness by the view of a justice, oath of one witness,

ness, &c. he shall forfeit 5s. for the first offence, to be levied by distress, and sale of his goods; and for want of a distress shall sit in the stocks six hours: and for the second offence, he is to be bound with two sureties in 10l. each, to be of good behaviour, or to be committed. And he who is guilty of any crime through his own voluntary drunkenness, shall be punished for it as if he had been sober. It has been held that drunkenness is a sufficient cause to remove a magistrate; and the prosecution for this offence by the statute of 4 Jac. I. c. 5. was to be, and still may be, before justices of peace in their sessions by way of indictment, &c. Equity will not relieve against a bond, &c. given by a man when drunk, unless the drunkenness is occasioned through the management or contrivance of him to whom the bond is given.

The appetite for intoxicating liquors appears to be almost always acquired. One proof of which is, that it is apt to return only at particular times and places; as after dinner, in the evening, on the market day, at the market town, in such a company, at such a tavern. And this may be the reason, that if a habit of drunkenness be ever overcome, it is upon some change of place, situation, company, or profession. A man sunk deep in a habit of drunkenness, will upon such occasions as these, when he finds himself loosened from the associations which held him fast, sometimes make a plunge, and get out. In a matter of such great importance, it is well worth while, where it is tolerably convenient, to change our habitation and society, for the sake of the experiment.

Habits of drunkenness commonly take their rise either from a fondness for, or connexion with, some company, or some companion, already addicted to this practice; which affords an almost irresistible invitation to take a share in the indulgencies which those about us are enjoying with so much apparent relish and delight; or from want of regular employment, which is sure to let in many superfluous cravings and customs, and often this amongst the rest; or, lastly, from grief or fatigue, both which strongly solicit that relief which inebriating liquors administer for the present, and furnish a specious excuse for complying with the inclination. But the habit, when once set in, is continued by different motives from those to which it owes its origin. Persons addicted to excessive drinking suffer, in the intervals of sobriety, and near the return of their accustomed indulgence, a faintness and oppression about the *præcordia* which it exceeds the ordinary patience of human nature to endure. This is usually relieved for a short time by a repetition of the same excess: and to this relief, as to the removal of every long-continued pain, they who have once experienced it are urged almost beyond the power of resistance. This is not all; as the liquor loses its stimulus, the dose must be increased, to reach the same pitch of elevation or ease; which increase proportionably accelerates the progress of all the maladies that drunkenness brings on. Whoever reflects, therefore, upon the violence of the craving in advanced stages of the habit, and the fatal termination to which the gratification of it leads, will, the moment he perceives the least tendency in himself of a growing inclination to intemperance, collect his resolution to this point; or (what perhaps he will find his best security) arm himself with some peremptory rule, as to the times and quantity of his indulgencies.

DRUPA, or **Druppa**, in *Botany*, a species of *pericarpium* or seed-vessel, which is succulent or pulpy, has no valve or external opening like the capsule and pod, and contains within its substance a stone or nut. The cherry, plum, peach, apricot, and all other stone fruits are of this kind.

The term, which is of great antiquity, is synonymous to Tournefort's *fructus mollis ossiculo*, "soft fruit with a stone;" and to the *prunus* of other botanists.

The stone or nut, which in this species of fruit is surrounded by the soft pulpy flesh, is a kind of ligneous or woody cup, which contains a single kernel or seed.

This definition, however, will not apply to every seed-vessel denominated *drupa* in the *Genera Plantarum.* The almond is a *drupa*, so is the seed-vessel of the elm tree and the genus *rumphia*, though far from being pulpy or succulent; the first and third are of a substance like leather, the second like parchment. The same may be said of the walnut, pistachia nut, *guettarda*, *quisqualis*, jack-in-a-box, and some others.

Again, the seeds of the elm, *schrebera*, *flagellaria*, and the mango tree, are not cantained in a stone. The seed-vessel of burr reed is dry, shaped like a top, and contains two angular stones.

This species of fruit, or more properly seed-vessel, is commonly roundish, and when seated below the calyx or receptacle of the flower, is furnished, like the apple, at the end opposite to the footstalk, with a small umbilicus or cavity, which is produced by the swelling of the fruit before the falling off of the flower-cup.

DRUSES, or **Druzes**, a remarkable nation in Palestine, inhabiting the environs of Mount Lebanon, of whose origin and history we have the following detail by M. Volney.

Twenty-three years after the death of Mahomet, the disputes between Ali his son-in-law and Moaouia governor of Syria, occasioned the first schism in the empire of the Arabs, and the two sects subsist to this day: but, in reality, this difference related only to power; and the Mahometans, however divided in opinion respecting the rightful successor of the prophet, were agreed with respect to their dogmas. It was not until the following century that the perusal of Greek books introduced among the Arabs a spirit of discussion and controversy, to which till then they were utter strangers. The consequence was, as might be expected, by reasoning on matters not susceptible of demonstration, and guided by the abstract principles of an unintelligible logic, they divided into a multitude of sects and opinions. At this period, too, the civil power lost its authority; and religion, which from that derives the means of preserving its unity, shared the same fate, and the Mahometans now experienced what had before befallen the Christians. The nations which had received the religion of Mahomet, mixed with it their former absurd notions; and the errors which had anciently prevailed over Asia again made their appearance, though altered in their forms. The metempsychosis, the doctrine of a good and evil principle, and the renovation after six thousand years, as it had been taught by Zoroaster, were again revived among the Mahometans. In this political and religious confusion every

every enthusiast became an apostle, and every apostle the head of a sect. No less than sixty of these were reckoned, remarkable for the numbers of their followers, all differing in some points of faith, and all disavowing heresy and error. Such was the state of these countries when, at the commencement of the 11th century, Egypt became the theatre of one of the most extravagant scenes of enthusiasm and absurdity ever recorded in history. The following account is extracted from the western writers.

In the year of the Hegira 386 (A. D. 996), the third caliph of the race of the Fatimites, called *Hakem-b'amr-ellah*, succeeded to the throne of Egypt at the age of 11 years. He was one of the most extraordinary princes of whom history has preserved the memory. He caused the first caliphs, the companions of Mahomet, to be cursed in the mosques, and afterwards revoked the anathema: He compelled the Jews and Christians to abjure their religion, and then permitted them to resume it. He prohibited the making slippers for women, to prevent them from coming out of their houses. He burnt one half of the city of Cairo for his diversion, while his soldiers pillaged the other. Not contented with these extravagant actions, he forbade the pilgrimage to Mecca, fasting, and the five prayers; and at length carried his madness so far as to desire to pass for God himself. He ordered a register of those who acknowledged him to be so, and the number amounted to sixteen thousand. This impious pretension was supported by a false prophet, who came from Persia into Egypt; which impostor, named *Mohammed ben-Ismael*, taught that it was not necessary to fast or pray, to practise circumcision, to make the pilgrimage to Mecca, or observe festivals; that the prohibition of pork and wine was absurd; and that marriage between brothers and sisters, fathers and children, was lawful. To ingratiate himself with Hakem, he maintained that this caliph was God himself incarnate; and instead of his name *Hakem-b'amr-ellah*, which signifies *governor by the order of God*, he called him *Hakem b'amr-eh, governing by his own order.* Unluckily for the prophet, his new god had not the power to protect him from the fury of his enemies, who slew him in a tumult almost in the arms of the caliph, who was himself massacred soon after on Mount Mokattam, where he, as he said, had held conversation with angels.

The death of these two chiefs did not stop the progres of their opinions; a disciple of Mohammed-ben-Ismael, named *Hamzu-ben-Ahmud*, propagated them with an indefatigable zeal in Egypt, in Palestine, and along the coast of Syria, as far as Sidon and Berytus. His proselytes being persecuted by the sect in power, they took refuge in the mountains of Lebanon, where they were better able to defend themselves; at least it is certain, that, shortly after this era, we find them established there, and forming an independent society.

The difference of their opinions disposes them to be enemies; but the urgent interest of their common safety forces them to allow mutual toleration, and they have always appeared united, and have jointly opposed, at different times, the Crusaders, the sultans of Aleppo, the Mamelukes, and the Ottomans. The conquest of Syria by the latter made no change in their situation. Selim I. on his return from Egypt, meditating no less than the conquest of Europe, disdained to waste his time before the rocks of Lebanon. Soliman II. his successor, incessantly engaged in important wars, either with the knights of Rhodes, the Persians, the kingdom of Yemen, the Hungarians, the Germans, or the emperor Charles V. had no time to think of the Druses. Emboldened by this inattention, and not content with their independence, they frequently descended from their mountains, to pillage the Turks. The pachas in vain attempted to repel their inroads; their troops were invariably routed or repulsed. And it was not till the year 1588 that Amurath III. wearied with the complaints made to him, resolved, at all events, to reduce these rebels, and had the good fortune to succeed. His general Ibrahim Pacha marched from Cairo, and attacked the Druses and Maronites with so much address and vigour as to force them into their strong holds, the mountains. Dissension took place among their chiefs, of which he availed himself to exact a contribution of upward of one million of piastres, and to impose a tribute which has continued to the present time.

It appears that this expedition was the epoch of a considerable change in the constitution of the Druses. Till then they had lived in a sort of anarchy, under the command of different sheiks or lords. The nation was likewise divided into two factions, such as is to be found in all the Arab tribes, and which are distinguished into the party Kaisi and the party Yamani. To simplify the administration, Ibrahim permitted them only one chief, who should be responsible for the tribute, and execute the office of civil magistrate; and this governor, from the nature of his situation, acquiring great authority, became almost the king of the republic; but as he was always chosen from among the Druses, a consequence followed which the Turks had not foreseen, and which was nearly fatal to their power. For the chief thus chosen, having at his disposal the whole strength of the nation, was able to give it unanimity and energy, and it naturally turned against the Turks; since the Druses, by becoming their subjects, had not ceased to be their enemies. They took care, however, that their attacks should be indirect, so as to save appearances, and only engaged in secret hostilities, more dangerous, perhaps, than open war.

About this time, that is, the beginning of the 17th century, the power of the Druses attained its greatest height; which it owed to the talents and ambition of the celebrated Faker-el-din, commonly called *Fakardin.* No sooner was this prince advanced to be the chief of that people, than he turned his whole attention to humble the Ottoman power, and aggrandise himself at its expence. In this enterprise he displayed an address seldom seen among the Turks. He first gained the confidence of the Porte, by every demonstration of loyalty and fidelity; and as the Arabs at that time infested the plain of Balbec and the countries of Sour and Acre, he made war upon them, freed the inhabitants from their depredations, and thus rendered them desirous of living under his government.

The city of Bairout was situated advantageously for his designs, as it opened a communication with foreign countries, and among others, with the Venetians, the natural enemies of the Turks. Faker-el-din availed himself of the misconduct of the aga, expelled ed him, seized on the city, and even had the art to make a merit of this act of hostility with the Divan, by paying a more considerable tribute. He proceeded in the same manner at Saide, Balbec, and Sour; and at length, about the year 1613, saw himself master of all the country as far as Adjaloun and Safad. The pachas of Tripoli and Damascus could not see these encroachments with indifference; sometimes they opposed him with open force, though ineffectually, and sometimes endeavoured to ruin him at the Porte by secret insinuations; but the emir, who maintained there his spies and defenders, defeated every attempt.

At length, however, the Divan began to be alarmed at the progress of the Druses, and made preparations for an expedition capable of crushing them. Whether from policy or fear, Faker-el-din did not think proper to wait this storm. He had formed connexions in Italy, on which he built great hopes, and determined to go in person to solicit the succours they had promised him; persuaded that his presence would increase the zeal of his friends, while his absence might appease the resentment of his enemies. He therefore embarked at Bairout; and after resigning the administration to his son Ali, repaired to the court of the Medici at Florence. The arrival of an Oriental prince in Italy did not fail to attract the public attention. Inquiry was made into his nation, and the origin of the Druses became a popular topic of research. Their history and religion were found to be so little known, as to leave it a matter of doubt whether they should be classed with the Mahometans or Christians. The Crusades were called to mind; and it was soon suggested, that a people who had taken refuge in the mountains, and were enemies to the natives, could be no other than the offspring of the Crusaders.

This idle conceit was too favourable to Faker-el-din for him to endeavour to disprove it: he was artful enough, on the contrary, to pretend he was related to the house of Loraine; and the missionaries and merchants, who promised themselves a new opening for conversion and commerce, encouraged his pretensions. When an opinion is in vogue, every one discovers new proofs of its certainty. The learned in etymology, struck with the resemblance of the names, insisted, that Druses and Dreux, must be the same word; and on this foundation formed the system of a pretended colony of French Crusaders, who, under the conduct of a Comte de Dreux, had formed a settlement in Lebanon. This hypothesis, however, was completely overthrown by the remark, that the name of the Druses is to be found in the itinerary of Benjamin of Tudela, who travelled before the time of the Crusades. Indeed the futility of it ought to have been sufficiently apparent at first, from the single consideration, that had they been descended from any nation of the Franks, they must have retained at least the traces of some European language; for a people, retired into a separate district, and living distinct from the natives of the country, do not lose their language. That of the Druses, however, is very pure Arabic, without a single word of European origin. The real derivation of the name of this people has been long in our possession, without our knowing it. It originates from the founder of the sect of Mohammed-ben-Ismael, who was surnamed *El-Dorzi*, and not *El-Darari*, as it is usually printed: the confusion of these two words, so different in our writing, arises from the figure of the two Arabic letters *r* and *z*, which have only this difference, that the *z* has a point over it, frequently omitted or effaced in the manuscripts.

After a stay of nine years in Italy, Faker-el-din returned to resume the government of his country. During his absence, his son Ali had repulsed the Turks, appeased discontents, and maintained affairs in tolerable good order. Nothing remained for the emir, but to employ the knowledge he could not but have acquired, in perfecting the internal administration of government, and promoting the welfare of the nation; but instead of the useful and valuable arts, he wholly abandoned himself to the frivolous and expensive, for which he had imbibed a passion while in Italy. He built numerous villas, constructed baths, and planted gardens: he even presumed, without respect to the prejudices of his country, to employ the ornaments of painting and sculpture, notwithstanding these are prohibited by the Koran.

The consequences of this conduct soon manifested themselves: the Druses, who paid the same tribute as in time of war, became dissatisfied. The Yamani faction were roused; the people murmured at the expences of the prince; and the luxury he displayed renewed the jealousy of the pachas. They attempted to levy greater tribute: hostilities again commenced, and Faker-el-din repulsed the forces of the pachas; who took occasion, from this resistance, to render him suspected by the sultan himself. Amurath III. incensed that one of his subjects should dare to enter into a competition with him, resolved on his destruction; and the pacha of Damascus received orders to march, with all his forces, against Bairout, the usual residence of Faker-el-din; while 40 galleys invested it by sea, and cut off all communication.

The emir, who depended on his good fortune and succours from Italy, determined at first to brave the storm. His son Ali, who commanded at Safad, was ordered to oppose the progress of the Turkish army: and in fact he bravely resisted them, notwithstanding the great disparity of his forces; but after two engagements, in which he had the advantage, being slain in a third attack, the face of affairs was greatly changed, and every thing went to ruin. Faker-el-din, terrified at the loss of his troops, afflicted at the death of his son, and enfeebled by age and a voluptuous life, lost both courage and presence of mind. He no longer saw any resource but in a peace, which he sent his second son to solicit of the Turkish admiral, whom he attempted to seduce by presents; but the admiral detaining both the presents and envoy, declared he would have the prince himself. Faker-el-din, intimidated, took to flight, and was pursued by the Turks, now masters of the country. He took refuge on the steep eminence of Niha, where they besieged him ineffectually for a whole year, when they left him at liberty; but shortly after, the companions of his adversity, wearied with their sufferings, betrayed and delivered him up to the Turks. Faker-el-din, though in the hands of his enemies, conceived hopes of pardon, and suffered himself to be carried to Constantinople;

where Amurath, pleased to behold at his feet a prince so celebrated, at first treated him with the benevolence which arises from the pride of superiority; but soon returning to his former jealousies, yielded to the instigations of his courtiers, and, in one of his violent fits of passion, ordered him to be strangled, about the year 1631.

After the death of Faker-el-din, the posterity of that prince still continued in possession of the government, though at the pleasure, and as vassals of the Turks. This family failing in the male line at the beginning of the last century, the authority devolved, by the election of the shaiks, on the house of Shelah, in which it still continues. The only emir of that house, whose name deserves to be preserved, is the emir Melhem, who reigned from 1740 to 1759; in which interval he retrieved the losses of the Druses, and restored them to that consequence which they had lost by the defeat of Faker-el-din. Towards the end of his life, about the year 1754, Melhem, wearied with the cares of government, abdicated his authority, to live in religious retirement, after the manner of the Okkals; but the troubles that succeeded occasioned him once more to resume the reins of government, which he held till 1759, when he died, universally regretted.

He left three sons, minors; the eldest of whom ought, according to the custom of the country, to have succeeded him; but being only 11 years of age, the authority devolved on his uncle Mansour, agreeably to a law very general in Asia, which wills the people to be governed by a sovereign who has arrived at years of maturity. The young prince was but little fitted to maintain his pretensions; but a Maronite, named Sad-el-Kouri, to whom Melhem had intrusted his education, took this upon himself. Aspiring to see his pupil a powerful prince, that he might himself become a powerful visir, he made every exertion to advance his fortune. He first retired with him to Djebail, in the Kesraouan, where the emir Yousef possessed large domains, and there undertook to conciliate the Maronites, by embracing every opportunity to serve both individuals and the nation. The great revenues of his pupil, and the moderation of his expenditure, amply furnished him with the means. The farm of the Kesraouan was divided between several shaiks, with whom the Porte was not very well satisfied. Sad treated for the whole with the pacha of Tripoli, and got himself appointed sole receiver. The Motoualis of the valley of Balbec had for some years before made several encroachments on Lebanon, and the Maronites began to be alarmed at the near approach of these intolerant Mahometans. Sad purchased of the pacha of Damascus a permission to make war upon them; and in 1763 drove them out of the conntry. The Druses were at that time divided into two factions: Sad united his interest with those who opposed Mansour, and secretly prepared the plot which was to raise the nephew on the ruin of the uncle.

At this period the Arab Daher, who had made himself master of Galilee, and fixed his residence at Acre, disquieted the Porte by his progress and pretensions; to oppose him, the Divan had just united the pachalics of Damascus, Saide, and Tripoli, in the hands of Osman and his children; and it was evident that an open war was not very remote. Mansour, who dreaded the Turks too much to resist them, made use of the policy usual on such occasions, pretending a zeal for their service, while he secretly favoured their enemy. This was a sufficient motive for Sad to pursue measures directly opposite. He supported the Turks against the faction of Mansour, and manœuvred with so much good fortune or address as to depose that emir in 1770, and place Yousef in his government.

In the following year Ali Bey declared war, and attacked Damascus. Yousef, called on by the Turks, took part in the quarrel, but without being able to draw the Druses from their mountains to enter into the army of the Ottomans. Besides their natural repugnance, at all times, to make war out of their country, they were on this occasion too much divided at home to quit their habitations, and they had reason to congratulate themselves on the event. The battle of Damascus ensued; and the Turks, as we have already seen, were completely routed. The pacha of Saide escaping from this defeat, and not thinking himself in safety in that town, sought an asylum even in the house of the emir Yousef. The moment was unfavourable; but the face of affairs soon changed by the flight of Mohammed Bey. The emir, concluding that Ali Bey was dead, and not imagining that Daher was powerful enough singly to maintain the quarrel, declared openly against him. Saide was threatened with a siege, and he detached 1500 men of his faction to its defence; while himself in person, prevailing on the Druses and Maronites to follow him, made an incursion with 25,000 peasants into the valley of Bekaa; and in the absence of the Motoualis, who had joined the army of Daher, laid the whole country waste with fire and sword from Balbec to Tyre.

While the Druses, proud of this exploit, were marching in disorder towards the latter city, 500 Motoualis, informed of what had happened, flew from Acre, inflamed with rage and despair, and fell with such impetuosity on their army as to give them a complete overthrow. Such was the surprise and confusion of the Druses, that, imagining themselves attacked by Daher himself, and betrayed by their companions, they turned their swords on each other as they fled. The steep declivities of Djezin, and the pine woods which were in the route of the fugitives, were strewed with dead, but few of whom perished by the hands of the Motoualis.

The emir Yousef, ashamed of this defeat, escaped to Dair-el-Kamar, and shortly after attempted to take revenge; but being again defeated in the plain between Saide and Sour (Tyre), he was constrained to resign to his uncle Mansonr the ring, which among the Druses is the symbol of command. In 1773 he was restored by a new revolution; but he could not support his power but at the expence of a civil war. In order, therefore, to prevent Bairout falling into the hands of the adverse faction, he requested the assistance of the Turks, and demanded of the pacha of Damascus a man of sufficient abilities to defend that city. The choice fell on an adventurer, who from his subsequent fortune, merits to be made known.

This man, named Ahmad, was a native of Bosnia, and

and spoke the Sclavonian as his mother tongue, as the Ragusan captains, with whom he conversed in preference to those of every other nation, assert. It is said, that flying from his country at the age of 16, to escape the consequences of an attempt to violate his sister-in-law, he repaired to Constantinople, where, destitute of the means of procuring subsistence, he sold himself to the slave merchants to be conveyed to Egypt; and, on his arrival at Cairo, was purchased by Ali Bey, who placed him among his Mamelukes.

Ahmad was not long in distinguishing himself by his courage and address. His patron employed him on several occasions in dangerous *coups de main*, such as the assassination of such beys and cachefs as he suspected; of which commissions he acquitted himself so well as to acquire the name of *Djezzar*, which signifies *Cut-throat.* With this claim to his friendship, he enjoyed the favour of Ali until it was disturbed by an accident.

This jealous bey having proscribed one of his benefactors called Saleh Bey, commanded Djezzar to cut off his head. Either from humanity or some secret friendship for the devoted victim, Djezzar hesitated, and even remonstrated among the order. But learning the next day that Mohammed Bey had executed the commission, and that Ali had spoken of him not very favourably, he thought himself a lost man, and, to avoid the fate of Saleh Bey, escaped unobserved, and reached Constantinople. He there solicited employment suitable to his former rank; but meeting, as is usual in capitals, with a great number of rivals, he pursued another plan, and went to seek his fortune in Syria as a private soldier. Chance conducted him among the Druses, where he was hospitably entertained, even in the house of the kiaya of the emir Yousef. From thence he repaired to Damascus, where he soon obtained the title of *Aga*, with a command of five pair of colours, that is to say, of 50 men; and he was thus situated when fortune destined him to the government of Bairout.

Djezzar was no sooner established there than he took possession of it for the Turks. Yousef was confounded at this proceeding. He demanded justice at Damascus; but finding his complaints treated with contempt, entered into a treaty with Daher, and concluded an offensive and defensive alliance with him at Ras-el-aen, near to Sour. No sooner was Daher united with the Druses than he laid siege to Bairout by land, whilst two Russian frigates, whose service was purchased by 600 purses, cannonaded it by sea. Djezzar was compelled to submit to force, and, after a vigorous resistance, gave up the city, and surrendered himself prisoner. Shaik Daher, charmed with his courage, and flattered with the preference he had given him in the surrender, conducted him to Acre, and showed him every mark of kindness. He even ventured to trust him with a small expedition into Palestine; but Djezzar, on approaching Jerusalem, went over to the Turks, and returned to Damascus.

The war of Mohammed Bey breaking out, Djezzar offered his service to the captain pacha, and gained his confidence. He accompanied him to the siege of Acre; and that admiral having destroyed Daher, and finding no person more proper than Djezzar to accomplish the designs of the Porte in that country, named him pacha of Saide.

Being now, in consequence of this revolution, superior lord to the emir Yousef, Djezzar is mindful of injuries in proportion as he has reason to accuse himself of ingratitude. By a conduct truly Turkish, feigning alternately gratitude and resentment, he is alternately on terms of dispute and reconciliation, with him, continually exacting money as the price of peace, or an indemnity for war. His artifices have succeeded so well, that within the space of five years he has extorted from the emir four millions of French money (above 160,000l.); a sum the more astonishing, as the farm of the country of the Druses did not then amount to 100,000 livres (4000l.).

In 1784, he made war on him, deposed him, and bestowed the government on the emir of the country of Hasbeya, named Ismael. Yousef, having once more purchased his favour, returned towards the end of the same year to Dair-el-Kamar, and even courted his confidence so far as to wait on him at Acre, from whence nobody expected him to return; but Djezzar is too cunning to shed blood while there are any hopes of getting money: he released the prince, and sent him back with every mark of friendship. Since that period the Porte has named him pacha of Damascus, while he also retained the sovereignty of the pachalic of Acre, and of the country of the Druses.

As to the religion of the Druses: What has been already said of the opinions of Mohammed-ben-Ismael may be regarded as the substance of it. They practise neither circumcision, nor prayers, nor fasting; they observe neither festivals nor prohibitions. They drink wine, eat pork, and allow marriage between brothers and sisters, though not between fathers and children. From this we may conclude, with reason, that the Druses have no religion; yet one class of them must be excepted, whose religious customs are very peculiar. Those who compose it are to the rest of the nation what the initiated are to the profane; they assume the name of *Okkals*, which means spiritualists, and bestow on the vulgar the epithet of *Djahel*, or ignorant: they have various degrees of initiation, the highest orders of which require celibacy. These are distinguishable by the white turban they affect to wear, as a symbol of their purity; and so proud are they of this supposed purity, that they think themselves sullied by even touching a profane person. If you eat out of their plate, or drink out of their cup, they break them; and hence the custom, so general in this country, of using vases with a sort of cock, which may be drank out of without touching them with the lips. All their practices are enveloped in mysteries: their oratories always stand alone, and are constantly situated on eminences: in these they hold their secret assemblies, to which women are admitted. It is pretended they perform ceremonies there in presence of a small statue resembling an ox or a calf; whence some have pretended to prove that they are descended from the Samaritans. But besides that the fact is not well ascertained, the worship of the ox may be deduced from other sources.

They have one or two books which they conceal with the greatest care; but chance has deceived their jealousy; for in a civil war which happened some years ago, the emir Yousef, who is *Djahel* or ignorant, found one among the pillage of one of their oratories. M. Volney was assured, by persons who had read it, that it contains only a mystic jargon, the obscurity of which doubtless renders it valuable to adepts. Hakem B'amr-ellah is there spoken of, by whom they mean God incarnated in the person of the caliph. It likewise treats of another life, of a place of punishment, and a place of happiness where the Okkals shall of course be most distinguished. Several degrees of perfection are mentioned, to which they arrive by successive trials. In other respects, these sectaries have all the insolence and all the fears of superstition: they are not communicative, because they are weak; but it is probable that, were they powerful, they would be promulgators and intolerant.

The rest of the Druses, strangers to this spirit, are wholly indifferent about religious matters. The Christians who live in their country pretend that several of them believe in the metempsychosis; that others worship the sun, moon, and stars: all which is possible; for, as among the Ansaria, every one, left to his own fancy, follows the opinion that pleases him most; and these opinions are those which present themselves most naturally to unenlightened minds. When among the Turks, they affect the exterior of Mahometans, frequent the mosques, and perform their ablutions and prayers. Among the Maronites, they accompany them to church, and, like them, make use of holy water. Many of them, importuned by the missionaries, suffer themselves to be baptized; and if solicited by the Turks, receive circumcision, and conclude by dying neither Christians nor Mahometans; but they are not so indifferent in matters of civil policy.

The Druses may be divided into two classes; the common people; and the people of eminence and property, distinguished by the title of shaiks and emirs, or descendants of princes. The greater part are cultivators, either as farmers or proprietors; every man lives on his inheritance, improving his mulberry trees and vineyards: in some districts they grow tobacco, cotton, and some grain; but the quantity of these is inconsiderable. It appears that at first all the lands were, as formerly in Europe, in the hands of a small number of families. But to render them productive, the great proprietors were forced to sell part of them, and let leases; which subdivision is become the chief source of the power of the state, by multiplying the number of persons interested in the public weal: there still exist, however, some traces of the original inequality, which even at this day produces pernicious effects. The great property possessed by some families gives them too much influence in all the measures of the nation; and their private interests have too great weight in every public transaction. Their history, for some years back, affords sufficient proofs of this; since all the civil or foreign wars in which they have been engaged have originated in the ambition and personal views of some of the principal families, such as the Lesbeks, the Djambelats, the Ismaels of Solyma, &c. The shaiks of these houses, who alone possess one-tenth part of the country, procured creatures by their money, and at last involved all the Druses in their dissensions. It must be owned, however, that possibly to this conflict between contending parties the whole nation owes the good fortune of never having been enslaved by its chief.

This chief, called *Hakem* or governor, also *Emir* or prince, is a sort of king or general, who unites in his own person the civil and military powers. His dignity is sometimes transmitted from father to son, sometimes from one brother to another; and the succession is determined rather by force than any certain laws. Females can in no case pretend to this inheritance. They are already excluded from succession in civil affairs, and consequently can still less expect it in political: in general, the Asiatic governments are too turbulent, and their administration renders military talents too necessary, to admit of the sovereignty of women. Among the Druses the male line of any family being extinguished, the government devolves to him who is in possession of the greatest number of suffrages and resources. But the first step is to obtain the approbation of the Turks, of whom he becomes the vassal and tributary. It even happens, that, not unfrequently to assert their supremacy, they name the Hakem, contrary to the wishes of the nation, as in the case of Ismael Hasbeya, raised to that dignity by Djezzar; but this constraint lasts no longer than it is maintained by that violence which gave it birth. The office of the governor is to watch over the good order of the state, and to prevent the emirs, shaiks, and villages, from making war on each other: in case of disobedience, he may employ force. He is also at the head of the civil power, and names the cadis, only always reserving to himself the power of life and death. He collects the tribute, from which he annually pays to the pacha a stated sum. This tribute varies in proportion as the nation renders itself more or less formidable: at the beginning of this century, it amounted to 160 purses, 8330l.; but Melhem forced the Turks to reduce it to 60. In 1784 Emir Yousef paid 80 and promised 90. This tribute, which is called *Miri*, is imposed on the mulberry trees, vineyards, cotton, and grain. All sown land pays in proportion to its extent; every foot of mulberries is taxed at three medins, or three sols nine deniers (not quite twopence). A hundred feet of vineyard pays a piastre or 40 medins; and fresh measurements are often made to preserve a just proportion. The shaiks and emirs have no exemption in this respect; and it may be truly said they contribute to the public stock in proportion to their fortune. The collection is made almost without expence. Each man pays his contingent at Dair-el-Kamar, if he pleases, or to the collectors of the prince, who make a circuit round the country after the crop of silks. The surplus of this tribute is for the prince; so that it is his interest to reduce the demands of the Turks, as it would be likewise to augment the impost: but this measure requires the sanction of the shaiks, who have the privilege of opposing it. Their consent is necessary, likewise, for peace and war. In these cases, the emir must convoke general assemblies, and lay before them the state of his affairs. There every shaik, and every peasant who has any reputation for courage or understanding, is entitled to give his suffrage; so that this government may be considered as a well-proportioned mixture of monarchy, aristocracy, and democracy. Every thing depends on circumstances: if the governor be a man of ability, he is absolute; if ruses.

Druses.

if weak, a cipher. This proceeds from the want of fixed laws; a want common to all Asia, and the radical cause of all the disorders in the governments of the Asiatic nations.

Neither the chief nor the individual emirs maintain troops; they have only persons attached to the domestic service of their houses, and a few black slaves. When the nation makes war, every man, whether shaik or peasant, able to bear arms, is called upon to march. He takes with him a little bag of flour, a musket, some bullets, a small quantity of powder, made in his village, and repairs to the rendezvous appointed by the governor. If it be a civil war, as sometimes happens, the servants, the farmers, and their friends, take up arms for their patron, or the chief of their family, and repair to his standard. In such cases, the parties irritated frequently seem on the point of proceeding to the last extremities; but they seldom have recourse to acts of violence, or attempt the death of each other; mediators always interpose, and the quarrel is appeased the more readily, as each patron is obliged to provide his followers with provisions and ammunition. This system, which produces happy effects in civil troubles, is attended with great inconvenience in foreign wars, as sufficiently appeared in that of 1784. Djezzar, who knew that the whole army lived at the expence of the emir Yousef, aimed at nothing but delay, and the Druses, who were not displeased at being fed for doing nothing, prolonged the operations; but the emir, wearied of paying, concluded a treaty, the terms of which were not a little rigorous for him, and eventually for the whole nation, since nothing is more certain than that the interests of a prince and his subjects are always inseparable.

"The ceremonies to which I have been a witness on these occasions (says M. Volney), bear a striking resemblance to the customs of ancient times. When the emir and the shaiks had determined on war at Dair-el-Kamar, cryers in the evening ascended the summits of the mountain; and there began to cry with a loud voice: 'To war, to war; take your guns, take your pistols: noble shaiks, mount your horses; arm yourselves with the lance and sabre; rendezvous to-morrow at Dair-el-Kamar. Zeal of God! zeal of combats!' This summons, heard from the neighbouring villages, was repeated there; and as the whole country is nothing but a chain of lofty mountains and deep valleys, the proclamation passed in a few hours to the frontiers. These voices, from the stillness of the night, the long resounding echoes, and the nature of the subject, had something awful and terrible in their effect. Three days after 15,000 armed men rendezvouzed at Dair-el-Kamar, and operations might have been immediately commenced.

"We may easily imagine that troops of this kind no way resemble our European soldiers; they have neither uniforms, nor discipline, nor order. They are a crowd of peasants with short coats, naked legs, and muskets in their hands; differing from the Turks and Mamelukes in that they are all foot; the shaiks and emirs alone having horses, which are of little use from the rugged nature of the country. War there can only be a war of posts. The Druses never risk themselves in the plain; and with reason: for they would be unable to stand the shock of cavalry, having no bayonets to their muskets. The whole art consists in climbing rocks, creeping among the bushes and blocks of stone; from whence their fire is the more dangerous, as they are covered, fire at their ease, and by hunting and military sports have acquired the habit of hitting a mark with great dexterity. They are accustomed to sudden inroads, attacks by night, ambuscades, and all those *coups de main* which require to fall suddenly on, and come to close fight with the enemy. Ardent in improving their success, easily dispirited, and prompt to resume their courage; daring even to temerity, and sometimes ferocious, they possess above all two qualities essential to the excellency of any troops; they strictly obey their leaders, and are endowed with a temperance and vigour of health at this day unknown to most civilized nations. In the campaign of 1784, they passed three months in the open air without tents or any other covering than a sheep skin; yet were there not more deaths or maladies than if they had remained in their houses. Their provisions consisted, as at other times, of small loaves baked on the ashes or on a brick, raw onions, cheese, olives, fruits, and a little wine. The table of the chiefs was almost as frugal; and we may affirm, that they subsisted 100 days on what the same number of Englishmen or Frenchmen would not have lived ten. They have no knowledge of the science of fortification, the management of artillery, or encampments, nor, in a word, any thing which constitutes the art of war. But had they among them a few persons versed in military science, they would readily acquire its principles, and become a formidable soldiery. This would be the more easily effected, as their mulberry plantations and vineyards do not occupy them all the year, and they could afford much time for military exercises."

By the last estimates, according to M. Volney's information, the number of men able to bear arms was 40,000, which supposes a total population of 120,000; no addition is to be made to this calculation, since there are no Druses in the cities or on the coast. As the whole country contains only 100 square leagues, there results for every league 1090 persons; which is equal to the population of our richest provinces. To render this more remarkable, it must be observed, that the soil is not fertile, that a great many eminences remain uncultivated, that they do not grow corn enough to support themselves three months in the year, that they have no manufactures, and that all their exportations are confined to silks and cottons, the balance of which exceeds very little the importation of corn from the Hauran, the oils of Palestine, and the rice and coffee they procure from Bairout. Whence arises then such a number of inhabitants within so small a space? "I can discover no other cause (says our author), than that ray of liberty which glimmers in this country. Unlike the Turks, every man lives in a perfect security of his life and property. The peasant is not richer than in other countries; but he is free. 'He fears not,' as I have often heard them say, 'that the Aga, the Kaimmakam, or the Pacha, should send their Djendis to pillage his house, carry off his family, or give him the bastinado.' Such oppressions are unknown among these mountains. Security, therefore, has been the original cause of population, from that inherent desire which all men have to multiply themselves wherever they find an easy subsistence. The frugality of the

the nation, which is content with little, has been a secondary, and not less powerful reason; and a third is the emigration of a number of Christian families, who daily desert the Turkish provinces to settle in Mount Lebanon, where they are received with open arms by the Maronites from similarity of religion, and by the Druses from principles of toleration, and a conviction how much it is the interest of every country to multiply the number of its cultivators, consumers, and allies.

"The comparison which the Druses often have an opportunity of making between their situation and that of other subjects of the Turkish government, has given them an advantageous opinion of their superiority, which, by a natural effect, has an influence on their personal character. Exempt from the violence and insults of despotism, they consider themselves as more perfect than their neighbours, because they have the good fortune not to be equally debased. Hence they acquire a character more elevated, energetic, and active; in short, a genuine republican spirit. They are considered throughout the Levant as restless, enterprising, hardy, and brave even to temerity. Only 300 of them have been seen to enter Damascus in open day, and spread around them terror and carnage. No people are more nice than they with respect to the point of honour: any offence of that kind, or open insult, is instantly punished by blows of the kanjur or the musket; while among the inhabitants of the towns it only excites injurious retorts. This delicacy has occasioned in their manners and discourse a reserve, or, if you will, a politeness, which one is astonished to discover among peasants. It is carried even to dissimulation and falsehood, especially among the chiefs, whose greater interests demand greater attentions. Circumspection is necessary to all, from the formidable consequences of that retaliation of which I have spoken. These customs may appear barbarous to us; but they have the merit of supplying the deficiency of regular justice, which is necessarily tedious and uncertain in these disorderly and almost anarchical governments.

"The Druses have another point of honour, that of hospitality. Whoever presents himself at their door in the quality of a suppliant or passenger, is sure of being entertained with lodging and food in the most generous and unaffected manner. M. Volney often saw the lowest peasants give the last morsel of bread they had in their houses to the hungry traveller; and when it was observed to them that they wanted prudence, their answer was, 'God is liberal and great, and all men are brethren.' There are, therefore, no inns in their country any more than in the rest of Turkey. When they have once contracted with their guest the sacred engagement of bread and salt, no subsequent event can make them violate it. Various instances of this are related, which do honour to their character. A few years ago, an aga of the janissaries having been engaged in a rebellion, fled from Damascus and retired among the Druses. The pacha was informed of this, and demanded him of the emir, threatening to make war on him in case of refusal. The emir demanded him of the shaik Talhouk, who had received him; but the indignant shaik replied, 'When have you known the Druses deliver up their guests? Tell the emir, that as long as Talhouk shall preserve his beard, not a hair of the head of his suppliant shall fall!' The emir threatened him with force; Talhouk armed his family. The emir, dreading a revolt, adopted a method practised as juridical in that country. He declared to the shaik, that he would cut down 50 mulberry trees a-day until he should give up the aga. He proceeded as far as a thousand, and Talhouk still remained inflexible. At length the other shaiks, enraged, took up the quarrel; and the commotion was about to become general, when the aga, reproaching himself with being the cause of so much mischief, made his escape without the knowledge even of Talhouk.

"The Druids have also the prejudices of the Bedouins respecting birth; like them, they pay great respect to the antiquity of families; but this produces no essential inconveniences. The nobility of the emirs and shaiks does not exempt them from paying tribute in proportion to their revenues. It confers on them no prerogatives, either in the attainment of landed property or public employments. In this country, no more than in all Turkey, are they acquainted with game laws, or glebes, or signorial or ecclesiastical tithes, franc fiefs or alienation fines: every thing is held in freehold: Every man, after paying his miri and his rent, is master of his property. In short, by a particular privilege, the Druses pay no fine for their succession; nor does the emir, like the sultan, arrogate to himself original and universal property: there exists, nevertheless, in the law of inheritance, an imperfection which produces disagreeable effects. Fathers have, as in the Roman law, the power of preferring such of their children as they think proper; hence it has happened in several families of the shaiks, that the whole property has centered in the same person, who has perverted it to the purpose of intriguing and caballing, while his relations remain, as they will express it, *princes of olives and cheese*; that is to say, poor as peasants.

"In consequence of their prejudices, the Druses do not choose to make alliances out of their own families. They invariably prefer their relation, though poor, to a rich stranger; and poor peasants have been known to refuse their daughters to merchants of Saide and Bairout, who possessed from twelve to fifteen thousand piastres. They observe also, to a certain degree, the custom of the Hebrews, which directed that a brother should espouse his brother's widow; but this is not peculiar to them, for they retain that, as well as several other customs of that ancient people, in common with other inhabitants of Syria and all the Arab tribes.

"In short, the proper and distinctive character of the Druses is a sort of republican spirit, which gives them more energy than any other subjects of the Turkish government; and an indifference for religion, which forms a striking contrast with the zeal of the Mahometans and Christians. In other respects, their private life, their customs and prejudices, are the same with other orientals. They may marry several wives, and repudiate them when they choose; but, except by the emir and a few men of eminence, that is rarely practised. Occupied with their rural labours, they experience neither artificial wants, nor those inordinate passions which are produced by the idleness of the inhabitants of cities and towns. The veil, worn by by their women, is of itself a preservative against those desires which are the occasion of so many evils in society. No man knows the face of any other woman than his wife, his mother, his sister, and sisters-in-law. Every man lives in the bosom of his own family, and goes little abroad. The women, those even of the shaiks, make the bread, roast the coffee, wash the linen, cook the victuals, and perform all domestic offices. The men cultivate their lands and vineyards, and dig canals for watering them. In the evening they sometimes assemble in the court, the area, or house of the chief of the village or family. There, seated in a circle, with legs crossed, pipes in their mouths, and poniards at their belts, they discourse of their various labours, the scarcity or plenty of their harvests, peace or war, the conduct of the emir, or the amount of the taxes; they relate past transactions, discuss present interests, and form conjectures on the future. Their children, tired with play, come frequently to listen; and a stranger is surprised to hear them, at ten or twelve years old, recounting, with a serious air, why Djezzar declared war against the emir Yousef, how many purses it cost that prince, what augmentation there will be of the miri, how many muskets there were in the camp, and who had the best mare. This is their only education. They are neither taught to read the psalms as among the Maronites, nor the Koran like the Mahometans; hardly do the shaiks know how to write a letter. But if their minds be destitute of useful or agreeable information, at least it is not preoccupied by false and hurtful ideas; and, without doubt, such natural ignorance is well worth all our artificial folly. This advantage results from it, that their understandings being nearly on a level, the inequality of conditions is less perceptible. For, in fact, we do not perceive among the Druses that great distance which, in most other societies, degrades the inferior, without contributing to the advantage of the great. All, whether shaiks or peasants, treat each other with that rational familiarity, which is equally remote from rudeness and servility. The grand emir himself is not a different man from the rest: he is a good country gentleman, who does not disdain admitting to his table the meanest farmer. In a word, their manners are those of ancient times, and of that rustic life which marks the origin of every nation; and prove, that the people among whom they are still found are as yet only in the infancy of the social state."

DRUSIUS, John, a Protestant writer of great learning, born at Oudenarde in Flanders in 1555. He was designed for the study of divinity; but his father being outlawed, and deprived of his estate, they both retired to England, where the son became professor of the oriental languages at Oxford: but upon the pacification of Ghent, they returned to their own country, where Drusius was also appointed professor of the oriental languages. From thence he returned to Friesland, where he was admitted Hebrew professor in the university of Franeker; the functions of which he discharged with great honour till his death in 1616. His works show him to have been well skilled in Hebrew; and the states-general employed him in 1600 to write notes on the most difficult passages in the Old Testament, with a pension of 400 florins a-year: but being frequently disturbed in this undertaking, it was not published till after his death. He held a vast correspondence with the learned; for besides letters in Hebrew, Greek, and other languages, there were found 2300 Latin letters among his papers. He had a son John, who died in England at 21, and was a prodigy for his early acquisition of learning.

DRYADES, in the heathen theology, a sort of deities, or nymphs, which the ancients thought inhabited groves and woods. They differed from the Hamadryades; these latter being attached to some particular tree, with which they were born, and with which they died; whereas the Dryades were goddesses of trees and woods in general. See HAMADRYADES.

DRYANDER, Jonas, an eminent Swedish naturalist. See SUPPLEMENT.

DRYAS, in *Botany*, a genus of plants belonging to the icosandria class; and in the natural method ranking under the 35th order, *Senticosæ*. See BOTANY *Index*.

DRYDEN, John, one of the most eminent English poets of the 17th century, descended of a genteel family in Huntingdonshire, was born in that county at Oldwincle 1631, and educated at Westminster school under Dr Bushby. From thence he was removed to Cambridge in 1650, being elected scholar of Trinity college, of which he appears, by his *Epithalamia Cantabrigiens.* 4to, 1662, to have been afterwards a fellow. Yet in his earlier days he gave no extraordinary indication of genius: for even the year before he quitted the university, he wrote a poem on the death of Lord Hastings, which was by no means a presage of that amazing perfection in poetical powers which he afterwards possessed.

On the death of Oliver Cromwell he wrote some heroic stanzas to his memory; but on the Restoration, being desirous of ingratiating himself with the new court, he wrote first a poem entitled *Astræa Redux*, and afterwards a panegyric to the king on his coronation. In 1662, he addressed a poem to the lord chancellor Hyde, presented on New Year's day; and in the same year a satire on the Dutch. In 1668 appeared his *Annus Mirabilis*, which was a historical poem in celebration of the duke of York's victory over the Dutch. These pieces at length obtained him the favour of the crown; and Sir William Davenant dying the same year, Mr Dryden was appointed to succeed him as poet laureat. About this time also his inclination to write for the stage seems first to have shown itself. For besides his concern with Sir William Davenant in the alteration of Shakespeare's Tempest, in 1669 he produced his Wild Gallants, a comedy. This met with very indifferent success; yet the author, not being discouraged by its failure, soon published his Indian Emperor. This finding a more favourable reception, encouraged him to proceed; and that with such rapidity, that in the key to the duke of Buckingham's Rehearsal he is recorded to have engaged himself by contract for the writing of four plays per year; and, indeed, in the years 1679 and 1680 he appears to have fulfilled that contract. To this unhappy necessity that our author lay under, are to be attributed all those irregularities, those bombastic flights, and sometimes even puerile exuberances, for which he has been so severely criticised; and which, in the unavoidable hurry in which he wrote, it was impossible he should find time either for lopping away or correcting.

In 1675, the earl of Rochester, whose envious and malevolent disposition would not permit him to see growing merit meet with its due reward, and was therefore sincerely chagrined at the very just applause with which Mr Dryden's dramatic pieces had been received, was determined if possible to shake his interest at court; and succeeded so far as to recommend Mr Crowne, an author by no means of equal merit, and at that time of an obscure reputation, to write a mask for the court, which certainly belonged to Mr Dryden's office as poet laureat.—Nor was this the only attack, nor indeed the most potent one, that Mr Dryden's justly acquired fame drew on him. For, some years before, the duke of Buckingham, a man of not much better character than Lord Rochester, had most severely ridiculed several of our author's plays in his admired piece called the *Rehearsal.* But though the intrinsic wit which runs through that performance cannot even to this hour fail of exciting our laughter, yet at the same time it ought not to be the standard on which we should fix Mr Dryden's poetical reputation, if we consider, that the pieces there ridiculed are not any of those looked on as the *chef d'œuvres* of this author; that the very passages burlesqued are frequently, in their original places, much less ridiculous than when thus detached, like a rotten limb, from the body of the work; and exposed to view with additional distortions, and divested of that connexion with the other parts, which, while preserved, gave it not only symmetry but beauty; and, lastly, that the various inimitable beauties, which the critic has sunk in oblivion, are infinitely more numerous than the deformities which he has thus industriously brought forth to our more immediate inspection.

Mr Dryden, however, did not suffer these attacks to pass with impunity; for in 1679 there came out an Essay on Satire, said to be written jointly by that gentleman and the earl of Mulgrave, containing some very severe reflections on the earl of Rochester and the duchess of Portsmouth, who, it is not improbable, might be a joint instrument in the above-mentioned affront shown to Mr Dryden; and in 1681 he published his Absalom and Achitophel, in which the well-known character of Zimri, drawn for the duke of Buckingham, is certainly severe enough to repay all the ridicule thrown on him by that nobleman in the character of Bayes.—The resentment shown by the different peers was very different. Lord Rochester, who was a coward as well as a man of the most depraved morals, basely hired three ruffians to cudgel Dryden in a coffeehouse: but the duke of Buckingham, as we are told, in a more open manner, took the task upon himself: and at the same time presented him with a purse containing no very trifling sum of money: telling him, that he gave him the beating as a punishment for his impudence, but bestowed the gold on him as a reward for his wit.

In 1680 was published a translation of Ovid's Epistles in English verse by several hands, two of which, together with the preface, were by Mr Dryden: and in 1682 came out his *Religio Laici*, designed as a defence of revealed religion, against Deists, Papists, &c. Soon after the accession of King James II. our author changed his religion for that of the church of Rome, and wrote two pieces in vindication of the Romish tenets; viz. A Defence of the Papers written by the late king, found in his strong box; and the celebrated poem, afterwards answered by Lord Halifax, entitled, The Hind and the Panther.—By this extraordinary step he not only engaged himself in controversy, and incurred much censure and ridicule from his contemporary wits: but on the completion of the Revolution, being, on account of his newly-chosen religion, disqualified from bearing any office under the government, he was stripped of the laurel, which, to his still greater mortification, was bestowed on Richard Flecknoe, a man to whom he had a most settled aversion. This circumstance occasioned his writing the very severe poem called *Mac Flecknoe.*

Mr Dryden's circumstances had never been affluent; but being now deprived of this little support, he found himself reduced to the necessity of writing for mere bread. We consequently find him from this period engaged in works of labour as well as genius, viz. in translating the works of others, and to this necessity perhaps our nation stands indebted for some of the best translations extant. In the year he lost the laurel, he published the life of St Francis Xavier from the French. In 1693 came out a translation of Juvenal and Persius; in the first of which he had a considerable hand, and of the latter the entire execution. In 1695 was published his prose version of Fresnoy's Art of Painting; and the year 1697 gave the world that translation of Virgil's works entire, which still does, and perhaps ever will, stand foremost among the attempts made on that author. The petite pieces of this eminent writer, such as prologues, epilogues, epitaphs, elegies, songs, &c. are too numerous to specify here, and too much dispersed to direct the reader to. The greatest part of them, however, are to be found in a collection of miscellanies in 6 vols. 12mo. His last work is what is called his *Fables*, which consists of many of the most interesting stories in Homer, Ovid, Boccace, and Chaucer, translated or modernized in the most elegant and poetical manner; together with some original pieces, among which is that amazing ode on St Cecilia's day, which, though written in the very decline of the author's life, and at a period when old age and distress conspired as it were to damp his poetic ardour, and clip the wings of fancy, yet possesses so much of both, as would be sufficient to have rendered him immortal had he never written a single line besides.

Dryden married the lady Elizabeth Howard, sister to the earl of Berkshire, who survived him eight years; though for the last four of them she was a lunatic, having been deprived of her senses by a nervous fever.—By this lady he had three sons; Charles, John, and Henry. Of the eldest of these there is a circumstance related by Charles Wilson, Esq. in his life of Congreve, which seems so well attested, and is itself of so very extraordinary a nature, that we cannot avoid giving it a place here. Dryden, with all his understanding, was weak enough to be fond of judicial astrology, and used to calculate the nativity of his children. When his lady was in labour with his son Charles, he being told it was decent to withdraw, laid his watch on the table, begging one of the ladies then present, in a most solemn manner, to take exact notice of the very

very minute that the child was born; which she did, and acquainted him with it. About a week after, when his lady was pretty well recovered, Mr Dryden took occasion to tell her that he had been calculating the child's nativity; and observed with grief, that he was born in an evil hour; for Jupiter, Venns, and the Sun, were all under the earth, and the lord of his ascendant afflicted with a hateful square of Mars and Saturn. "If he lives to arrive at the 8th year," says he, "he will go near to die a violent death on his very birthday; but if he should escape, as I see but small hopes, he will in the 23d year be under the very same evil direction; and if he should escape that also, the 33d or 34th year is, I fear"—. Here he was interrupted by the immoderate grief of his lady, who could no longer hear calamity prophesied to befal her son. The time at last came, and August was the inauspicious month in which young Dryden was to enter into the eighth year of his age. The court being in progress, and Mr Dryden at leisure, he was invited to the country seat of the earl of Berkshire, his brother-in-law, to keep the long vacation with him at Charlton in Wilts; his lady was invited to her uncle Mordaunt's to pass the remainder of the summer. When they came to divide the children, Lady Elizabeth would have him take John, and suffer her to take Charles: but Mr Dryden was too absolute, and they parted in anger; he took Charles with him, and she was obliged to be content with John. When the fatal day came, the anxiety of the lady's spirits occasioned such an agitation, as threw her into a violent fever, and her life was despaired of, till a letter came from Mr Dryden, reproving her for her womanish credulity, and assuring her that her child was well; which recovered her spirits, and in six weeks after she received an ecclaircissement of the whole affair. Mr Dryden, either through fear of being reckoned superstitious, or thinking it a science beneath his study, was extremely cautious of letting any one know that he was a dealer in astrology; therefore could not excuse his absence, on his son's anniversary, from a general hunting match which Lord Berkshire had made, to which all the adjacent gentlemen were invited. When he went out, he took care to set the boy a double exercise in the Latin tongue, which he taught his children himself, with a strict charge not to stir out of the room till his return; well knowing the task he had set him would take up longer time. Charles was performing his duty, in obedience to his father; but, as ill fate would have it, the stag made towards the house; and the noise alarming the servants, they hastened out to see the sport. One of them took young Dryden by the hand, and led him out to see it also; when, just as they came to the gate, the stag being at bay with the dogs, made a bold push, and leaped over the court wall, which was very low, and very old; and the dogs following, threw down a part of the wall 10 yards in length, under which Charles Dryden lay buried. He was immediately dug out; and after six weeks languishing in a dangerous way, he recovered, So far Dryden's prediction was fulfiled. In the 23d year of his age, Charles fell from the top of an old tower belonging to the Vatican at Rome, occasioned by a swimming in the head with which he was seized, the heat of the day being excessive. He again recovered, but was ever after in a languishing sickly state. In the 33d year of his age, being returned to England, he was unhappily drowned at Windsor. He had with another gentleman swam twice over the Thames; but returning a third time, it was supposed he was taken with the cramp, because he called out for help, though too late. Thus the father's calculation proved but too prophetical.

At last, after a long life, harassed with the most laborious of all fatigues, viz. that of the mind, and continually made anxious by distress and difficulty, our author departed this life on the first of May 1701.—The day after Mr Dryden's death, the dean of Westminster sent word to Mr Dryden's widow, that he would make a present of the ground and all other abbey fees for the funeral: and Lord Halifax likewise sent to the lady Elizabeth, and to Mr Charles Dryden, offering to defray the expences of our poet's funeral, and afterwards to bestow 500l. on a monument in the abbey; which generous offer was accepted. Accordingly, on Sunday following, the company being assembled, the corpse was put into a velvet herse, attended by 18 mourning coaches. When they were just ready to move, Lord Jeffreys, son of Lord Chancellor Jeffreys, a name dedicated to infamy, with some of his rakish companions, riding by, asked whose funeral it was; and being told it was Mr Dryden's, he protested he should not be buried in that private manner; that he would himself, with the lady Elizabeth's leave, have the honour of the interment, and would bestow 1000l. on a monument in the abbey for him. This put a stop to their procession: and the lord Jeffreys, with several of the gentlemen who had alighted from their coaches, went up stairs to the lady, who was sick in bed. His lordship repeated the purport of what he had said below; but the lady Elizabeth refusing her consent, he fell on his knees, vowing never to rise till his request was granted. The lady under a sudden surprise fainted away: and Lord Jeffreys, pretending to have obtained her consent, ordered the body to be carried to Mr Russel's an undertaker in Cheapside, and to be left there till further orders. In the mean time the abbey was lighted up, the ground opened, the choir attending, and the bishop waiting some hours to no purpose for the corpse. The next day Mr Charles Dryden waited on the lord Halifax and the bishop; and endeavoured to excuse his mother, by relating the truth. Three days after, the undertaker having received no orders, waited on the lord Jeffreys; who pretended that it was a drunken frolic, that he remembered nothing of the matter, and he might do what he pleased with the body. Upon this the undertaker waited upon the lady Elizabeth, who desired a day's respite, which was granted. Mr Charles Dryden immediately wrote to the lord Jeffreys. who returned for answer, that he knew nothing of the matter, and would be troubled no more about it. Mr Dryden, hereupon applied again to Lord Halifax and the bishop of Rochester, who absolutely refused to do any thing in the affair.

In this distress, Dr Garth, who had been Mr Dryden's intimate friend, sent for the corpse to the college of physicians, and proposed a subscription; which succeeding, about three weeks after Mr Dryden's decease, Dr Garth pronounced a fine Latin oration over the body, which was conveyed from the college, attended by a numerous train of coaches, to Westminster abbey, but in very great disorder. At last the corpse arrived at the abbey, which was all unlighted. No organ played, no anthem sung: only two of the singing boys preceded the corpse, who sung an ode of Horace, with each a small candle in their hand. When the funeral was over, Mr Charles Dryden sent a challenge to Lord Jeffreys: who refusing to answer it, he sent several others, and went often himself; but could neither get a letter delivered, nor admittance to speak to him: which so incensed him, that finding his lordship refused to answer him like a gentleman, he resolved to watch an opportunity, and brave him to fight, though with all the rules of honour; which his lordship hearing, quitted the town, and Mr Charles never had an opportunity to meet him, though he sought it to his death with the utmost application.

Mr Dryden had no monument erected to him for several years; to which Mr Pope alludes in his epitaph intended for Mr Row, in this line,

> Beneath a rude and nameless stone he lies.

In a note upon which we are informed that the tomb of Mr Dryden was erected upon this hint by Sheffield duke of Buckingham, to which was originally intended this epitaph:

> This *Sheffield* rais'd—The sacred dust below
> Was *Dryden* once; the rest, who does not know?

Which was since changed into the plain inscription now upon it, viz.

J. DRYDEN,
Natus Aug. 9. 1631.
Mortuus Maii 1. 1701.
Johannes Sheffield, dux Buckinghamiensis, fecit.

Mr Dryden's character has been very differently drawn by different hands, some of which have exalted it to the highest degree of commendation, and others debased it by the severest censure.—The latter, however, we must charge to that strong spirit of party which prevailed during great part of Dryden's time, and ought therefore to be taken with great allowances. Were we indeed to form a judgment of the author from some of his dramatic writings, we should perhaps be apt to conclude him a man of the most licentious morals; many of his comedies containing a great share of looseness, even extending to obscenity: But if we consider, that, as the poet tells us,

> Those who live to please, must please to live;

if we then look back to the scandalous license of the age he lived in, the indigence which at times he underwent, and the necessity he consequently lay under of complying with the public taste, however depraved; we shall not refuse our pardon to the compelled writer, nor our credit to his contemporaries, who have assured us there was nothing remarkably vicious in his character.

From some parts of his history he appears unsteady, and to have too readily temporized with the several revolutions in church and state. This however might in some measure have been owing to that natural timidity and diffidence in his disposition, which almost all the writers seem to agree in his possessing. Congreve, whose authority cannot be suspected, has given us such an account of him, as makes him appear no less amiable in his private character as a man, than he was illustrious in his public one as a poet. In the former light, according to that gentleman, he was humane, compassionate, forgiving, and sincerely friendly: of an extensive reading, a tenacious memory, and a ready communication: gentle in the correction of the writings of others, and patient under the reprehension of his own deficiencies: easy of access himself, but slow and diffident in his advances to others; and of all men the most modest and the most easy to be discountenanced in his approaches either to his superiors or his equals. As to his writings, he is perhaps the happiest in the harmony of his numbers, of any poet who ever lived either before or since his time, not even Mr Pope himself excepted. His imagination is ever warm, his images noble, his descriptions beautiful, and his sentiments just and becoming. In his prose he is poetical without bombast, concise without pedantry, and clear without prolixity. His dramatic have, perhaps, the least merit of all his writings. Yet there are many of them which are truly excellent; though he himself tells us that he never wrote any thing in that way to please himself but his *All for Love*. This last, indeed, and his *Spanish Friar*, may be reckoned two of the best plays in our language.

DRYPIS, a genus of plants belonging to the pentandria class; and in the natural method ranking under the 22d order, *Caryophyllei*. See BOTANY *Index*.

DRY-ROT, a destructive disease in timber. See SUPPLEMENT.

DUBLIN, the metropolis of Ireland, the second city in his majesty's dominions, and esteemed the fifth for magnitude in Europe, is situated in the province of Leinster, in the county of Dublin, at the bottom of a large bay. The river Liffey, which here falls into the ocean, divides the town into two nearly equal parts. Formerly the city of Dublin was confined to the south side of the river. It was a place of great antiquity. Ptolemy, who flourished in the reign of Antoninus Pius, about the year 140, says, it was anciently called *Aschcled*. In 155, Alpinus, whose daughter Auliana was drowned in the Liffey, changed the name from *Aschcled* to *Auliana*. It was afterwards named *Dublana*, and Ptolemy calls it *Eblana*. *Dublana*, whence comes *Dublinum* and *Dublin*, is evidently derived from *Dub-leana*, "the place of the black harbour or lake," or rather "the lake of the sea," the bay of Dublin being frequently so called. This city has had a variety of names. The Irish call it *Drum-choll-coil*, "the brow of a hazel wood;" and in 181, Eogan king of Munster being on a royal tour, paid a visit to this place, which was then called *Atha Cliath Dubh-Line*, "the passage of the ford of hurdles over the black pool:" the harbour of Dublin was likewise known by the name of *Lean-Cliath*, or *Leam-Cliath*, from *Lean* or *Leam*, "a harbour;" and from *Cliath* or *Cliabb*, which literally signifies "a hurdle or any thing made of wicker work;" it also signified certain wears formed with hurdles, and placed in rivers and bays by the ancient Irish for the purpose of taking fish: whence any river, or bay, wherein these wears were fixed had the name of *Cliath* or *Cliab*, annexed to it, to signify the establishment of a fishery. Dublin, therefore, being originally built on or near one of these harbours, Dublin.

harbours, was anciently called *Baly-lean-Cliath*, that is, "the town on the fishing harbour." It is described at the present day in the Irish language by the appellations of *Ath-Cliath*, "the ford of hurdles," and *Bally-ath-Cliath*, "the town of the ford of hurdles," the inhabitants having formerly had access to the river by hurdles laid on the low marshy grounds adjoining the water: and this name was also extended to the north side of the river, from a temporary bridge of hurdles thrown over the Anna Liffey, a corruption of *Auin Louiffa*, or "the swift river," so termed from the rapidity of the mountain floods. This side was enlarged by Mac Turkill the Danish prince, who, notwithstanding, fixed his habitation on the south side, and abandoned the northern town; which, from the original country of the invaders, was called *Eastmantown*, since corrupted to *Oxmantown*. King Edgar, in the preface to his charter dated 964, mentions Ireland with its most noble city (*nobilissima civitas*) of *Dublin*. By the Fingalians it is called *Divelin*, and by the Welch *Dinas Dulin*, or *the city of Dulin*.

In 448, Alpin Mac Eachard, king of Dublin, and all his subjects, were converted to Christianity by St Patrick.

In the year 498, the Ostmen or Danes having entered the Liffey with a fleet of 60 sail, made themselves masters of Dublin and the adjacent country, and soon after environed the city with walls. About 1170 Dermot Mac Murrough, king of Leinster, having quarrelled with the other princes of the kingdom, a confederacy was formed against him by Roderick O'Conor, monarch of Ireland. Dermot applied to Henry II. king of England, who sent over a number of English adventurers, by whose assistance he was reinstated in his dominions; and in the year 1171, the descendants of the Danes still continuing to hold possession of Dublin, it was besieged and taken by a powerful party of the English under Raymond le Gros. Mac Turkill the Danish king escaped to his shipping: he returned, however, soon after with a strong fleet to recover the city, but was killed in the attempt, and in him ended the race of easterling princes in Ireland.

In 1172, Henry II. landed at Waterford, and obtained from Richard Earl Strongbow (who married the daughter of Dermot Mac Murrough, and by compact was his successor) a surrender of the city of Dublin, where he built a pavilion of wicker work near St Andrew's church, then situated where Castlemarket lately stood, and there entertained several Irish princes, who voluntarily submitted to him on condition of being governed by the same laws as the people of England. Henry also held a parliament here. In 1173 he granted his first charter to Dublin, and by divers privileges encouraged a colony from Bristol to settle here.

In 1210, upwards of 20 Irish princes swore allegiance to King John at Dublin; engaging to establish the English laws and customs in the kingdom; and in the same year courts of judicature were instituted. In 1216, magna charta was granted to the Irish by Henry III. an entry of which was made in the red book of the exchequer at Dublin. In 1217, the city was granted to the citizens in fee-farm at 200 marks per annum; and in 1227 the above monarch ordained that the charter granted by King John should be kept inviolably. In 1404, the statutes of Kilkenny and Dublin were confirmed in a parliament held at this city under the earl of Ormond. The charter of the city of Dublin was renewed in 1609 by James I.

Dublin.

The civil government of the city was anciently under the management of a provost and bailiffs; in 1308, John le Decer was appointed the first provost, and Richard de St Olave and John Stakebold bailiffs. In 1409, the title of the chief magistrate was changed to that of mayor, when Thomas Cusack was appointed to the office, Richard Bove and Thomas Shortall being bailiffs; the office of bailiffs was changed to sheriffs in 1547. In 1660, Charles II. gave a collar of SS. and a company of foot guards to the mayor; and in 1665, this monarch conferred the title of lord mayor on the chief magistrate, to whom he also granted 500l. per annum in lieu of the foot company. Sir Daniel Bellingham was the first lord mayor of Dublin; Charles Lovet and John Quelsh were sheriffs the same year. In 1672, Arthur earl of Essex introduced new rules for the better government of the city; and in 1683 the Tholsel was built for the purpose of the magistrates meeting to hold their courts, assemblies, &c.

In the 10th century, after the fortifications of Dublin were repaired by the Ostmen, the walls of the city, including those of the castle, did not occupy more than an Irish mile; they extended from Winetavern gate to Audeon's arch, and were continued from thence to where Newgate formerly stood; and from a plan published by John Speed in 1610, it appears that they were continued to Ormond's gate, or, as it has been since called, *Wormwood gate*; from thence to the old bridge, and along the banks of the river to a very large portal called *Newman's tower*, nearly in the present site of the south entrance of Essex bridge; and from Newman's tower in an angular direction to Dame's gate, at the west end of Dame's street. From the gate at the south-west angle of the castle the wall ran to Nicholas gate, and was continued from thence to Newgate. The principal streets without the walls were, on the west, New row, Francis street, Thomas street, and James's street; on the south were Patrick street, Bride street, and Ship street; and on the east, Dame street, George's lane, and Stephen street. That space of ground now occupied by Crane lane, Temple bar, Fleet street, Lazar's hill, or as it is now called *South Townsend street*, Crampton, Aston's, George's, and Sir John Rogerson's quays, &c. was then overflowed by the Liffey. On the north side of the river there were only Church street, Mary's lane, Hammond lane, and Pill lane, then built but on one side as far as Mary's abbey, which terminated the extent of that part of the town to the eastward; Grange Gorman, Stoney-batter, now called *Manor street*, and Glassmanogue, were then villages at some distance from the city; and at the latter the sheriffs have held their courts in times of the plague, as being remote from the stage of infection. In 1664, the inhabitants being numbered amounted to 2565 men and 2986 women, Protestants; and 1202 men and 1406 women, Roman Catholics; making in the whole 8159.

By comparing this account of the ancient state and boundaries of the metropolis with the following description of its present extent, population, and magnificence, an idea will be readily formed of the amazing increase and improvement it has experienced within the course of a century.

Dublin is seated in view of the sea on the east, and a fine country which swells into gently-rising eminences on the north and west, while it towers boldly up in lofty mountains that bound the horizon on the south. The city itself cannot be seen to full advantage on entering the harbour: but the approach to it from thence exhibits a fine prospect of the country for improvement and cultivation, interspersed with numerous villas, that have a most agreeable effect to enliven this delightful scene, which, beginning at the water's edge, is continued all over the coast to the northward of the bay as far as the eye can reach, and is finely contrasted by a distant view of the Wicklow mountains to the south, where the conical hills, called the *Sugar Loaves*, contribute not a little, by the singularity of their appearance, to embellish the landscape, so extensive and picturesque as not to be equalled by any natural scenery in Europe, but the entrance of the bay of Naples, to which it bears a very striking resemblance.

The form of Dublin is nearly square, a figure that includes the largest area proportioned to its circumference. From the royal hospital at Kilmainham, at the western extremity of the town, to the east end of Townsend street, the length is two miles and a half, and its greatest breadth is computed to be of the same extent: hence the city is about 10 miles in circumference. Its increase within the last thirty years has been amazing. It contains 16,458 houses, and 187,939 inhabitants.

Dublin, with respect to its streets, bears a near resemblance to London. Some of the old streets were formerly narrow: but this defect is now in a great measure remedied by an act of parliament, passed in 1774, for opening the public avenues, taking down sign posts, palisades, pent-houses, &c. new paving the streets, and flagging the foot passages: and, in 1785, another act passed for the better paving, cleansing, and lighting the city. Still greater improvements have been made in the essential points of paving, lighting, and cleansing, since 1806. Those necessary improvements contribute exceedingly to the beauty and convenience of the metropolis: the new streets are wide and commodious, the houses lofty, uniform, and elegant; nor are several of the old streets totally deficient in these respects; Sackville street, or the Mall, which, though built many years ago, has been included in the number of our new streets by the late geographers (a self-evident proof that these writers had not even seen the city), is a noble avenue, with a gravel walk in the centre, enclosed by a wall of about three feet high; this walk is 36 feet and a half broad, and the distance between it and the palisades fronting the houses, on either side, is 42 feet and a half. The new customhouse, a building universally admired for its beauty, has rendered this a most desirable situation for wholesale merchants, not only on account of its proximity to that building, but its great depth in the rear. Some years ago, it was esteemed one of the finest public avenues in Europe: many of the new streets, however, in this city are now much superior to it in the magnificence and uniformity of the houses. Among these, on the north side of the river, in the same quarter with Sackville street, are Gardiner's row, North Great George's street, Cranby row, Cavendish row, and Palace row; the last three form a superb square, having the garden of the lying-in hospital in the centre: the old wall that encompassed the garden has been taken down: there is now a full view of this delightful spot surrounded with iron palisades, and upwards of 100 globes with double burners disposed at equal distances, which added to the globes from the surrounding houses, have a most brilliant effect. This square, which for its size, is not perhaps to be equalled, has received the name of Rutland square, in compliment to his grace the duke of Rutland, who contributed munificently towards the improvements in the enclosure of the new garden, and the erecting an elegant edifice for a ball and supper rooms, situated to the east of the hospital. In Sackville street is Nelson's pillar, a fluted column 130 feet high.

Among the new streets and buildings on the south side of the river, those wherein persons of distinction reside, lie chiefly to the eastward of the college and Stephen's green; which last, though it does not rank with the new buildings, possesses much grandeur and elegance, being one of the largest squares in Europe: it is an English mile in circumference, surrounded by a gravel walk planted on each side with trees; within this walk is a smooth level meadow, having in the centre an equestrian statue of the late king: there are several fine edifices, though almost all differing in the style of their architecture; this variety, however, is esteemed by many rather a beauty than a defect: but, besides the other streets and buildings in this quarter, there is a new square nearly as extensive as Stephen's green, called *Merion square;* it was laid out some years ago by the late Lord Fitzwilliam: the houses on the north side are uniform and lofty; most of them being carried up with hewn stone to the first story, gives the whole an air of strength, beauty, and magnificence. At the south-west angle of Stephen's green, a new street has been also opened, called *Harcourt street*, in which are several elegant structures that merit notice, particularly the town residence of the right honourable Lord Earlsford. A variety of other public buildings have been erected since the union. The Dublin penitentiary, begun in 1813, cost 40,000l.; the Richmond lunatic asylum, finished in 1815, cost 28,000l.; and the post-office, begun in 1815, and which was estimated to cost 50,000l.

The principal entrance to the walks of Stephen's green is on the west side opposite the end of York-street (which may properly be classed among the new streets), as all the old houses have been pulled down and modern buildings erected in their room. Those parts of the city inhabited by merchants and traders begin to wear a new face; and amongst this number the new buildings of Dame street on the south side, exhibit an extensive, uniform, and beautiful range of houses all of an equal height; the shop doors and windows are formed by arches, exactly similar in their construction and ornaments, which are simply elegant. When the other side of this street shall be rebuilt, it may be justly pronounced one of the first trading streets in Europe; and Parliament street, which was built some years ago, is now nearly equal to any trading street in London.

The river Liffey, being banked in through the whole length of the town, exhibits spacious and beautiful quays, where vessels below the bridges load and unload before the merchants doors and warehouses: it is navigable as far as a bridge near the west end of the custom-house. This bridge, which is a very elegant structure, was built since the year 1790. Essex bridge was first built in 1681, and took its name from the unfortunate earl of Essex, then viceroy of Ireland. It was taken down in 1753, and rebuilt in an elegant form, after the model of Westminster bridge, but much better proportioned, and on a more secure foundation. It has five arches, the buttresses between which support semicircular niches that project from the parapet; there are balustrades between these niches, and continued to the ends of the bridge, which is commodiously flagged for foot passengers; the whole constructed with hewn stone in a very fine taste. There are five bridges besides the two already mentioned; three of which have nothing to recommend them, further than the antiquity of the Old bridge, which was erected in this city at a very early period, when it had the name of *Dublin Bridge;* it was rebuilt in 1428, since which time it received its present title. Bloody bridge, built in 1671, was originally constructed with wood, and derives its present harsh appellation from an attempt to break it down, wherein four persons were killed. Ormond bridge was built in 1684, during the Ormond administration. Arran bridge, now called *Queen's bridge*, was erected in the same year; but, being destroyed by the floods in 1763, was rebuilt of hewn stone, and finished in 1768. It consists of three arches, with flagged foot passages, stone balustrades and ornamental decorations, in a handsome light style, which has been much admired. Richmond bridge, which was begun in 1813, was opened to the public in 1816. It is 52 feet broad, and 220 long, and cost 25,800l. Between this bridge and Essex bridge, an iron bridge for foot passengers was opened in 1816. It is 140 feet long, 12 feet broad, and cost 3000l. The foundation of Whitworth bridge was laid in 1816, in place of the one formerly known under the names of the Old bridge, Dublin bridge, and Ormond bridge, which was carried away in 1802.

This city has 2 cathedrals, 19 parish churches, several chapels of ease, 26 Roman Catholic chapels, 6 meeting houses for Presbyterians, 1 for Anabaptists, 4 for Methodists, 2 for Quakers, a church for French Calvinists, a Danish and a Dutch church, and a Jewish synagogue.

Christ church, or the Holy Trinity, built in 1038 by Donat bishop of Dublin, to whom Sitricus the son of Amlave king of the Ostmen of Dublin granted the site for that purpose, stands on the summit of the rising ground at the head of Winetavern street. It is a venerable Gothic pile; and its present appearance evinces its antiquity. St Patrick's cathedral, first built by Archbishop Comyn in 1190, and decorated by Archbishop Minot in 1370 with a steeple, on which a lofty spire was erected in 1750, is also a fine Gothic structure; it stands on the east side of Patrick's street; the monuments here are more numerous than in Christ church; and the steeple is the highest in the city.

St Werburgh's church was originally built in a very early age. In 1301, when a great part of the city was consumed by an accidental fire, this church suffered in the conflagration: it was burnt a second time in 1754, and repaired in its present beautiful form in 1759. The front and steeple are admired for their elegance, lightness, and symmetry: the spire is a fine octagon supported by eight pillars; and a gilt ball terminates the whole, being 160 feet from the ground. Catherine's church, first built in 1105, and re-edified in its present form in 1769, is situated on the south side of Thomas's street. St Thomas's church is the latest foundation of the kind in this city, having been begun in the year 1758, and finished and consecrated in 1762. It is situated on the west side of Marlborough street, opposite Gloucester street, to which it forms an elegant termination. The other churches in this city are; on the north side of the river, Mary's, Michan's, and Paul's; on the south side, James's, Luke's, Kevin's, Peter's, Bride's, Nicholas within, Audeon's, Michael's, Mark's, Anne's, John's, and Andrew's: this last is called also the *Round church*, from its form being exactly circular: most, if not all the others were built in an early age: many, however, have been since re-edified, and assumed a more modern form; some of these are not totally devoid of elegance, particularly Anne's. St John's in Fishamble street was rebuilt in 1773, and has now a handsome front of hewn stone decorated with columns supporting a pediment. Besides these churches, Dublin is adorned with several other public buildings; the most remarkable of which are the following: The castle, the residence of the chief governor, built in 1213 by Henry de Londres, was formerly moated and flanked with towers; but the ditch has been long since filled up, and the old buildings razed, the chapel and wardrobe tower excepted, which still remain: Birmingham tower was rebuilt in 1777, and is now called *Harcourt tower*. The castle at present consists of two courts, the principal of which is an oblong square formed by four ranges of building: within a few years, in the middle of the south range, a handsome edifice called *Bedford tower* has been erected; the front is decorated with a small arcade of three arches, over which is a colonnade supporting a pediment, from whence rises an octagon steeple crowned with a small cupola and gilt ball in a light pleasing style. This tower, which fronts the entrance to the viceroy's apartments, is connected with the buildings on each side by two fine gates; over that on the right hand is a statue of Fortitude; and over the left gate, which is the grand portal to the upper court, is the statue of Justice. In the lower court are the treasury and other offices, with military stores, an arsenal and armory for 40,000 men, and a barrack in which a captain's detachment of infantry are stationed. Between this barrack and the arsenal is the castle garden; opposite to which, at the rear of the lord lieutenant's apartments, is a range of building called the *Garden front*, erected about the year 1740, finished in mountain stone, ornamented by semicolumns of the Ionic order, and the windows embellished with cornices and architraves, in a fine taste. The hall room is now titled *St Patrick's Hall*. The viceroy's body guard consists of a captain, two subalterns, and sixty private men, with a subaltern's guard of horse. The parliament

ment house, a most superb structure, is situated on the north side of College green; it was begun in 1729, finished in 10 years, and cost 40,000l. It is built with Portland stone, and the front formed by a grand portico of Ionic columns in the most finished style of architectural elegance: the internal parts correspond with its outward magnificence; and the manner in which the inside is lighted is universally admired. The house of commons is an octagon, covered with a dome supported by columns of the Ionic order, that rise from an amphitheatrical gallery balustraded with iron scroll-work; this room is admirably well adapted to its purpose. The house of lords is an oblong room, spacious and lofty, and ornamented in a superb manner; it is also judiciously adapted for the reception of the august assembly which formerly met there; among other decorations are two very fine pieces of tapestry, representing the battle of the Boyne and siege of Derry. Since the union of Ireland with Great Britain, this building being no longer necessary as a place of meeting for the Irish legislative body, has been converted into apartments for the national bank.

The college founded by Queen Elizabeth in 1591 is situated at the east end of College green. It is a most beautiful structure, consisting of two spacious squares, the first of which contains the refectory, the old hall and chapel, and the new theatre for lectures and examinations; the front of this last building is finely decorated with Corinthian columns supporting a pediment; and over the front of the old hall, on the east side of this square, a handsome steeple rises crowned with a cupola. In the other square, which consists partly of brick buildings for the students, there is a superb library, extending through its whole length on the south side: behind this square there is a fine park. The west side of the first square, which is built with Portland stone, forms the grand front, upwards of 300 feet in length, ornamented with Corinthian pillars and other decorations in a very fine taste. At a small distance to the south side of this front is an elegant edifice in which the provost resides. The printing office is a neat handsome structure on the north side of the park; and opposite to it is the anatomy house, in which are to be seen the celebrated wax models of the human figure, executed at Paris by M. Douane, purchased by the right honourable the earl of Shelburne, and presented to this university. The college of Dublin is an university in itself, consisting of a provost, vice provost, 7 senior and 15 junior fellows, and 17 scholars of the house; the number of students in 1817 was 1230: it has also professors in divinity, common and civil law, physic, Greek, modern languages, mathematics, oriental tongues, history and oratory, modern history, natural philosophy, anatomy and surgery, chemistry and botany. To accommodate the increasing number of students at the university, it has been found necessary to erect a new and extensive range of apartments, on the south side of the New Square, which had not before been completed. This wing forms a new front to the college, 270 feet in length.

The Royal Exchange, situated on Cork hill, was begun in 1769, and opened for business in 1779; the expence, amounting to 40,000l. being defrayed by lottery schemes, conducted by the merchants of Dublin with an integrity that did them honour. The building is nearly a square, having three fronts of Portland stone in the Corinthian order, and crowned in the midst with a fine dome, which is supported on the inside by 12 Composite fluted pillars that form a circular walk in the centre of the ambulatory: above these pillars are 12 circular windows, and the ceiling of the dome, which is ornamented with stucco, in the mosaic style, has also a large window in the middle that illuminates most of the building. Opposite the north entrance, in the circular walk, is a statue of his late majesty George III. in a Roman military habit; it is executed in bronze by Van Nost, and elevated on a white marble pedestal. In a niche on the staircase leading to the coffee room is a white marble statue of the late Dr Charles Lucas, executed by Smith. The north front, which commands a fine view of Parliament street and Essex bridge, is embellished by a range of six columns and their correspondent pilasters, supporting a grand pediment with a balustrade on each side: a flight of stone steps leads from the street to the entrance, which is by three fine iron-railed gates: the west front varies but little from the north, except in the want of a pediment, and having only three steps ascending to the entrance, the ground on that side being nearly on a level; this front is opposite the east end of Castle street, near the principal entrance to the castle.

The hospital for lying-in women, founded by Dr Bartholomew Mosse, and opened in 1757, stands on the north side of Great-Britain street. The building is extremely light and elegant; a beautiful steeple rises in the centre, and the wings are formed by simicircular colonnades on each side. Adjoining the east colonnade is the Rotunda, where balls and assemblies are held, and concerts performed, for the benefit of the charity: close to it are erected the grand suit of apartments before mentioned. The garden at the rear of the hospital is laid out in a good taste.

The Blue-coat hospital was founded on the west side of Queen street by Charles II. in 1670, for educating the children of reduced freemen of the city: but the original building being greatly decayed, was taken down, and the new Blue-coat hospital, situated in Oxmantown green, was begun in 1773. The front is enriched by four Ionic columns, supporting a pediment in the centre, over which the steeple rises, embellished with Corinthian and Composite columns in an admired taste. Connected with the front by circular walls ornamented with balustrades and niches, are the school on one side and the church on the other: these form two well-proportioned wings; they are of a similar construction; and each is crowned with a small steeple or turret, corresponding with the rest in uniform harmony and beauty.

The Barracks, the foundation of which was laid in 1704, are esteemed the largest and most commodious in Europe. They consist of four squares, situated at the west end of the town, on the north side of the river. The royal square in the centre, with the horse barrack and the little square on each side, form a spacious and extensive front to the south: the palatine, now called the new square, is opposite to Oxmantown green; it has been lately rebuilt with hewn stone in a very elegant manner.

The royal hospital at Kilmainham for the support of invalids of the Irish army was founded by King Charles II. on a plan similar to that of Chelsea in England. The building was completed in 1683, and cost upwards of 23,500l. It is situated at the west end of the town, on a rising ground near the south side of the river, from whence there is an easy ascent to it through several rows of tall trees. This edifice is of a quadrangular form, enclosing a specious area handsomely laid out in grass plots and gravelled walks: an arcade is carried along the lower story in each square to the entrance of the hall and chapel, which are both curiously decorated; in the former are several whole-length portraits of royal personages and other distinguished characters.

Dr Stevens's Hospital, the foundation of which was laid in 1720, is a neat quadrangular building, pleasantly situated on the banks of the river near the west end of James's street, from whence a gravelled walk leads by a gentle descent to the entrance of the hospital, and is continued from thence to the water's edge.

The Linen Hall, at the north end of Linen Hall street, which was opened at the public expence in 1728, for the reception of linen cloths brought to the Dublin market, is a handsome building, lately enlarged with treble its number of former rooms, which furnish a new proof of commercial prosperity.

The New Prison in Green street, the first stone of which was laid in 1773, is a large quadrangular structure, designed and executed under the direction of the late Mr Cooley. The east front consists of a centre break of mountain stone rusticated and crowned by a pediment, with a plain façade of black limestone on each side; and at the external angles of the building are four round towers.

There are many other public edifices in this city and its environs which merit particular notice. The Hospital for Lunatics in West Bow lane, founded by Dean Swift, and opened in 1757; the Hibernian school in the Phœnix Park, and the Marine School on Sir John Rogerson's Quay, the first for educating the poor children of soldiers, and the other for bringing up to the sea service the sons of deceased or disabled seamen; the Hospital for Incurables in South Townsend street; Mercer's Hospital in Stephen street; the Meath Hospital on the Coombe; and Simpson's Hospital in Great-Britain street, the last of which was established for the reception of blind and gouty men; are all handsome edifices constructed of hewn stone in the modern style.

To these public buildings may be added St Nicholas's Hospital in Francis street; the Infirmary for sick and wounded soldiers of the army, and the Foundling Hospital in James's street; the Magdalen Asylum in Leeson street; and the House of Industry in Channel row; the halls for corporations (particularly the Weavers Hall on the Coombe, over the entrance of which is a statue of his late majesty George II.); the Tholsel; the old Four Courts; the old Customhouse; and several others. The Charitable Infirmary, which was first opened in 1728 and rebuilt in 1741, stood on the Inn's Quay, but has lately been pulled down, together with most of the houses on that quay, where the new courts of justice are to be erected; and the benefits of this humane institution are now dispensed to the public at a house taken for that purpose in Jervis street.

Dublin.

The new courts of justice, on the north side of the river, form a principal ornament to the metropolis, and are from a design of Mr Gandon's, as well as the new customhouse on the north wall. The front of the latter extends 375 feet, enriched with arcades and columns of the Doric order, crowned with an entablature: the centre has a portico finished with a pediment, in which is a bas relief of emblematical figures alluding to commerce: over the pediment is an attic story; and a magnificent dome finishes the centre, whereon is a pedestal supporting a statue of Commerce; the key stones over the entrances and in the centre of the pavilions are decorated with emblematical heads representing the produce of the principal rivers of Ireland: the south or front to the river, with the arms of Ireland over each pavilion, is of Portland stone: the whole, being formed of large and striking parts, adds much to the picturesque scene of the river, and will remain a lasting monument of reputation to the several artists employed in this superb building.

The playhouses, considered as public buildings, have nothing to recommend them to notice. One only, viz. the old house, now the theatre-royal, in Smock-alley, is kept open by Mr Daly; who, in consequence of a bill passed in the Irish parliament for the regulation of the stage, enjoys the exclusive privilege of managing and directing the theatrical exhibitions in this metropolis. The playhouse in Crow street, which formerly possessed the distinction of theatre-royal, has been shut up these several years past.

But a minute description of every public edifice would occupy more room than this publication admits, not to mention the several private houses justly admired for their elegance. Among these are,

Leinster House, the town residence of his grace the duke of Leinster. The entrance to this princely mansion is from Kildare street, through a grand gateway of rustic stone work, into a spacious court which forms a segment of a circle before the principal front. The inside of this magnificent structure is equal to its exterior appearance; the hall is lofty and noble; and the apartments, which are decorated and furnished in a splendid taste, are enriched with several very valuable paintings. The garden front, plain yet bold, possesses a pleasing simplicity; the garden is spacious and elegant, with a beautiful lawn in the centre. The whole of this building is inferior to few private edifices in the British dominions.

The earl of Charlemont's house is finely situated in the middle of Palace row, on an eminence exactly fronting the centre of the garden at the rear of the lying-in hospital. The front is built with hewn stone brought from Arklow, superior to that of Portland. The inside of this house is superb and convenient: the hall ceiling is supported by columns; some of the apartments are decorated with a select but choice collection of paintings of the best masters; among which are one of Rembrandt's finest pictures, representing Judas repenting and casting the silver pieces on the ground; a portrait of Cæsar Borgia, by Titian; and the Lady's Last Stake by Hogarth, &c. &c. The library is esteemed one of the finest apartments in Dublin, and contains a very valuable collection of the best authors. At one end of it is an antichamber, with a fine statue in white marble of the Venus de Medicis, by Wilton; and

Dublin.

and at the other end are two small rooms, one a cabinet of pictures and antiquities, the other of medals: it is situated at the rear of the house, and connected with it by a corridore, in which are some handsome statues and Egyptian curiosities.

Dublin, which is the seat of government and of the chief courts of justice, has received many charters and ample privileges from the kings of England since the reign of Henry II. who introduced the English laws into this kingdom. Richard II. erected it into a marquisate in favour of Robert de Vere earl of Oxford, whom he also created duke of Ireland. It is an archiepiscopal see, and returns with the university and the county six members to parliament. The civil government of Dublin is executed by a lord mayor, recorder, two sheriffs, twenty-four aldermen, and a common council formed of representatives from the twenty-five corporations. Every third year the lord mayor, in conformity with an old charter, perambulates the bounds of the city and its liberties; and formerly the freemen of the several corporations, armed and mounted on horseback, were accustomed to attend the chief magistrate on this occasion, which was titled riding the franchises: but as this custom was productive of idleness, intoxication, and riots, among the lower orders of the people, it has been of late years very properly laid aside. Besides the silk, woollen, and worsted manufactures carried on in that quarter of the suburbs called the Earl of Meath's Liberty, and which have been considerably improved within these few years, other branches of useful manufactures are establishing in different parts of the metropolis; and though the trade of Dublin has heretofore consisted chiefly in the importation of foreign commodities, yet, now that the restrictions on their woollens and most of their other goods are removed, it is hoped the daily enlargement of their export trade will cause a proportionable increase of national opulence.

Dublin would have had a commodious station for shipping, were it not that the harbour is choked up with two banks of sand, called the *North and South Bulls*, which prevent vessels of large burden from coming over the bar. This, however, is in some measure remedied by a prodigious work of stone, and piles of wood extending some miles into the bay on the south side, at the end of which there is a lighthouse, beautifully constructed, after a design of the late Mr Smith's. But the port of Dublin is capable of much greater improvement; particularly by turning the course of the river Dodder, building a mole from the north wall to Ringsend, and clearing the harbour so as to form a grand bason on the south side for the reception of vessels of all burthens. This work is to be immediately carried into execution, and will no doubt meet every possible encouragement, from that spirit for promoting the national welfare which now prevails throughout this kingdom, and is remarkably conspicuous in the capital, where, among others, are the following public institutions.

The Board of Trustees for promoting the linen and hempen manufactures, established by act of parliament. The Dublin Society, incorporated by charter in the year 1749, for improving husbandry and other useful arts. The Royal College of Physicians, established in the year 1679 for promoting medical knowledge. The Royal College of Surgeons, instituted in the year 1785. The Royal Irish Academy, for the advancement of science, polite literature, and antiquities, incorporated by letters patent the 28th of January 1786: His majesty is patron, and the chief governor for the time being his visitor. The Hibernian Society, for maintaining, educating, and apprenticing, the orphans and children of soldiers in Ireland. The Hibernian Marine Society, for maintaining, educating, and apprenticing, the orphans and children of decayed seamen in his majesty's navy and the merchants service; also incorporated by royal charter.

But among these public institutions, that of the Bank of Ireland must not be omitted: it was established by act of parliament in 1783; and by facilitating the circulation of specie, gives life and vigour to manufactures and commerce. It is conducted under the management of a governor, deputy-governor, and fifteen directors, chosen annually from among the subscribers; with this restriction, that five new directors at least must be chosen every year. This bank is kept in the late parliament house of Ireland. There are four other great banks in the city under the following firms, viz. Right Honourable David La Touche and Co. and Sir William Glendowe Newcomen, Bart. and Co. both in Castle street; John Dawson Coats, Esq. Thomas street; and John Finlay and Co. Upper Ormond quay. The houses in which the first three are kept are structures worthy of notice, particularly that of Sir William Glendowe Newcomen's, which has been rebuilt with hewn stone, in a good taste, after a design of the late Mr Ivory's.

To these public institutions may be added the General Post Office of Ireland, established by act of parliament in 1784, previous to which time the post office of this kingdom was only considered a branch of the English one. The building erected for this purpose was begun in 1815. It is 223 feet in front and 150 in depth, and consists of three stories. In the centre is a grand portico 80 feet in length, consisting of a pediment supported by six pillars, and surmounted by three beautiful statues. There are two postmasters-general, a secretary, treasurer, accountant-general, resident surveyor, and comptroller. There is also a penny-post under the direction of the same officers, established for the conveyance of letters to all parts throughout the city and its environs.

Dublin is remarkably well supplied with flesh, fowl, and fish, the latter in much greater perfection than any other capital in Europe. It is supplied with coals chiefly from Cumberland and Scotland; and water is conveyed to the city on the north side from the river Liffey, by machines curiously constructed for the purpose, at an outlet called *Island bridge;* the south side is supplied with that necessary article from a fine reservoir or bason, surrounded with a wall and a handsome grass walk enclosed on each side by a thick-set hedge and trees planted at equal distances. From one end of it there is a view of the canal for the convenience of inland water carriage, now completed as far as Monastereven, between which and the canal harbour in James's street, passage boats ply daily; they are well appointed and accommodated with all necessary refreshments. At a small distance from the bason there is a bridge of a single arch thrown over the canal, the elegance and architecture of which are much admired: the sides of the canal for some miles into the

the country are planted with elm trees, which renders its banks in fair weather a delightful place of exercise for the citizens; who also resort for recreation to his majesty's Phœnix park, a fine extensive inclosure at the west end of the town, and on the side of the river opposite to the canal, diversified with woodland, champaign, and rising ground, and well stocked with deer. It is seven miles in circuit; and besides the Hibernian school, is adorned with the viceroy's beautiful villa and some handsome lodges belonging to the rangers: in this park are also a magazine for powder and a battery that commands the city. In 1747, a fluted pillar 30 feet high, with a phœnix on the top, was erected in the centre of a ring in this park by the celebrated earl of Chesterfield when lord lieutenant of Ireland.

The circular road which surrounds the city, beginning on one side of the river, at the east end of the town, and terminating on the opposite shore, is carried through the park. This road forms a very agreeable ride, and is much frequented. It is the boundary of the jurisdiction of the new police, instituted for the better preservation of the peace and good order of the city and the personal security of its inhabitants. This institution, established by act of parliament, is under the direction of a chief commissioner, assistant commissioners, and divisional justices, who are all aldermen of the city; which is therefore properly termed *the district of the metropolis*, and divided into four wards. The police guard consists of horsemen and foot, well armed, and in regular uniform: they are taught military discipline, and stationed at night time in the several watchhouses; from whence parties are constantly patrolling the streets, and centinels are placed at different stands. This institution is found by experience to be a much more effectual prevention of robberies, riots, and nocturnal outrages, than the parish watches; and to this security which the well-disposed working manufacturers enjoy, may in a great measure be attributed that increasing spirit of industry and peaceable behaviour now so prevalent among this useful class of the community. See the recent improvements of Dublin more particularly described in the article Dublin, in the Supplement.

Dublin, a county of Ireland. See Supplement.

DUBOS, John Baptist, a learned and ingenious French author, born at Beauvais in 1670. He finished his studies at Paris, and at length was intrusted with the management of several important affairs in Italy, England, and Holland. At his return to Paris, he had a prebendary given him; afterwards he had a pension of two thousand livres, and the abbey of Notre Dame at Ressons, near Beauvais. He died at Paris, when perpetual secretary of the French academy, on the 23d of March 1742. His principal works are, 1. Critical Reflections on Poetry and Painting, in three volumes duodecimo. 2. A Critical History of the French Monarchy in Gaul, two volumes 4to.

DUBRIS, in *Ancient Geography*, a town of Britain; now *Dover*, from *Dovoria* of the lower age. A port town in Kent, opposite to Calais.

DUCAL, in general, something belonging to a duke. See Duke.

The letters patent granted by the senate of Venice are called *ducal:* so also are the letters wrote, in the name of the senate, to foreign princes. The denomination of ducal is derived hence; that, at the beginning of such patents, the name of the duke or doge is wrote in capitals, thus, *N— Dei Gratia Dux Venetiorum*, &c. The date of ducals is usually in Latin, but the body is in Italian. A courier was despatched with a ducal to the emperor, returning him thanks for renewing the treaty of alliance in 1716, against the Turks, with the republic of Venice.

DUCAS, a learned Greek, who wrote a history of what passed under the last emperors of Constantinople, till the ruin of that city. This work, which is esteemed, was printed at the Louvre in 1649, with the Latin translation and notes of Boillaud.

DUCAT, a foreign coin, either of gold or silver, struck in the dominions of a duke; being about the same value with a Spanish piece of eight, or a French crown; or four shillings and sixpence sterling when of silver, and twice as much when of gold. See Coin.

The origin of ducats is referred to one Longinus, governor of Italy; who revolting against the emperor Justin the Younger, made himself duke of Ravenna, and called himself *Exarcha*, i. e. *without lord or ruler;* and to show his independence, struck pieces of money of very pure gold in his own name, and with his own stamp, which were called *ducati*, ducats; as Procopius relates the story.

After him, the first who struck ducats were the Venetians, who called them *Zecchini* or *sequins*, from Zecca, the place where they first were struck. This was about the year 1280, in the time of John Danduli; but we have pretty good evidence, that Roger king of Sicily had coined ducats as early as 1240. And Du Cange scruples not to affirm, that the first ducats were struck in the duchy of Apulia in Calabria. The chief gold ducats now current are, the single and double ducats of Venice, Florence, Genoa, Germany, Hungary, Poland, Sweden, Denmark, Flanders, Holland, and Zurich. The heaviest of them weighs 5 pennyweights 17 grains, and the lightest 5 pennyweights 10 grains; which is to be understood of the double ducats, and of the single in proportion.

The Spaniards have no ducats of gold; but, in lieu thereof, they make use of the silver one; which, with them, is no real species, but only a money of account like our pound. It is equivalent to 11 rials. See Rial. The silver ducats of Florence serve there for crowns.

DUCATOON, a silver coin, struck chiefly in Italy; particularly at Milan, Venice, Florence, Genoa, Lucca, Mantua, and Parma; though there are also Dutch and Flemish ducatoons. They are all nearly on the same footing; and being a little both finer and heavier than the piece of eight, are valued at twopence or threepence more; viz. at about four shillings and eightpence sterling.

There is also a gold ducatoon struck and current chiefly in Holland: it is equivalent to twenty florins, on the footing of one shilling and elevenpence halfpenny the florin.

DUCENARIUS, in antiquity, an officer in the Roman army, who had the command of 2000 men.

The emperors had also ducenarii among their procurators or intendants, called *procuratores ducenarii.* Some say, that these were such whose salary was two hundred sesterces; as in the games of the circus, horses hired for two hundred sesterces were called *ducenarii*. Others hold, that ducenarii were those who levied the two hundredth penny, the officers appointed to inspect the raising of that tribute. In the inscriptions at Palmyra, the word *ducenarius*, in Greek δȣκεναριος, occurs very often.

DUCENTESIMA, in antiquity, a tax of the two hundredth penny, exacted by the Romans.

DUCHAL, James, D. D. a late pious and learned dissenting minister, was born in Ireland, and finished his studies at the university of Glasgow; which afterwards, from a regard to his merit, conferred on him the degree of doctor of divinity. He resided 10 or 11 years at Cambridge, as the pastor of a small congregation there; where he enjoyed his beloved retirement, the advantage of books and of learned conversation, which he improved with the greatest diligence. On Mr Abernethy's removal from Antrim, he succeeded him there; and on that gentleman's death, he succeeded him as minister of a dissenting meeting-house in Wood-street, Dublin. In this situation he continued till his death, which happened on the 4th of May 1761, when he had completed his 64th year. He published a volume of excellent discourses on the presumptive arguments in favour of the Christian religion, and many occasional tracts; and after his death was published a number of his sermons, in three volumes 8vo.

DUCHY, in *Geography*, an appellation given to the dominions of a duke.

Duchy Court, a court where all matters belonging to the duchy or county palatine of Lancaster are decided by decree of the chancellor of that court.

The origin of this court was in Henry IV's time, who obtained the crown by the deposition of Richard II. and having the duchy of Lancaster by descent, in right of his mother, became seized thereof as king, not as duke: So that all the liberties, franchises, and jurisdictions of the said county passed from the king by his great seal, and not by livery or attornment, as the earldom of March, and other possessions, which descended to him by other ancestors than the king's did. Henry IV. by authority of parliament severed the possessions, liberties, &c. of the said duchy from the crown; but Edward IV. restored them to their former nature.

The officers belonging to this court are, a chancellor, attorney general, receiver general, clerk of the court, and messenger; beside the assistants, as an attorney in the exchequer, another in chancery, and four counsellers.

DUCK. See Anas, Ornithology *Index*.

This fowl is furnished with a peculiar structure of vessels about the heart, which enables it to live a considerable time under water, as is necessary for it in diving. This made Mr Boyle think it a more proper subject for experiments with the air-pump, than any other bird. A full-grown duck, being put into the receiver of an air-pump, of which she filled one-third part, and the air exhausted, the creature seemed to bear it better for the first moments than a hen or other such fowl: but after about a minute, she showed great signs of uneasiness, and in less than two minutes her head fell down, and she appeared dying, till revived by the admission of the air. Thus, whatever facility of diving this and other water fowl may have, it does not appear that they can subsist, without air for respiration, any longer than other animals. A young callow duck was afterwards tried in the same manner, and with the same success, being reduced very near death in less than two minutes. But it is observable, that both birds swelled very much in pumping out the air, so that they appeared greatly larger to the spectators, especially about the crop. It not being intended that any water-fowl should live in an exceeding rarefied air, but only be able to continue occasionally some time under water, Nature, though she has provided them with the means of this, hath done nothing for them in regard to the other.

The strongest instance of these creatures being calculated to live almost in any situation, we have in the accounts of the blind ducks in the Zirchnitzer lake in Carniola. It is supposed that this lake communicates with another lake under ground in the mountain Savornic, and fills or empties itself according to the fulness or emptiness of that lake; the water of the upper lake running off, and that in vast quantities, by holes in the bottom. The ducks which are here always in great numbers, are often carried down along with the water, and forced into the subterraneous lake to which it retires. In this unnatural habitation many of these creatures undoubtedly perish, but some remain alive. These become blind, and lose all their feathers; and in the next filling of the lake, both they and vast numbers of fish are thrown up with the water. At this time they are fat, but make a strange appearance in their naked state, and are easily caught, by reason of their want of sight. In about a fortnight they recover their sight and feathers: and are then of the size of a common wild duck, but of a black colour, with a white spot on their forehead. When opened, on being taken at their first coming up in their blind state, their stomachs are found full of small fishes, and somewhat resembling weeds. From this it seems that they cannot be absolutely blind: but that the degree of light to which they have been accustomed in their subterraneous habitation, is sufficient to enable them to procure food for themselves: and their blindness, on coming again to open day light, is no other than that of a man who has been long in the dark, on having in an instant a large blaze of candles set under his eyes.

Duck, *Stephen*, originally a thrasher in a barn, was born about the beginning of the 18th century. By his poetical talents, he first attracted the notice of some gentlemen at Oxford; and being recommended to Queen Caroline, he, under her patronage, took orders, and was preferred to the living of Byfleet in Surry. His abilities were, however, much more conspicuous in his primitive station than in his advancement: though, it is said, he was not disliked as a preacher. Falling at length into a low-spirited melancholy way, probably owing to his change of life and cessation from his usual labour, he in a fit of lunacy flung himself into the Thames, in 1756.

DUCKING, plunging in water, a diversion anciently practised among the Goths by way of exercise; but among the Celtæ, Franks, and ancient Germans, it was a sort of punishment for persons of scandalous lives.—At Marseilles and Bourbon their men and women

men of scandalous life are condemned to the cale, as they call it; that is, to be shut up naked to the shift in an iron cage fastened to the yard of a shallop, and ducked several times in the river. The same has been done at Thoulouse to blasphemers.

Ducking, a sort of marine punishment, inflicted by the French, on those who have been convicted of desertion, blasphemy, or exciting sedition. It is performed as follows: The criminal is placed astride of a short thick batten, fastened at the end of a rope, which passes through a block hanging at one of the yard-arms. Thus fixed, he is hoisted suddenly up to the yard, and the rope being slackened at once, he is plunged into the sea. This chastisement is repeated several times conformable to the purport of the sentence pronounced against the culprit, who has at that time several cannon shot fastened to his feet during the punishment; which is rendered public by the firing of a gun, to advertise the other ships of the fleet thereof, that their crews may become spectators.

Ducking is also a penalty which veteran sailors pretend to inflict on those who, for the first time, pass the tropic of Cancer, the equator, or the straits of Gibraltar, in consequence of their refusal or incapacity to pay the usual fine levied on this occasion.

Ducking-Stool. See Castigatory.

DUCKUP, at sea, is a term used by the steersman, when the main-sail, fore-sail, or sprit-sail, hinders his seeing to steer by a land-mark: upon which he calls out, *Duck up the clew-lines of these sails;* that is, haul the sails out of the way.

DUCLOS, Charles Pineau, a French miscellaneous writer. See Supplement.

DUCT, in general, denotes any tube or canal. It is a term much used by anatomists.

DUCTILITY, in *Physics*, a property possessed by certain solid bodies, which consists in their yielding to percussion or pressure, and in receiving different forms without breaking.

Some bodies are ductile both when they are hot and when they are cold, and in all circumstances. Such are metals, particularly gold and silver. Other bodies are ductile only when heated to a sufficient degree; such as wax and other substances of that kind, and glass. Other bodies, particularly some kinds of iron, called by the workmen *red short*, brass, and some other metallic mixtures, are ductile only when cold, and brittle when hot. The degrees of heat requisite to produce ductility in bodies of the first kind, vary according to their different natures. In general, the heat of the body must be such as is sufficient to reduce it to a middle state, betwixt solidity and perfect fusion. As wax, for instance, is fusible with a very small heat, it may be rendered ductile by a still smaller one; and glass, which requires a most violent heat for its perfect fusion, cannot acquire its greatest ductility until it is made perfectly red hot, and almost ready to fuse. Lastly, Some bodies are made ductile by the absorption of a fluid. Such are certain earths, particularly clay. When these earths have absorbed a sufficient quantity of water to bring them into a middle state betwixt solidity and fluidity, that is, to the consistence of a considerable firm paste, they have then acquired their greatest ductility. Water has precisely the same effect upon them in this respect that fire has upon the bodies above mentioned.

DUDLEY, Edmund, an eminent lawyer and able statesman in the reign of Henry VII.; who with Sir Richard Empson, another lawyer of the same complexion, assisted in filling that rapacious monarch's coffers by arbitrary prosecutions of the people on old penal statutes. They were beheaded on the accession of Henry VIII. to pacify the clamours of the people for justice.

Dudley, *John*, duke of Northumberland, son of the above, a statesman; memorable in the English history for his unsuccessful attempt to place the crown on the head of his daughter-in-law, Lady Jane Grey, who fell a victim to his ambition; was born in 1502, and beheaded in 1553. See (*History of*) England. Ambrose his eldest son was a brave general and able statesman under Queen Elizabeth; and received the appellation of *the good earl of Warwick*. Henry, the duke's second son, was killed at the siege of St Quintin. Robert, the third son, a man of bad character, was created earl of Leicester; and was one of Queen Elizabeth's favourites. His fourth son was the unfortunate Lord Guildford Dudley, whose only crime was his being the husband of Lady Jane Grey, for which he was beheaded in 1554.

Dudley, *Sir Robert*, as he was called in England, and, as he was styled abroad, *earl of Warwick and duke of Northumberland*, was the son of Robert above mentioned, by the lady Douglas Sheffield; and was born at Sheen in Surrey in 1573, where he was carefully concealed, to prevent the queen's knowledge of the earl's engagement with his mother. He studied at Oxford; when his father dying, left him the bulk of his estate. He was at this time one of the finest gentleman in England: and having a particular turn to navigation, fitted out a small squadron at his own expence, with which he sailed to the river Oroonoque, and took and destroyed nine sail of Spanish ships. In 1595, he attended the earl of Essex, and the lord high admiral of England, in their expedition against the Spaniards; when, for his gallant behaviour at the taking of Cadiz, he received the honour of knighthood. He now endeavoured to prove the legitimacy of his birth, in order to be entitled to his hereditary honours. But being overpowered by the interest of the countess dowager of Leicester, he applied for a license to travel; and being well received at the court of Florence, resolved to continue there, notwithstanding his receiving a letter of recal; on which his whole estate was seized by King James I. and vested in the crown. He discovered at the court of Cosmo II. great duke of Tuscany, those great abilities for which he had been admired in England, and was at length made chamberlain to his serene highness's consort. He there contrived several methods of improving shipping; introduced new manufactures; and by other services obtained so high a reputation, that at the desire of the archduchess, the emperor Ferdinand, in 1620, created him a duke of the holy Roman empire. He afterwards drained a vast tract of morass between Pisa and the sea; and raised Leghorn, which was then a mean, pitiful place, into a large and beautiful town, improving the haven by a mole, which rendered it both safe and

and commodious; and having engaged his highness to declare it a free port, he by his influence and correspondence, drew many English merchants to settle and set up houses there, which was of very great service to his native country, as well as to the Spaniards. He was also the patron of learned men, and held a high place himself in the republic of letters. His most celebrated work is his *Del Arcano del Mare*, in two volumes folio.

DUEL, a single combat, at a time and place appointed, in consequence of a challenge. This custom came originally from the northern nations, among whom it was usual to decide all their controversies by arms. Both the accuser and accused gave pledges to the judges on their respective behalf; and the custom prevailed so far amongst the Germans, Danes and Franks, that none were excused from it but women, sick people, cripples, and such as were under 21 years of age or above 60. Even ecclesiastics, priests, and monks, were obliged to find champions to fight in their stead. The punishment of the vanquished was either death, by hanging or beheading; or mutilation of members, according to the circumstances of the case. Duels were at first admitted not only on criminal occasions, but on some civil ones for the maintenance of rights to estates, and the like? in latter times, however, before they were entirely abolished, they were restrained to these four cases. 1. That the crime should be capital. 2. That it should be certain the crime was perpetrated. 3. The accused must by common fame be supposed guilty. And, 4. The matter not capable of proof by witnesses.

DUEL, at present, is used for single combat on some private quarrel; and must be premeditated, otherwise it is called a *rencounter*. If a person is killed in a duel, both the principals and seconds are guilty, whether the seconds engage or not. (See the article MURDER). It is also a very high offence to challenge a person either by word or letter, or to be the messenger of a challenge. (See LAW *Index*.)

The general practice of duelling, in this last sense, took its rise in the year 1527, at the breaking up of a treaty between the emperor Charles V. and Francis I. The former desired Francis's herald to acquaint his sovereign, that he would henceforth consider him not only as a base violator of public faith, but as a stranger to the honour and integrity becoming a gentleman. Francis, too high-spirited to bear such an imputation, had recourse to an uncommon expedient to vindicate his character. He instantly sent back the herald with a cartel of defiance, in which he gave the emperor the lie in form, challenged him to single combat, requiring him to name the time and place of the encounter, and the weapons with which he chose to fight. Charles, as he was not inferior to his rival in spirit or bravery, readily accepted the challenge; but after several messages concerning the arrangement of all the circumstances relative to the combat, accompanied with mutual reproaches bordering on the most indecent scurrility, all thoughts of this duel, more becoming the heroes of romance than the two greatest monarchs of their age, were entirely laid aside.

The example of two personages so illustrious, drew such general attention, and carried with it so much authority, that it had considerable influence in introducing an important change in manners all over Europe. Duels, as has already been observed, had been long permitted by the laws of all the European nations; and, forming a part of their jurisprudence, were authorized by the magistrate on many occasions, as the most proper method of terminating questions with regard to property, or of deciding in those which regarded crimes. But single combats being considered as solemn appeals to the omniscience and justice of the Supreme Being, they were allowed only in public causes, according to the prescription of law, and carried on in a judicial form †. Men accustomed to this manner of decision in courts of justice, were naturally led to apply it to personal and private quarrels. Duels, which at first could be appointed by the civil judge alone, were fought without the interposition of his authority, and in cases to which the laws did not extend. The transactions between Charles and Francis strongly countenanced this practice. Upon every affront or injury which seemed to touch his honour, a gentleman thought himself entitled to draw his sword, and to call on his adversary to make reparation. Such an opinion, introduced among men of fierce courage, of high spirit, and of rude manners, where offence was often given, and revenge was always prompt, produced most fatal consequences. Much of the best blood in Christendom was shed; many useful lives were lost; and, at some periods, war itself had hardly been more destructive than these contests of honour. So powerful, however, is the dominion of fashion, that neither the terror of penal laws, nor reverence for religion, have been able entirely to abolish a practice unknown among the ancients, and not justifiable by any principle of reason: though at the same time we must ascribe to it, in some degree, that extraordinary gentleness and complaisance of modern manners, and that respectful attention of one man to another, which at present render the social intercourses of life far more agreeable and decent than among the most civilized nations of antiquity.

† See the article *Battel*.

Public opinion is not easily controlled by civil institutions; for which reason it may be questioned whether any regulations can be contrived of sufficient force to suppress or change the rule of honour which stigmatizes all scruples about duelling with the reproach of cowardice.

The inadequate redress which the law of the land affords for those injuries which chiefly affect a man in his sensibility and reputation, tempts many to redress themselves. Prosecutions for such offences, by the trifling damages that are recovered, serve only to make the sufferer more ridiculous.—This ought to be remedied.

For the army, where the point of honour is cultivated with exquisite attention and refinement, there might be established a court of honour, with a power of awarding those submissions and acknowledgements which it is generally the object of a challenge to obtain; and it might grow into a fashion with persons of rank of all professions to refer their quarrels to the same tribunal.

Duelling, as the law now stands, can seldom be overtaken by legal punishment. The challenge, appointment, and other previous circumstances, which indicate the intention with which the combatants meet, being suppressed,

suppressed, nothing appears to a court of justice but the actual rencounter; and if a person be slain when actually fighting with his adversary, the law deems his death nothing more than manslaughter.

DUERO, or DOURO, a large river, which, rising in Old Castile in Spain, runs from east to west, crosses the province of Leon, and after dividing Portugal from Spain, falls into the Atlantic ocean near Oporto.

DUGDALE, SIR WILLIAM, an eminent English historian, antiquarian, and herald, born in Warwickshire in 1605. He was introduced into the herald's office by Sir Christopher Hatton; and ascended gradually through all the degrees, until he became Garter principal king at arms. His chief work is the *Monasticon Anglicanum*, in three vols. folio; containing the charters and descriptions of all the English monasteries, adorned with engravings: in the former part of which work he was assisted by Mr Roger Dodsworth. Nor are his antiquities of Warwickshire less esteemed. He wrote likewise, among other things of less note, the History of St Paul's Cathedral; a History of Embanking and Draining; a Baronage of England; and completed the second volume of Sir Henry Spelman's Councils, with a second part of his Glossary. He died in 1686. His son, Sir John, was Norroy king at arms, and published a Catalogue of English Nobility. His daughter Elizabeth married the famous Elias Ashmole.

DUHAMEL, HENRY LEWIS, a French writer on natural history, &c. See SUPPLEMENT.

DUILLIA LEX, was enacted by M. Duillius, a tribune, in the year of Rome 304. It made it a capital crime to leave the Roman people without its tribunes, or to create any new magistrate without a sufficient cause. Another in 392, to regulate what interest ought to be paid for money lent.

DUILLIUS NEPOS, C. a Roman consul, the first who obtained a victory over the naval power of Carthage in the year of Rome 492. He took fifty of the enemy's ships, and was honoured with a naval triumph, the first that ever appeared at Rome. The senate rewarded his valour by permitting him to have music playing and torches lighted at the public expence every day while he was at supper. There were some medals struck in commemoration of his victory; and there exists a column at Rome which was erected on the occasion.

DUKE, (*Dux*), a sovereign prince, without the title or quality of king. Such are the dukes of Lorrain, of Holstein, of Savoy, of Parma, &c. The word is borrowed from the modern Greeks, who call *doucas* what the Latins call *dux*.

There are also two sovereigns who bear the title of *grand duke*: as the grand duke of Tuscany, and the grand duke of Muscovy, now called the *czar* or emperor of Russia. The title of *great duke* belongs to the apparent heir of Russia; and the title of *archduke* is given to all the sons of the house of Austria, as that of *archduchess* to all the daughters.

DUKE, (*Dux*), is also a title of honour or nobility, the next below princes.

The dukedom or dignity of duke is a Roman dignity, denominated *à ducendo*, "leading" or "commanding." Accordingly, the first dukes, *duces*, were the *ductores exercituum*, "commanders of armies." Under the later emperors, the governors of provinces in war time were entitled *duces*. In after times the same denomination was also given to the governors of provinces in time of peace. The first governor under the name of *duke* was a duke of the Marchia Rhætica, or Grisons, whereof mention is made in Cassiodorus; and there were afterwards thirteen dukes in the eastern empire, and twelve in the western. The Goths and Vandals, upon their overrunning the provinces of the western empire, abolished the Roman dignities wherever they settled. But the Franks, &c. to please the Gauls, who had long been used to that form of government, made it a point of politics not to change any thing therein: and accordingly they divided all Gaul into duchies and counties; and gave the names sometimes of dukes, and sometimes of counts, *comites*, to the governors thereof.

In England, during the Saxon times, Camden observes, the officers and commanders of armies were called dukes, *duces*, after the ancient Roman manner, without any addition. After the Conqueror came in, the title lay dormant till the reign of Edward III. who created his son Edward, called the *Black Prince*, first duke of Cornwall; which hath ever since been the peculiar inheritance of the king's eldest son during the life of his father; so that he is *dux natus, non creatus*. After whom there were more made, in such a manner as that their titles descended to their posterity. They were created with much solemnity, *per cincturam gladii, cappæque, et circuli aurei in capite impositionem*. However, in the reign of Queen Elizabeth, A. D. 1572, the whole order became utterly extinct; but it was revived about 50 years afterwards by her successor, in the person of George Villiers duke of Buckingham.

Though the French retained the names and forms of the ducal government, yet under their second race of kings there were scarce any such thing as dukes: but all the great lords were called *counts*, *peers*, or *barons*; excepting, however, the dukes of Burgundy and Aquitain; and the duke of France, which was a dignity Hugh Capet himself held, corresponding to the modern dignity of maire de palais, or the king's lieutenant. By the weakness of the kings, the dukes or governors sometimes made themselves sovereigns of the provinces trusted to their administration. This change happened chiefly about the time of Hugh Capet; when the great lords began to dismember the kingdom, so that that prince found more competitors among them than subjects. It was even with a great deal of difficulty they could be brought to own him their superior, or to hold of him by faith and homage. By degrees, what with force, and what by marriages, these provinces, both duchies and counties, which had been rent from the crown, were again united to it. But the title *duke* was no longer given to the governors of provinces. From that time duke became a mere title of dignity, annexed to a person and his heirs male, without giving him any domain, territory, or jurisdiction over the place whereof he was duke. All the advantages thereof now consist in the name, and the precedence it gives.

The dukes of our days retain nothing of their ancient splendour but the coronet on their escutcheon, which is the only mark of their departed sovereignty. They are created by patent, cincture of the sword, mantle of state, imposition of a cap and coronet of gold on the head, and a verge or rod of gold in their hand.

The eldest sons of dukes are by the courtesy of England styled *marquises*, though they are usually distinguished by their father's second title, whether it be that of marquis or earl: and the younger sons *lords*, with the addition of their Christian name, as Lord James, Lord Thomas, &c. and they take place of viscounts, though not so privileged by the laws of the land.

A duke has the title of *grace;* and being writ to, he is styled, in the herald's language, *most high, potent, and noble prince.* Dukes of the blood royal are styled *most high, most mighty, and illustrious princes.*

DUKE, among Hebrew grammarians, is an appellation given to a species of accents answering to our comma. See ACCENT.

DUKE-Duke, a quality given in Spain to a grandee of the house of Sylva, on account of his having several duchies from the uniting of two considerable houses in his person. Don Roderigo de Sylva, eldest son of Don Ruy Gomez de Sylva, and heir of his duchies and principalities, having married the eldest daughter of the duke de l'Infantado, the duke de Pastrana, who is descended therefrom, added to his other great titles that of duke-duke, to distinguish himself from the other dukes; some whereof may enjoy several duchies, but none so considerable ones.

DULCIFYING, in *Chemistry*, is the sweetening any matter impregnated with salts, by frequently washing it in pure water.

DULL, in the manege. The marks of a dull horse, called by the French *marques de ladre*, are white spots round the eye and on the tip of the nose, upon any general colour whatsoever. Though the vulgar take these spots for signs of stupidity, it is certain they are great marks of the goodness of a horse; and the horses that have them are very sensible and quick upon the spur.

DULLART, HEIMAN, a Dutch painter and poet. He was a pupil to Rembrandt, for whose works the few he left are often mistaken. He died in 1684.

DUMARSAIS, CESAR CHESNAU, a French writer on Grammar. See SUPPLEMENT.

DUMBARTON. See DUNBARTON.

DUMBNESS, the privation of the faculty of speech. The most general, or rather the sole cause of dumbness, is the want of the sense of hearing. The use of language is originally acquired by imitating articulate sounds. From this source of intelligence, deaf people are entirely excluded: they cannot acquire articulate sounds by the ear: unless, therefore, articulation be communicated to them by some other medium, these unhappy people must for ever be deprived of the use of language; and as language is the principal source of knowledge, whoever has the misfortune to want the sense of hearing, must remain in a state little superior to that of the brute creation. Deafness has in all ages been considered as such a total obstruction to speech or written language, that an attempt to teach the deaf to speak or read has been uniformly regarded as impracticable, till Dr Wallis and some others have of late shown, that although deaf people cannot learn to speak or read by the direction of the ear, there are other sources of imitation, by which the same effect may be produced. The organs of hearing and of speech have little or no connexion. Persons deprived of the former generally possess the latter in such perfection, that nothing further is necessary, in order to make them articulate, than to teach them how to use these organs. This indeed is no easy task; but experience shows that it is practicable. Mr THOMAS BRAIDWOOD, late of Edinburgh, was perhaps the first who ever brought this surprising art to any degree of perfection. He began with a single pupil in 1764; and since that period has taught great numbers of people born deaf to speak distinctly; to read, to write, to understand figures, the principles of religion and morality, &c. At the time we first conversed with him, being a few years after the commencement of his practice, he had a considerable number of deaf pupils, some of them above 20 years of age, all making a rapid and amazing progress in those useful branches of education.

Mr Braidwood's principal difficulty, after he had discovered this art, was to make people believe in the practicability of it. He advertised in the public papers; he exhibited his pupils to many noblemen and gentlemen: still he found the generality of mankind unwilling to believe him. A remarkable instance of this incredulity occurred some years ago. A gentleman in England sent a deaf girl of his to Mr Braidwood's care. A year or two afterwards, Mr Braidwood wrote to the father, that his daughter could speak, read, and write distinctly. The father returned an answer, begging Mr Braidwood's excuse, as he could not believe it: however, he desired a friend of his, who was occasionally going to Edinburgh, to call at Mr Braidwood, and inquire into the truth of what he had wrote him: he did so; conversed with Mr Braidwood, saw the young lady, heard her read, speak, and answer any question he put to her. On his return, he told the father the surprising progress his child had made; but still the father thought the whole an imposition; the girl herself wrote to her father, but he looked upon the letter as a forgery. About this time the father died; and the mother sent an uncle and cousin of the deaf lady's from Shrewsbury, in order to be satisfied of the truth. When they arrived, Mr Braidwood told the girl her uncle and cousin were in the parlour; and desired her to go and ask them how they did, and how her mother and other friends did. The friends were astonished, and could hardly credit their own ears and eyes.

When we conversed with Mr Braidwood concerning the nature and method of teaching this wonderful art, he seemed to be very desirous of communicating and transmitting his discovery to posterity; but observed, and from the nature of the thing we believe it to be true, that he could not communicate it so fully in writing as to enable any other person to teach it. The first thing in the method is, to teach the pupil to pronounce the simple sounds of the vowels and consonants. We have even seen him performing this operation; but are unable to give a clear idea of it. He pronounces the sound of *a* slowly, pointing out the figure of the letter at the same time; makes his pupil observe the motion of his mouth and throat; he then puts his finger into the pupil's mouth, depresses or elevates the tongue, and makes him keep the parts in that position; then he lays hold of the outside of the windpipe, and gives it some kind of squeeze, which it is impossible to describe:

scribe: all the while he is pronouncing *a*, the pupil is anxiously imitating him, but at first seems not to understand what he would have him to do. In this manner he proceeds, till the pupil has learned to pronounce the sounds of the letters. He goes on in the same manner to join a vowel and a consonant, till at length the pupil is enabled both to speak and read.

That his pupils were taught not only the mere *pronunciation*, but also to understand the *meaning* of what they read, was easily ascertained by a conversation with any of them. Of this Mr Pennant gives a remarkable instance in a young lady of about 13 years of age, who had been some time under the care of Mr Braidwood. "She readily apprehended (says he) all I said, and returned me answers with the utmost facility. She read; she wrote well. Her reading was not by rote. She could clothe the same thoughts in a new set of words, and never vary from the original sense. I have forgot the book she took up, or the sentences she made a new version of: but the effect was as follows.

"*Original passage.* Lord Bacon has divided the whole of human knowledge into history, poetry, and philosophy; which are referred to the three powers of the mind,—memory, imagination, and reason.

"*Version.* A nobleman has parted the total or all of man's study or understanding into, An account of the life, manners, religion or customs of any people or country; verse or metre; moral or natural knowledge: which are pointed to the three faculties of the soul or spirit; the faculty of remembering what is past, thought or conception, and right judgment."

Mr Braidwood's success since he went to settle in London is universally known. Several other persons have since attempted the same art with various degrees of ability. But a new and different method, equally laborious and successful we understand, is practised by the abbé de l'Epee of Berlin. We are informed* that he begins his instructions not by endeavouring to form the organs of speech to articulate sounds, but by communicating ideas to the mind by means of signs and characters: to effect this, he writes the names of things; and, by a regular system of signs, establishes a connection between these words and the ideas to be excited by them. After he has thus furnished his pupils with ideas, and a medium of communication, he teaches them to articulate and pronounce, and renders them not only grammarians but logicians. In this manner he has enabled one of his pupils to deliver a Latin oration in public, and another to defend a thesis against the objections of one of his fellow pupils in a scholastic disputation; in which the arguments of each were communicated to each other, but whether by signs or in writing is not said; for it does not appear that the abbé teaches his pupils to discern what is spoken, by observing the motion of the organs of speech, which those instructed by Messrs Braidwoods are able to do with astonishing readiness.

There is perhaps no word, says the abbé, more difficult to explain by signs than the verb *croire*, "to believe." To do this, he writes the verb with its significations in the following manner:

Je crois {
Je dis oui par l' esprit, Je pense qui oui.
Je dis oui par le coeur, J'aime à penser que oui.
Je dis oui par la bouche.
Je ne vois pas des yeux.

After teaching these four significations, which he does by as many signs, he connects them with the verb, and adds other signs, to express the number, person, tense, and mood, in which it is used. If to the four signs, corresponding with the lines above mentioned, be added that of a substantive, the pupil will write the word *foi* "faith;" but, if a sign, indicating a participle used substantively, be adjoined, he will express *la croyance*, "belief;" to make him write *croyable*, "credible," the four signs of the verb must be accompanied with one that indicates an adjective terminating in *able*; all these signs are rapidly made, and immediately comprehended.

M. Linguet, a member of the Royal Academy, having asserted that persons thus instructed could be considered as little more than automata, the abbé invited him to be present at his lessons, and expressed his astonishment that M. Linguet should be so prejudiced in favour of the medium by which he had received the first rudiments of knowledge, as to conclude that they could not be imparted by any other; desiring him, at the same time to reflect, that the connexion between ideas, and the articulate sounds by which they are excited in the mind, is not less arbitrary than that between these ideas and the written characters which are made to represent them to the eye. M. Linguet complied with the invitation; and the abbé having desired him to fix on some abstract term which he would by signs communicate to his pupils, he chose the word *unintelligibility*: which, to his astonishment, was almost instantly written by one of them. The abbé informed him, that to communicate this word he had used five signs, which, though scarcely perceivable to him, were immediately and distinctly apprehended by his scholars: the first of the signs indicated an internal action; the second represented the act of a mind that reads internally, or, in other words, comprehends what is proposed to it; a third signified that such a disposition is possible; those, taken together, form the word *intelligible*: a fourth sign transforms the adjective into the substantive; and a fifth, expressing negation, completes the word required. M. Linguet afterwards proposed this question, *What do you understand by metaphysical ideas?* which being committed to writing, a young lady immediately answered on paper in the following terms: "I understand the ideas of things which are independent of our senses, which are beyond the reach of our senses, which make no impression on our senses, which cannot be perceived by our senses." On reading this, we cannot help exclaiming with the poet, *Labor omnia vincit improbus!* a maxim by none more forcibly illustrated than by the abbé de l'Epee.

Periodical DUMBNESS. In the Ephemerides of the Curious, we have an account of a periodical dumbness, which had continued for more than 15 years, and had not gone off at the time the account was wrote. The person was son to an innkeeper at Jesing in the duchy of Wirtemberg in Germany. He was one night taken so ill after supper, that he could neither stand nor sit. He continued, for about an hour, oppressed with sickness to such a degree as to be in danger of suffocation. At the expiration of this time he grew better; but, during three months, he was much dejected, melancholy, and, at times, fearful. He was then suddenly struck

---

* Nov. Me de 'Acemie Roy, &c. de Berlin, 78 (Mo Rev. vol. xx. 6)

struck dumb, and became unable to pronounce the least word, or form the least sound, though he could speak very articulately before. The loss of speech was at first instantaneous, and continued only a few minutes; but the duration of it began to lengthen every day; so that it soon amounted to half an hour, two hours, three hours, and at last to 23 hours, yet without any order. At last the return of speech kept so constant and regular an order, that, for 14 years together, he could not speak except from noon, during the space of one entire hour, to the precise moment of one o'clock. Every time he lost his speech, he felt something rise from his stomach to his throat. Excepting this loss of speech, he was afflicted with no other disorder of any animal function. Both his internal and external senses continued sound: he heard always perfectly well, and answered the questions proposed to him by gestures or writing. All suspicion of deceit was removed by his keeping exactly the same hour, though he had no access to any instruments by which time can be measured.

DUMFERMLINE, a royal borough of Scotland, situated in the county of Fife, 15 miles north-west of Edinburgh. W. Long. 30. 20. N. Lat. 56. 15. Here was formerly a magnificent abbey and palace of the kings of Scotland, in which the princess Elizabeth, daughter of King James VI. and mother of the princess Sophia, from whom the present royal family are descended, was born. In the inn of this town, it is said, is the marriage-bed of James VI. and his queen: it is still entire, and used by strangers who lodge here. This place is noted for a manufactory of figured linen cloth called diaper. The town gave title of earl to a baronet of the Seton family, which was forfeited in the year 1690.

DUMFRIES, a county in the south of Scotland, comprehending the shire of Nithsdale, the stewarty of Annandale, and the lordship of Eskdale, extends in length from north-west to south-east about 60 miles, and is about 30 miles in breadth where broadest. It is bounded on the south-west by Galloway and part of Kyle; on the north-east by the counties of Roxburgh, Selkirk, and Peebles; on the north-west by Clydesdale; and on the south-east by Solway frith and the marches between Scotland and England. A great part of the county is mountainous and overspread with heath, well stocked with game of all kinds: but the valleys, through which the Esk, the Annan, the Nith, and other small rivers run, are extremely pleasant; and some of them well cultivated, and very fertile, and produce oats, barley, and wheat in abundance, both for maintaining the inhabitants and for exportation; while the mountainous parts afford pasture for innumerable flocks of sheep and herds of black cattle, many thousands of which are annually exported to England. In the valleys are several natural woods, and some extensive plantations of different kinds of timber. In the division called *Nithsdale*, are the rich lead mines of Wanlockhead, the coal mines of Sanquhar and Cairnburn, the inexhaustible lime quarries of Closeburn and Barjarg, and freestone in almost every parish. Annandale has the rich lime quarries of Kellhead and Comlongan, with plenty of freestone near the towns of Annan and Lochmaben: and in the lower part of Eskdale are limestone and some coal.

The following is a view of the population of this county, with the number of souls in each parish, taken at two different periods, and extracted from the Statistical History of Scotland.

Parishes.	Population in 1755.	Population in 1790—1798.
1 Annan	1498	2500
Applegirth	897	741
Caerlaverock	784	955
Cannobie	1733	2725
5 Closeburn	999	1490
Cummertrees	631	1056
Dalton	451	615
Dornock	716	738
Drysdale	1097	1600
10 Dumfries	4517	5600
Dunscore	651	1033
Durrisdeer	1019	1031
Eskdalemuir	675	619
Ewes	392	320
15 Glencairn	1794	1700
Gratney	1051	1810
Hoddam	1393	1198
Holywood	596	736
Hutton	993	583
20 Johnston	494	565
Keir	495	520
Kirkconnell	899	1000
Kirkmahoe	1098	1200
Kirkmichael	894	950
25 Kirkpatrick Fleming	1147	1542
Kirkpatrick Juxta	794	617
Langholm	1833	2582
Lochmaben	1395	3000
Middlebie	991	1404
30 Moffat	1612	1600
Morton	435	908
Mousewald	553	628
Penpont	838	800
Ruthwell	599	1061
35 St Mungo	481	640
Sanquhar	1998	2600
Tinwald	795	850
Torthorwald	584	660
Tundergarth	625	510
40 Tynron	464	500
Wamphray	458	487
42 Westerkirk	544	655
	41,913	52,329
Population in 1811	62,960	

See Dumfries-shire, Supplement.

Dumfries, the capital of the above mentioned county, a handsome town, situated on a ridge or rising ground on the north-east side of the river Nith, about 10 miles above where it falls into Solway frith, in N. Lat. 55. 8. 30. Long. W. of Greenwich Observatory, 3. 56. Its ancient name, it is said by some of the Scotch historians, was *Cotiac*; but on what authority we cannot tell. Its present name appears to have been derived partly from its situation, and partly from the monastery of Gray Friars that formerly stood near the head

head of the street called the *Friar vennal*, the kitchen of which is all that now remains; being only a corruption of *Drum friars*, or "the eminence of the friary:" and accordingly, till within these 40 or 50 years, it was always spelt *Drumfries*, and not *Dumfries*, as it is now for the sake of greater softness. Besides the pleasantness of its situation on the side of a beautiful winding river, it is surrounded on all sides with one of the finest and best cultivated sheets of dale country that one can anywhere meet with, and the prospect from it terminated, at the distance of a few miles, by a continued chain of hills, forming altogether one of the grandest natural amphitheatres perhaps in Britain. There was anciently a strong castle at the south end of the town belonging to the Cummings, lords of Badenoch, of which there are now no remains. Another castle was afterwards built at the north-west end, which was taken down about a century ago. On the north-east side of it, at some little distance, are the ruins of a chapel built by King Robert Bruce, and endowed for a number of priests to say mass for the repose of the soul of Sir Christopher Seaton his brother-in-law, who was taken prisoner by Edward I. at Loch Urr, and hanged at this place. It is now only employed as a burying place for suicides. It is not certain at what period Dumfries was erected into a royal borough; but it must have been before the middle of the eleventh century, as a grave-stone was discovered some time ago bearing the date of 1079, and mentioning the person buried under it to have been a merchant and burgess of the town; and that it was a place of consequence in the beginning of the fourteenth century, is evident from this circumstance, that Edward II. called the estates of Scotland to meet there in the year 1307. In the above-mentioned monastery too, King Robert Bruce killed his rival Cumming lord of Badenoch, with the assistance of James Lindsay and Roger Kirkpatrick, on the 5th of February 1305. As to the present state of the town, the houses are well built and commodious, the streets spacious, open, and neatly paved. It has two very elegant churches, an Episcopal chapel with a fine little organ, besides four meeting houses belonging to different descriptions of sectaries; a tolbooth; a council chamber; a trades hall; a meal market; a strong prison; a correction house; a large hospital; an infirmary, with apartments for insane patients; a narrow bridge of nine arches over the river, said to have been built by one of the three daughters and co-heiresses of Alan Lord Galloway, and a handsome new bridge built in 1795. A large village, called the *Bridge-end*, stands on the opposite side, and is within the stewarty of Kircudbright. The assizes for the county, and for the shire of Galloway and stewarty of Kircudbright, are held in the town twice a-year. It is also the place for holding the sheriff and commissary courts, the quarter-sessions of the peace, and the courts of the commissioners of supply. It is governed by a provost, three bailies, a dean of guild, and a town council, composed of merchants and the convener and deacons of the incorporated trades, of which there are seven, viz. square-men, smiths, weavers, tailors, shoemakers, skinners, and butchers. The trades got from King James VI in one of his journeys to England, a small silver tube, like a pistol barrel, called the *silver gun*, with his royal license to shoot for it every year. At that festival they all appear in arms, and march out of the town under their respective colours, to some convenient place, where they shoot at a mark; and the person that hits or shoots nearest to it, returns to town, marching at the convener's right hand, with the silver gun tied to his hat with ribbons; after which they conclude the day with a social entertainment. The town has a weekly market on Wednesday, with two annual fairs, the first on the Wednesday on or next after the 13th of February, and the other on the Wednesday on or next after the 25th of September. But though well situated for fuel at a cheap rate, it has only two manufactures, one for stockings and the other for cottons; but the latter only in its infancy. Its foreign trade for many years has only consisted in timber, iron, and other articles for home consumption. It gives the title of earl to the chief of the family of Crichton: and is the seat of a presbytery and provincial synod. A handsome monument to the memory of Robert Burns, the Ayrshire poet, was erected in the church-yard in 1817. The town contained 9262 inhabitants in 1811.

DUMONT, Francis, a Frenchman, compiler of a general collection of treaties of commerce, alliance, and peace, between the powers of Europe. This collection, with Barbeyrac's, containing the treaties B. C. makes 16 vols. folio, very useful for historical writers. Dumont retired to Holland in 1720. The time of his death is uncertain.

DUMOSÆ (from *dumus*, "a bush"), an order of plants in the *Fragmenta methodi naturalis* of Linnæus, containing the following genera, viz. *Viburnum*, *Tinus*, *Opulus*, *Sambucus*, *Rondeletia*, *Bellonia*, *Cassine*, *Ilex*, *Tomax*, &c.

DUN, or Burgh, the name of an ancient species of buildings, of a circular form, common in the Orkney and Shetland islands, the Hebrides, and northern parts of Scotland. The latter term points out the founders, who at the same time bestowed on them their natal name of *borg*, "a defence or castle," a Sueo-Gothic word; and the Highlanders universally apply to these places the Celtic name *dun*, signifying a hill defended by a tower, which plainly points out their use. They are confined to the countries once subject to the crown of Norway. With few exceptions, they are built within sight of the sea, and one or more within sight of the other; so that on a signal by fire, by flag, or by trumpet, they could give notice of approaching danger, and yield a mutual succour. In the Shetland and Orkney islands, they are most frequently called *wart* or *ward hills*, which shows that they were garrisoned. They had their wardmadher, or watchman, a sort of centinel, who stood on the top, and challenged all who came in sight. The gackman was an officer of the same kind, who not only was on the watch against surprise, but was to give notice if he saw any ships in distress. He was allowed a large horn of generous liquor, which he had always by him, to keep up his spirits. Along the Orkney and Shetland shores, they almost form a chain; and by that means not only kept the natives in subjection, but were situated commodiously for covering the landing of their countrymen, who were perpetually roving on piratical expeditions. These towers were even made use of as state prisons; for we learn from Torfæus, that after Sueno had surprised Paul, count of Caithness, he carried him into Sutherland, and confined him there in a Norwegian tower. Out of our own kingdom, no buildings similar to these are to be found, except in Scandinavia. On the mountain Swalberg in Norway is one; the Stir-biskop, at Upsal in Sweden, is another; and Umseborg, in the same kingdom, is a third.

These towers vary in their inner structure; but externally are universally the same; yet some have an addition of strength on the outside. The burgh of Culswick in Shetland, notwithstanding it is built on the top of a hill, is surrounded with a dry ditch 13 feet broad; that of Snaburgh in Unst, has both a wet and a dry ditch; the first cut, with great labour, through the live rock. The burgh of Moura is surrounded by a wall, now reduced to a heap of stones, and the inside is cylindrical, not taper, as is usual with others. The burgh of Hogscter, upon an isle in a loch of the same name, has also its addition of a wall; a peculiarity in a causeway, to join it to the main land, and a singular internal structure. Numbers of little burghs, with single cells, are scattered about these islands, in the neighbourhood of the greater; and which probably were built by the poorer sort of people, in order to enjoy their protection. A multitude of places in these islands have the addition of burgh to their names, notwithstanding there is not a vestige of a tower near them; the materials having long since been carried away, and applied to various uses.

DUNBAR, a royal borough of Scotland, in the shire of East Lothian, once remarkable for a strong castle, the key of Scotland from the east, and which gave shelter to Edward II. of England in his flight from Bannockburn, but of which scarce a vestige now remains. Here are still preserved some of the Scottish pikes, six ells long, and formed both for offence and defence. This town has now a tolerable trade in the fisheries, and is remarkable for making good malt. Dunbar contained 3965 inhabitants in 1811.

DUNBARTON, the county town of Lennox or Dunbartonshire, in Scotland, situated in W. Long. 4. 32. N. Lat. 56. 30. is a royal borough, and one of the most ancient towns of Scotland. It is said to have been once the capital of a kingdom of the Britons, established in the vale of the Clyde, and to have been one of the seats of Fingal, called in the poems of Ossian, the *tower of Balclutha*. Alcluid was indeed the name of this ancient capital of the Strathclydenses; but whether it was situated on the site of the present town, or confined within the precincts of the castle, cannot be exactly ascertained. Dunbarton is built upon the eastern bank of the Leven, which almost encircles it. The greater part of the buildings are old, and the principal street has an air of decayed grandeur. It was erected into a royal borough by Alexander II. in the year 1221, and declared to be free of all imposts and borough taxes; but notwithstanding this material advantage, and the excellent harbour it possesses, it is by no means in a flourishing state. There are here considerable glass-houses, which employ about 300 hands; and some idea may be conceived of the extent of this manufacture, from the amount of the duties to government, which, in the five years preceding 1818, averaged 97,300l. per annum. This place is exceedingly well adapted for manufactures, both on account of its situation on the Clyde, and from its being well supplied with fuel at a cheap rate. The parish is nearly circular, having a diameter of about two miles and a half: the surface is flat, and the soil fertile, but shallow, inclining to gravel. The Clyde washes it on the south, and the Leven on the west, both of which contain excellent trout and salmon. The population of the town in 1811 was 2970, of the parish 3121. The castle of Dunbarton lies at a small distance from the town, on the point of land formed by the junction of the Clyde and Leven; it is situated on the top of a rock, which presents a picturesque object: the rock divides about the middle, and forms two summits: the sides are craggy, and the buildings upon it, though not of themselves beautiful, have a good effect, and, as Mr Gilpin observes, "serve to give it an air of consequence." The fortress is entered by a gate at the bottom; and within the rampart, which defends the entrance, is the guard-house, and lodgings for the officers; from hence the ascent is by a long flight of stone steps to the part where the rock divides: here is a strong battery, barracks for the garrison, and a reservoir always filled with water; above these, on the lower summit, are several batteries, which command a most extensive range. According to Pennant, the Britons, in very early times, made this rock a fortress, it being usual for them, after the departure of the Romans, to retire to the tops of craggy inaccessible mountains, to forests, and to rocks on the sides of rivers, or the shores of the sea. Boethius, however, asserts, that it was possessed by the Caledonians long before the Britons, and that it resisted all the efforts of Agricola to reduce it. The venerable Bede informs us, that it was the strongest fortification in the kingdom in his time, and deemed almost impenetrable; it was reduced by famine in the year 756, by Egbert king of Northumberland, and taken by escalade in the year 1551. The rock seems to have been anciently a volcano: the sides are composed of rude basaltic columns, of which huge masses have been broken off, and fallen to the bottom, by the injuries of time. Many parts of the rock are strongly magnetic, causing the compass to vary at a considerable distance: this circumstance was long since noticed by Buchanan, (Scot. Hist. lib. xx. lect. 28.). As the castle of Dunbarton commands the navigation of the Clyde, and is the key of the western Highlands, the fortifications are generally kept in repair. It is garrisoned by a governor, lieutenant-governor, a fort-major, subaltern officers, and a company of invalids. The government is said to be worth 700l. per annum.

DUNBARTONSHIRE, or, as it was anciently called, the shire of *Lennox*, extends in length about 40 miles, and in breadth about 23. It is bounded on the north by Argyleshire; on the east by the counties of Perth and Stirling; on the south by the river Clyde, and part of Lanarkshire; and on the west by an arm of the sea, called *Loch Long*. The greater part of the county is covered with heathy hills which are now assuming a more luxuriant appearance, since the introduction of sheep. Many of the mountains are elevated to a great height, Benlomond measuring 3158 feet above the level of the sea. The ridge of which Benlomond is a part, is the beginning of that extensive ridge which crosses the country from this place to the east coast at Aberdeen, called the *Grampians*. The lower grounds, which lie on the banks of Loch Lomond, the river Clyde and the Leven, are not so fertile as the corresponding parts of some of the neighbouring counties; notwithstanding which, it is agreeably diversified, and well inhabited. The banks of the Leven, in particular, are covered with numerous bleachfields, printfields, and cotton-works, giving employment to thousands; while the villages erected for the accommodation of the workmen, the hamlets, and elegant seats, cannot fail to impress the mind with high ideas of the wealth, the industry, the public spirit, and the happiness of the inhabitants. Agriculture in this county was formerly rather neglected; but the public spirit has of late been roused to this most useful and important occupation; and the county of Dunbarton, which is capable of much improvement, is fast advancing in agricultural progress. The county contains altogether 230 square miles, or 147,200 acres. The farmers here, indeed, possess numerous advantages: being near a sea-port town, where every article bears the highest price, they find a ready market for their corn; and the numerous inhabitants in the immediate neighbourhood require supplies of other necessaries from the farmer. Upwards of 12,000 acres are covered with natural wood, and there are many fine lakes or lochs, of which Loch Lomond is the chief. Dunbartonshire contains one royal borough, Dunbarton, several thriving manufacturing villages; and is divided into 12 parishes, containing in all 24,189 inhabitants in 1811.

Population of this County at two different periods, from Statist. Hist. of Scotland.

Parishes.	Population in 1755.	Population in 1790—1798.
1 Arroquhar	466	379
Bonhill	901	2310
Cardross	795	2194
Cumbernauld	2303	1600
5 Dunbarton	1480	2003
Kilmaronock	1193	820
Kilpatrick, New	1390	1700
Kilpatrick, Old	1281	2452
Kirkintilloch	1696	2639
10 Luss	978	917
Roseneath	521	394
12 Row	853	1000
	13,857	18,408
Population in 1811	24,189	

See Dunbartonshire, Supplement.

DUNCANNON, a fort in the county of Wexford, and province of Leinster, in Ireland, seated on the river Ross. It commands the river, insomuch that no ship can pass to Waterford or Ross without its permission. Here are barracks for three companies of foot. W. Long. 6. 30. N. Lat. 52. 10.

DUNCARDS, Dunkers, or *Tunkers*. See Tunkers.

DUNCOMBE, William, younger, son of John Duncombe, Esq. of Stocks in Hertfordshire, in 1722 published a translation of Racine's Athaliah; which was well received by the public, and has gone through three editions. In 1724 he was editor of the works of Mr Needler; in 1755, of the poems of his deceased brother-in-law Mr Hughes, 2 vols 12mo; in 1737, of the miscellanies of his younger brother Mr Jabez Hughes, for the benefit of his widow, in one volume 8vo; and in 1745, of the works of the Rev. Mr Samuel Say, in one volume 4to. In 1726 he married the only sister of John Hughes, Esq. whom he long survived. In 1734 his tragedy of Lucius Junius Brutus was acted at Drury Lane theatre. It was published in 1735, and again in 1747. The works of Horace, in English verse, by several hands, were published by him in two vols 8vo, with notes, &c. in 1757. A second edition, in 4 vols 12mo, with many imitations, was published in 1762. In 1763 he collected and republished "Seven sermons by Archbishop Herring, on public occasions, with a biographical preface." He died Feb. 26. 1769, aged 80.

DUNDALK, a town of Ireland, in the county of Louth, about 48 miles from Dublin. It is a large, ancient, and thriving town, with a wide street, near a mile long, and a very fine market-house, near the entrance from Dublin. In the reign of Edward II. it was a royal city, and the last we read of where a monarch of all Ireland was actually crowned and resided. It was formerly very strong, and had many towers and small castles in it. The bay has good moorings at all times, in four to upwards of eight fathoms water, with very good land-marks, either for bringing up to, or making the harbour; and in crossing the bar at high water, or ordinary neap tides, there is from 15 to 18 feet water. The only cambric manufacture in Ireland is in this town. The population is about 15,000.

DUNDAS, Henry, *Viscount Melville*, an eminent British statesman. See Supplement.

DUNDEE, a borough town of Scotland, in the shire of Forfar or Angus, is seated on the north side of the river Tay, about 12 measured miles from its mouth, 40 measured miles north of Edinburgh, and 22 east from Perth, in W. Long. 2. 48. N. Lat. 56. 26. Its situation for commerce is very advantageous. Trading vessels of the largest burden can get into the harbour; and on the quay there are three very convenient and handsome warehouses built in 1756, as well as good room for shipbuilding, which is carried on to a large extent. The houses are built of stone, generally three or four stories high. The market-place or high street in the middle of the town is a very spacious oblong square, 360 feet long and 100 feet broad; from whence branch out the four principal streets, which with a number of lesser ones are all paved in the best manner. On the south side of the market-place stands the townhouse, an elegant structure, with a very handsome front, piazzas below, and a neat spire over it 140 feet high. This building was finished in the year 1734, and contains the guildhall, the court-room, a very neat mason lodge, the bank, vaulted repositories for the records, and the common prison, which is in the upper story, and does honour to the taste and humanity of the magistrates, under whose auspices it was constructed, being well aired commodious rooms, at the same time very strong and secure. Each prison is

20 feet by 12, and 7½ feet high, well arched above and below.

The meal market and shambles, which were formerly on the high street, and esteemed a nuisance, were removed some years ago; and in the place of the shambles there is now erected by the incorporated trades, on the east end of the above large square, a grand building, with a large and elegant cupola: in the ground flat of which is a very neat coffee room, and several merchant shops; and in the upper stories public rooms for each trade, and a common hall occasionally used as a theatre. This hall is 50 feet long, 30 feet broad, and 25 feet high; having its front to the square decorated with Ionic columns.

The opulence of the corporations, nine in number, may be inferred from this, that they had, along with the kirk session, but very lately finished a most elegant church when they set about building the hall. This church, which is called *St Andrew's Church*, stands on a rising ground a little north from the Cowgate street; and has an elegant spire 130 feet high, with a peal of bells much admired. There is a neat entry to the church by a broad gravel walk, with grass plots on each side; and the whole policies around it are laid out with excellent taste, and in a superb style, as complete and well executed as any in Scotland.

Dundee, beside St Andrew's church, has four other churches, and five ministers on the legal establishment. The old church, in which were originally four places of worship, when entire, had been a very magnificent building, with a large square Gothic tower or steeple 186 feet high, on the west end of the church. This building was in the form of a cross, erected by David earl of Huntingdon, brother to William I. of Scotland (surnamed the Lion), and was dedicated to the virgin Mary. This he did on his return from the third crusade (in which with 500 of his countrymen he had accompanied Richard I. of England) anno 1189, in gratitude for his deliverance from several imminent dangers, and particularly from shipwreck, by which he had nearly perished when in sight of this town. At the same time he changed the name of the town from *Allectum* to *Dei Donum*, whence its present name is thought by many to be derived; while others maintain that its name was *Duntay*, or "the hill of Tay." The word *Allectum* in the Gaelic signifies "beautiful," and harmonizes very well with the Scripture sense of the hill of God. The word *Duntay* has the very same signification, "the Hill of God;" and both agree with the delightful situation of Dundee, and unite in giving it with propriety the name of *Bonny Dundee.* The hill rises on the north of the town to a great height, and is called *The Law of Dundee; law* being a Saxon word for a round hill such as it is. On its top there is evidently the remains of a camp, said to have been first erected by Edward I. of England, and lastly repaired by General Monk. Where the meal market stood is now erected an elegant Episcopal meeting-house; with handsome shops below.

Dundee had an old castle which was demolished by the famous Scots governor Sir William Wallace, who was educated in this town. The castle had proved very useful to Edward I. when he put a garrison into it to awe the inhabitants; but Wallace getting possession, ordered it to be destroyed, lest it should again fall into the hands of the English. This treatment so exasperated Edward, that, taking the town by storm, he set fire to the churches; and a number of the inhabitants having taken sanctuary there with their most valuable effects, were all burnt along with them. At that time he burnt also a great part of the town. The desolation he brought on the church has continued ever since, till the year 1787, when a noble edifice began to be built on the site of the one that was burnt down, and is now finishing; in which the ancient Gothic of the outside is excellently united with internal modern architecture, making one of the largest and neatest churches in the kingdom, and again completing the superb superstructure as erected at first by the earl of Huntingdon.

This town suffered greatly last century during the troubles of Charles II. and the usurpation of Oliver Cromwell; being sometimes under the command of one party, and at others in the mercy of another. In 1645 the marquis of Montrose took it by storm; and in 1651, under the command of its provost Major General Lumsden, it vigorously opposed General Monk, who carried it by storm the 1st of September, and put all in arms to the sword. And so great were the riches of Dundee, all the neighbouring gentlemen having retired to it with their best effects as a place of safety, that every private soldier in General Monk's army had near 60l. sterling to his share of the plunder; there being above 60 merchant vessels in the harbour at that time, and the like number of vessels sailed for England loaded with the spoils of the unfortunate inhabitants. By these and other invasions, the whole ancient records of the town were destroyed, except a deed of Queen Mary, signed by herself, conferring the present burying ground; and some charters of the Charles's, confirming the ancient rights and privileges as disponed by the Alexanders and other kings of Scotland. This burying-ground is the only place in Scotland we know of called *The Hoff*, a Dutch word bearing all the senses of the English word *court*, having been formerly the burying-ground of one of the many religious houses that were in this town previous to the Reformation.

Dundee at present has 154 vessels belonging to the port, of about 16,000 tons burden, which employ 1300 seamen. Of these vessels 8 are employed in the Greenland fishery, 11 in the London trade, and the rest in the Baltic and country trade. Between 1814 and 1818 the bonding system was extended to Dundee by various acts of parliament. The magistrates have been lately and still are at great expence in enlarging and fitting up the harbour, so as to render it of easy access, safe, and commodious; and have now made the passage over the Tay, where there is a great resort, so convenient, that travellers with their horses can get over at any time of tide, and a sufficient number of good boats properly manned are always ready. The river Tay opposite Dundee is about three miles broad; and being sheltered by high lands on both sides is a safe road for ships of the greatest burden: the piers are extensive, broad, and well adapted for the purposes of loading and discharging vessels; and when the harbour is completed on the plan they are presently engaged in, there will not be one superior to it in Scotland.

To enable the town to repair the damage done by Cromwell's ndee.

Cromwell's army, and also their harbour and other public works, Charles II. granted them a small impost of one-sixth of a penny sterling, for 25 years, on the pint of ale brewed or brought into the town for sale; which grant has been frequently renewed by subsequent parliaments; and the fund arising therefrom is most properly bestowed by the magistrates in improving the town, and making it more convenient and healthy. For these purposes, several new streets have been made, the old ones have been widened, and a large convenient one at a considerable expence, carried down from the market place to join a fine walk, shaded very neatly with trees, that leads to the shore. This new street makes the acces easy and commodious, which was formerly much confined and steep.

Till the year 1745, the town had only draw wells; but since that period it is most amply supplied from a large fine fountain of excellent water, conveyed through the town in lead pipes, and discharged by good wells at proper distance. These, with a fine well in the town's meadows, and a stream of water that runs through the ward and the meadows (two large beautiful greens on the north of the town), make it as well watered as any town in Scotland; and these greens, just at hand, serve all the inhabitants most commodiously for the necessary labours of washing and bleaching.

The number of inhabitants in Dundee has increased amazingly since 1780. There was then an accurate list of them taken, when they amounted to near 16,000; but by the census of 1801, the number was 26,084; and by the census of 1811, it was 29,616. Beside the established churches, there are three Episcopal meeting-houses, two of Seceders, one of Methodists, two of Independents, one Berean, and two Anabaptists. One of the Independents is of the Glassite denomination. Mr John Glass, from whom they take that name, resided here; and his principles, though spread far and wide, have always had the most extensive influence in Dundee.

The trade in the town has increased amazingly of late. Its staple is undoubtedly the linen manufacture: for which in summer 1788, they imported from the Baltic 32 cargoes of flax, hemp, &c. (near 3000 tons), besides several quantities from London, Leith, and other places; and on an average the brown linen stamped for the two preceding seasons at the stamp office here amounted to above four millions of yards, in value about 115,000l. sterling. But the annual average value of the cloth stamped in Dundee for 1815, 1816, and 1817, was above 300,000l. The flax is wrought up into coarse linens, chiefly osnaburgs, sheetings, soldiers shirtings, &c. which is sold partly bleached (several fine large bleachfields being well employed in the neighbourhood) and partly brown. These linens are sent principally to London, Glasgow, and Liverpool, and from thence exported. Seven or eight vessels are constantly employed in the trade between Dundee and London, one of which sails every ten or twelve days. The making sailcloth has been long established here, and is carried on to a good extent; and rope-works have succeeded well. The Dundee coloured threads have been long justly esteemed, and give bread to a great number of people; indeed it was here that coloured threads first made a figure among the articles of trade in Scotland. Their sugar-house, a large undertaking, and tan works, are of established reputation. There has been lately erected a large glass-work at a great expence, and a plumbery and foundery are also now carried on to advantage. No doubt the trade of the place has been greatly promoted by the Bank; which is carried forward on the surest and most steady footing, and has always managed the business of the town and neighbourhood in such a way as to keep any other establishment of that kind from taking place. Of late the cotton manufactory has been introduced; a number of jennies being employed in spinning, and several looms in weaving it. A spirit for literature and education has greatly prevailed of late years in Dundee: for beside the public grammar school, which has an able rector and two good masters; the public English and writing school, where are three very proper masters; there is also lately established, and much encouraged, an academy for mathematics, French, Italian, and the polite arts, with masters suitable for the different branches, and a large apparatus for natural philosophy.

Dundee
||
Dunkeld.

The salmon fishing in Tay is of much consequence; and the town is generally well supplied with fish of various kinds, though like every other article of living much raised in price of late years. Their other markets are also well supplied. An excellent nursery at the west end of the town has been much encouraged; and its neighbourhood is now adorned with many neat and elegant villas, showing the wealth and taste of the inhabitants.

Dundee is the birthplace of the celebrated and learned Hector Boethius, whose History of Scotland has been long in much reputation with many. Dundee, with Perth, Forfar, St Andrew's, and Cupar, returns one member to the British parliament.

DUNFERMLINE. See DUMFERMLINE.

DUNG, in *Husbandry*. See AGRICULTURE *Index*.

DUNG-*Bird*. See UPUPA, ORNITHOLOGY *Index*.

DUNG-*Meers*, in *Husbandry*, places where soils and dungs are mixed and digested together. These consist of pits, prepared at the bottom with stone and clay, that they may hold water, or the moisture of the dung: and ought to be so situated, that the sinks and drips of the houses and barns may run into them. Into these pits they cast refuse, fodder, litter, dung, weeds, &c. where they lie and rot together, till the farmer have occasion for them.

DUNG-*Worms*, a species of fly worms, of a short and somewhat flat body, found in great plenty among cowdung in the months of September and October.

DUNGANNON, the chief town of the county of Tyrone, in the province of Ulster in Ireland. It is seated on a hill, and is a place of some strength.

DUNGARVON, a town of Ireland, in the county of Waterford. It stands on a bay of the same name, has a commodious harbour for ships, and is a walled town, with a castle. W. Long. 7. 55. N. Lat. 51. 57.

DUNIPACE. See CARRON.

DUNKELD, a town of Scotland, in the shire of Perth, seated on the north side of the river Tay, in a situation truly romantic, among very high and almost inaccessible crags, part naked and part wooded.

wooded. It is the chief market town of the Highlands, and has been greatly improved with buildings by the dukes of Athol.

The place is of great antiquity. It was the capital of ancient Caledonia. About the dawn of Christianity, a Pictish king made it the seat of religion, by erecting a monastery of Culdees there; which King David I. in 1130 converted into a cathedral, and it ranked as the first in Scotland. The entire shell of the cathedral still remains, the east end serving for a kirk, on the north side of which is the burial place of the dukes of Athol. The style of architecture is simple and elegant, the pillars round. The monument of one of its bishops remains on the south aisle of the nave, as also that of Alexander Stuart earl of Buchan, third son of Robert II. called for his cruelty *The Wolf of Badenoch*, who died in 1394. The tower at the west end, with a singular crack down one of its sides, adds to the picturesque appearance which the whole makes among the venerable pines at the end of the duke's garden. His Grace's seat is a modern building, and not large, with pleasant walks and plantations, and a fine cascade on the water of Bran, which in its way from the western hills forms an astonishing fall of 150 feet, called the *Rumbling Brig*, from a narrow bridge made by the fall of two rocks across the stream. The pencil of Rosa never formed a more horrid scene. The stream has a second fall, which, without seeing the other, would be deemed capital. Sir James Galloway, master of requests to James VI. and Charles I. was created Lord Dunkeld 1645, whose grandson James was attainted at the Revolution, and dying at the beginning of this century, the title became extinct. Population 1360 in 1811.

DUNKERS, DUNCARDS, or *Tunkers*. See TUNKERS.

DUNKIRK, a maritime town of the French Netherlands, situated in E. Long. 2. 28. N. Lat. 51. 10. and is the most easterly harbour on the side of France which is next to Great Britain.—It was originally a mean hamlet, consisting only of a few fishermen's huts: but a church being built there, it was from that, and from its situation, which is a sandy eminence, called *Dunkirk; dun* signifying, in the old Gallic language, a hill; and *kirk* being the old Flemish name for church.

About the year 960, Baldwin earl of Flanders, thinking the situation convenient, enlarged it into a kind of town, and surrounded it with a wall. In the year 1322, Robert of Flanders, who held it as an appendage, built a castle for its defence; which was afterwards demolished by the revolters of Flanders. Robert of Bar erected a fortification round it, the remains of which are visible on the side next the harbour. The emperor Charles V. who held it as part of Flanders, built another castle to defend the harbour; but this was also demolished soon afterwards. In 1588, the French, under Marshal de Thermes, took Dunkirk by storm, and almost ruined the place; the Spaniards recovered it again in about a fortnight, and put all the French to the sword.

During a peace procured for the Dunkirkers by Philip II. of Spain, they rebuilt their town with greater splendour than before, and the inhabitants for a long time subsisted by privateers fitted out against the Dutch; and at length, growing rich by these hostilities, they fortified their town and harbour, and fitted out no less than 15 ships of war at their own charge.

In 1634, the Dunkirkers agreed with the inhabitants of Bergues to dig a canal, at their joint expence, for a communication between the two towns; which was some time afterwards effected. By this time Dunkirk was become the best harbour the Spaniards possessed in Flanders, which induced many foreigners to settle there; and it being necessary to enlarge the town for their accommodation, a new fortified wall was built at a considerable distance from the former. In 1646, it was besieged and taken by the prince of Condé. In 1652 it was retaken by the archduke Leopold, then governor of the Netherlands. France entering into a treaty with England in 1655, the Dunkirkers, with views of pecuniary advantage, fitted out privateers against both these powers: the consequence of which was, that the French, assisted by Cromwell, attacked and took it; and it was put into the hands of the English, in consequence of a treaty between them and the French. To the English it was even then of very great importance; for during the war in which it was taken, the Dunkirkers had made prizes of no less than 250 of their ships, many of which were of great value. They therefore improved the fortifications, and built a citadel; yet they kept it only four years; for in 1662, two years after the Restoration, Charles II. sold this valuable acquisition to France, for the paltry sum of 500,000l. In consequence of this sale, the town was taken possession of for the French king Louis XIV. by the count d'Estrades, on the 29th of November 1662. Louis having acquainted the celebrated engineer Monsieur Vauban, that he intended to make Dunkirk one of the strongest places in Europe, Vauban drew up a plan with that view, which was gradually executed. An arsenal was erected, large enough to contain all the stores necessary for fitting out and maintaining a large fleet of men of war; the fortifications on the land side were constructed in a manner that was thought to render them impregnable; and, towards the sea, the entrance of the harbour being properly formed, it was fortified by the jetties, and the two forts called *Green Fort* and the *Fort of Good Hope* at their extremities; the famous risbank was also erected on the side of the jetties, and Fort Galliard on the other, to secure the town. These works were all completed in 1683; and in 1685, the whole circumference of the bason was faced with masonry, and the keys completely formed: at the same time care was taken to build at the entrance of this bason a sluice, almost 45 feet wide, that the ships within might be constantly afloat. In 1689, the fort called the *Cornichon*, and some other works, were completed. But though 30 years had been now employed in improving the fortifications of Dunkirk, it was not yet in the state in which Louis intended to put it; and therefore, in 1701, he caused a new risbank to be built, called *Fort Blanc*.

At the treaty of Utrecht, it having been made appear, that the privateers of Dunkirk had, during the war then closing, taken from the English no less than 1614 prizes valued at 1,334,375l. sterling, it was stipulated, that the fortifications of the city and port

port of Dunkirk should be entirely demolished, and the harbour filled up, so as never to be a harbour again.

The treaty of which this demolition of Dunkirk was an article, was signed on the 28th of April 1713; but the demolition did not take place till the September following, when the queen deputed Colonel Armstrong and Colonel Clayton to oversee the execution of the treaty as far as concerned the works and harbour of Dunkirk. Under the inspection of these gentlemen, the places of arms were broken down, the ditches filled up, and the demi-lunes, bastions, and covered way, totally destroyed; the citadel was razed, and the harbour and bason filled up; the jetties were also levelled with the strand, and all the forts which defended the entrance into the harbour were demolished. A large dam, or bar, was also built across the mouth of the harbour between the jetties and the town, by which all communication between the harbour and the canal, which formed its entrance, was entirely cut off. The sluices were also broken up, and the materials of them broken to pieces.

But this was no sooner done, than Louis XIV. ordered 30,000 men to work incessantly upon a new canal, the canal of Mardick, which in a short time they accomplished; by which the harbour was rendered almost as commodious as ever; but in 1717 this likewise was rendered unserviceable. In the year 1720, during a great storm, the sea broke up the bar or dam, and restored to the Dunkirkers the use of the harbour in a very considerable degree. In the year 1740, when Great Britain was engaged in a war with Spain, Louis XV. set about improving the advantage which Dunkirk had derived from the storm in 1720, by restoring the works, and repairing the harbour; and soon afterwards he espoused the cause of Spain, and became a principal in the war against us. But at the peace of Aix-la-Chapelle in 1748, it was stipulated, that all the works towards the sea should be destroyed a second time; yet, before the declaration of the American war, the place was in a good state of defence towards the sea. At the peace in 1783 Britain was not in a condition to insist on so obnoxious a stipulation, and its harbour has since been unmolested. The check which the British troops received here in 1793, was the commencement of a series of disasters.

DUNNING John, *Lord Ashburton*, an eminent English lawyer. See Supplement.

DUNSE, a market town of Scotland, in the shire of Mers, situated in W. Long. 2. 15. N. Lat. 55. 42. It is situated on a rising ground in the middle of the shire, and has a weekly market for cattle. It is by some reputed the birthplace of the famous John Duns Scotus. A mile south of the town is a well of mineral water, of great use as a deobstruent and antiscorbutic, first discovered in 1747 by Dr Thomas Simpson who practised there. Population 3082 in 1811.

DUNS SCOTUS, *John*, a Franciscan friar, commonly called *Doctor Subtilis*, was born in the year 1274; but whether in England, Scotland, or Ireland, hath long been a matter of dispute among the learned of each nation. Dempster, Mackenzie, and other Scottish writers, assert positively that he was born at Dunse, a town in Scotland, about 15 miles from Berwick; and, to secure him more effectually, Mackenzie makes him descended from the Dunses in the Mers. Maccaghwell, an Irish author, who wrote the life of this Scotus, proves him to have been born at Down in the province of Ulster in Ireland: but Leland, Bale, Camden, and Pits, assure us, that he was born at Dunstone in the parish of Emildune, near Alnwick in Northumberland; and this opinion is rendered probable by the following conclusion of his manuscript works in the library of Merton college in Oxford.—"Here end the writings of that subtile doctor of the university of Paris, John Duns, who was born in a certain village, in the parish of Emildune, called *Dunston*, in the county of Northumberland." We are told, that when a boy, he became accidentally known to two Franciscan friars; who, finding him to be a youth of very extraordinary capacity, took him to their convent at Newcastle, and afterwards persuaded him to become one of their fraternity. From thence he was sent to Oxford, where he was made fellow of Merton college, and professor of divinity; and Mackenzie says, that not less than 30,000 students came to Oxford to hear his lectures. His fame was now become so universal, that the general of his order commanded him to go to Paris, that the students of that university might also profit from his lectures. He went to Paris in the year 1304, where he was honoured first with the degree of bachelor, then of doctor of divinity, and in 1307 was appointed regent of the divinity schools: during his residence here, the famous controversy about the *Immaculate conception of the virgin Mary* arose. Albertus Magnus maintained that she was born in original sin. Scotus advanced 200 arguments in support of the contrary opinion, and convinced the university of Paris that she was really conceived immaculate. This important nonsense, however, continued to be disputed till the year 1496, after the council of Basil, when the university of Paris made a decree, that no student, who did not believe the *immaculate conception*, should be admitted to a degree. Our author had not been above a year at Paris, when the same general of the Franciscans ordered him to remove to Cologne; where he was received with great pomp and ceremony by the magistrates and nobles of that city, and where he died of an apoplexy soon after his arrival, in the year 1308, in the 34th year of his age. Some writers have reported, that Scotus was buried in an epileptic fit; and that, upon removing his bones, he appeared to have turned himself in his coffin. This *Doctor Subtilis* was doubtless one of the first wranglers of his time, admirably well versed in scholastic divinity, and a most indefatigable scribbler; but the misfortune is, that all his huge volumes do not contain a single page worth the perusal of a rational being. He was the author of a new sect of schoolmen called *Scotists;* who opposed the opinions of the Thomists, so called from St Thomas Aquinas. The reader will find a more particular account of Scotus in the Franciscan Martyrology, published at Paris in 1638. He was a most voluminous writer; his works making 12 vols folio, as published at Lyons by Luke Wadding, 1639.

DUNSTABLE, a town in Bedfordshire, with a market on Wednesdays. It is seated on a chalky hill; and has ponds in the streets, which are never dry though only supplied with rain-water. It is remarkable for several good inns, it being a great thoroughfare on the northern

Dunstable
‖
Dunstan.

northern road. It consists of four streets, intersecting each other at right angles; and in the centre stood one of those beautiful crosses of Queen Eleanor, which was destroyed in the time of the civil wars. Population 1616 in 1811. W. Long. 0. 29. N. Lat. 51. 50.

DUNSTAFFNAGE. See LORNE.

DUNSTAN, a famous saint, and archbishop of Canterbury: of whom the monkish historians give us the following account. He was descended from a noble family in Wessex, and educated in the abbey of Glastonbury. Here he studied so hard, that it threw him into a violent fever, which brought him to the very point of death. When the whole family were standing about his bed, dissolved in tears, and expecting every moment to see him expire, an angel came from heaven in a dreadful storm, and gave him a medicine which restored him to perfect health in a moment. Dunstan immediately started from his bed, and ran with all his speed towards the church to return thanks for his recovery; but the devil met him by the way, surrounded by a great multitude of black dogs, and endeavoured to obstruct his passage. This would have frightened some boys; but it had no such effect upon Dunstan; who pronouncing a sacred name, and brandishing his stick, put the devil and all his dogs to flight. The church doors being shut, an angel took him in his arms, conveyed him through an opening in the roof, and set him softly down on the floor, where he performed his devotions. After his recovery, he pursued his studies with the greatest ardour, and soon became a perfect master in philosophy, divinity, music, painting, writing, sculpture, working in gold, silver, brass, and iron, &c. When he was still very young he entered into holy orders, and was introduced by his uncle Athelm archbishop of Canterbury to King Athelstan; who, charmed with his person and accomplishments, retained him in his court, and employed him in many great affairs. At leisure hours he used to entertain the king and his courtiers with playing on his harp, or some other musical instrument; and now and then he wrought a miracle, which gained him great admiration. His old enemy the devil was much offended at this, and prompted some envious courtiers to persuade the king that his favourite was a magician, which that prince too readily believed. Dunstan discovering by the king's countenance that he had lost his favour, and resolving to resign rather than be turned out, retired from court to another uncle, who was bishop of Winchester. This good prelate prevailed upon his nephew to forsake the world and become a monk; after which he retired to a little cell, built against the church wall of Glastonbury. Here he slept, studied, prayed, meditated, and sometimes amused himself with forging several useful things in brass and iron. One evening, as he was working very busily at his forge, the devil, putting on the appearance of a man, thrust his head in at the window of his cell, and asked him to make something or other for him. Dunstan was so intent upon his work that he made no answer; on which the devil began to swear and talk obscenely, which betrayed the lurking fiend. The holy blacksmith, putting up a secret ejaculation, pulled his tongs, which were red hot, out of the fire, seized the devil with them by the nose, and squeezed him with all his strength; which made his infernal majesty roar and scold at such a rate, that he awakened and terrified all the people for many miles around. Thus far the legend.

Dunstan

Ridiculous as were these fictions, they served, in those times of ignorance, to procure Dunstan a reputation which has been confirmed by the authority of several succeeding historians. It appears that this extraordinary person was called to court by King Edmund, A. D. 941; who bestowed upon him the rich abbey of Glastonbury, which for his sake he honoured with many peculiar privileges. He enjoyed a very high degree of the favour of this prince during his short reign of six years; but he stood much higher in the favour of his brother and successor King Edred, to whom he was confessor, chief confidant, and prime minister. He employed all his influence during this period of court favour in promoting the interest of the monks of the Benedictine order, to which he belonged, and of which he was a most active and zealous patron. Having the treasures of these two princes, especially of the last, very much at his command, he lavished them away in building and endowing monasteries for these monks, because almost all the old monasteries were in the possession of secular canons. Not contented with this, he persuaded Edred (who was a bigotted valetudinary) to bestow such immense treasures on the churches and monasteries by his last will, that the crown was stripped of its most valuable possessions, and left in a state of indigence. This conduct of Dunstan, while he was in power, rendered him very odious to Edwi, who succeeded his uncle Edred A. D. 955; and his rude behaviour to himself, and his beloved queen Elgiva, raised the resentment of that prince so high, that he deprived him of all his preferments, and drove him into exile *. The banishment of Dunstan, the great patron, or (as Malmsbury calls him) the prince of monks, was a severe blow to that order, who were expelled from several monasteries; which were made the impure stables (according to the same author) of the married clergy. But their sufferings were not of long continuance. For Edgar the younger brother of Edwi, having raised a successful rebellion against his unhappy brother, and usurped all his dominions on the north side of the river Thames, recalled Dunstan, and gave him the bishopric of Worcester, A. D. 957. From this moment he was the chief confidant and prime minister of King Edgar, who became sole monarch of England A. D. 959, by the death of his elder brother Edwi. In the following year Dunstan was raised to be archbishop of Canterbury; and being thus possessed of the primacy, and assured of the royal support and assistance, he prepared to execute the grand design which he had long meditated, of compelling the secular canons to put away their wives and become monks; or of driving them out, and introducing Benedictine monks in their room. With this view he procured the promotion of Oswald to the see of Worcester, and of Ethelwald to that of Winchester; two prelates who were monks themselves, and animated with the most ardent zeal for the advancement of their order. And these three great champions of the order found means, by their arts and intrigues, in the course of a few years, to fill no fewer than 48 monasteries with Benedictines. But on the death of Edgar in 975 they received a check. The

sufferings

---

*See
land, N

sufferings of the persecuted canons had excited much compassion; and many of the nobility, who had been overawed by the power and zeal of the late king, now espoused their cause and promoted their restoration. Elferc duke of Mercia drove the monks by force out of all the monasteries in that extensive province, and brought back the canons, with their wives and children; while Elfwin duke of East Anglia, and Brithnot duke of Essex, raised their troops to protect the monks in these countries. To allay these commotions, several councils were held: in which Dunstan was so hard pushed by the secular canons and their friends, that he was obliged to practise some of his holy stratagems; and finally, by dint of miracles, overcame all opposition *.

St Dunstan died A. D. 988, in the 64th year of his age, having held the bishopric of London, together with the archbishopric of Canterbury, about 27 years. As this prelate was the great restorer and promoter of the monastic institutions, the grateful monks, who were almost the only historians of those dark ages, have loaded him with the most extravagant praises, and represented him as the greatest wonder-worker and highest favourite of heaven that ever lived. To say nothing of his many conflicts with the devil, in which he often belaboured that enemy of mankind most severely, the following short story, which is told with great exultation by his biographer Osbern, will give the reader some idea of the astonishing impiety and impudence of those monks, and of the no less astonishing blindness and credulity of those unhappy times. "The most admirable, the most inestimable Father Dunstan (says that author), whose perfections exceeded all human imagination, was admitted to behold the mother of God and his own mother in eternal glory; for before his death he was carried up into heaven, to be present at the nuptials of his own mother with the Eternal King, which were celebrated by the angels with the most sweet and joyous songs. When the angels reproached him for his silence on this great occasion, so honourable to his mother, he excused himself on account of his being unacquainted with those sweet and heavenly strains; but being a little instructed by the angels, he broke out into this melodious song, O King and Ruler of nations," &c. It is unnecessary to make any comment on this most shocking story.

The violent and too successful zeal of Dunstan and his associates, in promoting the building and endowing so great a number of houses for the entertainment of useless monks and nuns, was very fatal to their country: for by this means a spirit of irrational unmanly superstition was diffused amongst the people, which debased their minds, and diverted them from nobler pursuits; and a very great proportion of the lands of England being put into hands who contributed nothing to its defence, rendered it an easy prey, first to the insulting Danes, and afterwards to the victorious Normans.

DUNUM, a Celtic term, denoting a hill or eminence, and which often concurs to form the names of towns, to signify their high situation, places of strength or citadels; hills or eminences being adapted to such structures. See DUN.

DUNUM (Ptolemy), a town of Ireland; now thought to be *Down* or *Down-Patrick*, in the county of Down. W. Long. 5. 57. N. Lat. 54. 23.

DUO, in *Music*, a song or composition, to be performed on two parts only; one sung, the other played on an instrument, or by two voices.

DUO is also when two voices sing different parts, as accompanied with a third, which is a thorough bass. It is seldom that unisons and octaves are used in duos, except at the beginning and end.

DUODECIMA, in *Music*, is the twelfth or the fifth doubled.

DUODENUM. See ANATOMY *Index*.

DUPIN, LEWIS ELLIS, a learned doctor of the Sorbonne, and one of the greatest critics of his time, especially in ecclesiastical matters, was born at Paris in 1657. When he published the first volume of his *Bibliotheque Universelle des Auteurs Ecclesiastiques*, in 1686, the liberty with which he treated some ecclesiastical writers gave such offence, that M. de Harlay, archbishop of Paris, obliged Dupin to retract many propositions, and suppressed the work. He was nevertheless suffered to continue it, by altering the title from *Bibliotheque Universelle* to *Bibliotheque Nouvelle*. This great undertaking, continued in several successive volumes, though sufficient to occupy the life of an ordinary man, did not hinder M. Dupin from obliging the world with several other works. He was a man of prodigious reading; and had an easy happy way of writing, with an uncommon talent at analyzing the works of an author; which makes his Ecclesiastical Bibliotheque so valuable. M. Dupin was professor of philosophy in the royal college: but was banished some time from the chair to Chatelherault, on account of the famous *Cas de Conscience*; but was restored, and died in 1719.

DUPLE, among mathematicians, denotes the ratio of 2 to 1. Thus the ratio of 8 to 4 is duple, or as 2 to 1.

Sub-DUPLE Ratio, is just the reverse of the former, or as 1 to 2. Such is 4 to 8, or 6 to 12.

DUPLICATE, among lawyers, denotes a copy of any deed, writing, or account. It is also used for the second letters-patent, granted by the lord chancellor in a case wherein he had before done the same. Also a second letter written and sent to the same party and purpose as a former, for fear of the first's miscarrying, is called a *Duplicate*.

DUPLICATE Proportion or *Ratio*. See RATIO.

DUPLICATION, in general, signifies the doubling of any thing, or multiplying of it by 2: also the folding of any thing back again on itself.

DUPLICATURE, among anatomists, a term used to denote the folds of any membrane or vessel: thus we say, the *duplicatures of the intestines*, *peritonæum*, &c.

DUPONDIUS, in antiquity, a weight of two pounds, or money of the value of two asses. See AS.

As the as at first weighed just a pondo or libra, the dupondius then weighed two; and hence the name.

And though the weight of the as was afterwards diminished, and of consequence that of the dupondius also, yet they still retained the denomination. See POUND and LIBRA.

DUPPA, BRIAN, a learned English bishop, born in 1589

---

* S Eng- an N°64.

1589 at Lewisham in Kent, of which place his father was then vicar. In 1634, he was instituted chancellor of the church at Sarum, and soon after made chaplain to Charles I. He was appointed tutor to Charles prince of Wales, and his brother James duke of York; was made bishop of Chichester; and in 1641 translated to Salisbury, though the confusions that followed deprived him of all benefit from his promotion. Charles I. held him in high esteem, and he is said to have assisted the king in composing the *Eikon Basilike*. On the Restoration he was made bishop of Winchester, and lord high almoner; but died in 1662.

DUPUIS, Charles Francis, an eminent French writer. See Supplement.

DURANDUS, William, born at Puimoission in Provence, in the 13th century, was one of the most knowing lawyers of his time. Pope Martin made him one of his nuncios, and then bishop of Mende and Languedoc. His *Speculum Juris* gave him the name of *Speculator*; his second piece was *Rationale divinorum officiorum*, containing eight books. He wrote several others.

DURANTA, in *Botany*, a genus of plants, belonging to the didynamia class, and in the natural method ranking under the 40th order, *Personatæ*. See Botany *Index*.

DURATION, an idea we get by attending to the fleeting and perpetual perishing parts of succession. See Metaphysics.

Duration, as marked by certain periods and measures, is what we most properly call *time*. See Time.

Duration of Action, according to Aristotle, is confined to a natural day in tragedy; but the epopea, according to the same critic, has no fixed time. See Poetry.

DURER, Albert, descended of an Hungarian family, and born at Nuremberg in 1471, was one of the best engravers and painters of his age. He was at the same time a man of letters and a philosopher; and he was an intimate friend of Erasmus, who revised some of the pieces which he published. He was a man of business also, and for many years the leading magistrate of Nuremberg. Though not the inventor, he was one of the first improvers of the art of engraving; and he bethought himself of working also in wood, for expedition, having an inexhaustible fund of designs. In many of those prints which he executed on copper, the engraving is elegant to a great degree. His *Hell-Scene* particularly, which was engraved in the year 1513, is as highly finished a print as ever was engraved, and as happily executed. In his wooden prints too we are surprised to see so much meaning in so early a master; the heads so well marked, and every part so well executed.—This artist seems to have understood the principles of design. His composition, too, is often pleasing; and his drawing generally good. But he knows very little of the management of light; and still less of grace: and yet his ideas are purer and more elegant than we could have supposed from the awkward archetypes which his country and education afforded. In a word, he was certainly a man of very extensive genius; and, as Vasari remarks, would have been an extraordinary artist, if he had had an Italian instead of a German education. His prints are very numerous. They were much admired in his own lifetime, and eagerly bought up; which put his wife, who was a teasing woman, upon urging him to spend more time upon engraving than he was inclined to do. He was rich; and chose rather to practice his art as an amusement than as a business. He died in the year 1527.

DURESSE, Hardship, in *Law*, is where a person is kept in prison or restrained of his liberty, contrary to order of law; or is threatened to be killed, maimed, or beaten. In which case, if a person so in prison, or in fear of such threats, make any specialty or obligation, by reason of such imprisonment or threats, such deed is void in law; and in an action brought on such specialty, the party may plead, that it was brought by duresse.

D'URFEY, Thomas, an eminent English satirist and songster, whose name, though as well known as that of any writer extant, yet there are very few particulars of his life to be collected. He was born in Devonshire; but when, where, or of what family, are all uncertain. He was bred to the law, which he forsook for the more agreeable employment of writing plays and songs; and the latter he had so happy a talent both of writing and singing, that he received many favours from persons of quality on that account. Even crowned heads did not disdain his company. The writer of the Guardian, N° 67. tells us, he remembered to have seen Charles II. leaning on Tom D'Urfey's shoulder more than once, humming over a song with him. This indeed was not extraordinary in so merry a monarch; but even the phlegmatic King William could relax his muscles on hearing him sing. He was certainly by all accounts a cheerful, honest, good-natured man; but as this character does not include prudence, D'Urfey grew poor as he grew old: and prevailing on the managers of the playhouse to act his comedy of the *Plotting Sisters* for his benefit, Mr Addison wrote the above-mentioned paper in the Guardian, with another, N° 82. representing him in a good-humoured light, to procure him a full house. He died very old, in 1723.

DURHAM, Bishopric of, one of the counties of England. Before the arrival of the Romans it was included in the British principality of the Brigantes, and after their arrival made part of the province of Maxima Cæsariensis. During the Heptarchy it made part of the kingdom of Northumberland, the 5th established, which began in 547, and ended in 827, having been governed by 31 kings. It was not mentioned by Alfred in his division of counties, being at that time considered as a part of Yorkshire. At present it is included in the northern circuit, in the province of York; and is a diocese and principality under the government of its own bishop, being a county palatine, the second in rank, and the richest in England. It is bounded on the north by Northumberland, on the south by Yorkshire, on the east by the North sea, and on the west by Cumberland. It is 39 miles long, 35 broad, and 107 in circumference; containing 410,000 square acres, or 758 square miles; with 177,625 inhabitants (1811), 80 parishes, 21 vicarages, one city (Durham), and 9 market towns, viz. Stockton, Sunderland, Barnard-Castle, Darlington, Stanhope, Hartlepool, Auckland, Staindrop, and Marwood; besides 223 villages. It is divided ham. divided into 4 wards, sends 4 members to parliament, pays three portions of the land tax, and provides 400 of the national militia. It has 21 parks, 4 castles, and 20 bridges, with the rivers Tees, Tine, Were, Tame, Lune, Darwent, Gauntless, Skern, &c. and the Lune and Teesdale forests. Its principal products are lead, coals, iron, corn, mustard, salt, glass, fine ale, with excellent butter and salmon. The soil is various; the south is rich, but the western parts rocky and moorish.

Durham, as already observed, is a county palatine, governed by the bishop, who had formerly great prerogatives. He had power to create barons, appoint judges, convoke parliaments, raise taxes, and coin money. The courts of justice were kept in his name; and he granted pardons for trespasses, alienations, rapes, murders, and felonies of every denomination. He erected corporations, granted markets and fairs, created officers by patent, was lord admiral of the seas and waters within the county palatine: great part of the lands were held of the see *in capite*. In a word, he exercised all the power and jurisdiction of a sovereign prince. How and at what period these prerogatives were obtained, it is not easy to determine. Malmsbury says, the lands were granted by King Alfred, who likewise made the church a sanctuary for criminals. This see was anciently called the *patrimony of St Cuthbert*, who had been bishop of Lindisfarne or Holy Island near Berwick. His bones being transferred to Durham, were long esteemed as precious relics; and the people of the county considered themselves as Halwerk men, exempted from all other but holy work, that is, the defence of St Cuthbert's body. Certain it is, they pretended to hold their lands by this tenure; and refused to serve out of the county either for the king or bishop: but King Edward I. broke through these privileges, and curtailed the prerogatives of the bishops, which were still further abridged by Henry VIII. Nevertheless, the bishop is still earl of Sadberg, a place in this county which he holds by barony. He is sheriff paramount, and appoints his own deputy, who makes up his audit to him, instead of accounting to the exchequer. He has all the forfeitures upon outlawries: and he and his temporal chancellor act as justices of the peace for the county palatine, which comprehends Creke in Yorkshire, Bedlington, Northam, and Holy Island, in Northumberland; the inhabitants of these places having the benefit of the courts at Durham. The judges of assize, and all the officers of the court, have still their ancient salaries from the bishop; and he constitutes the standing officers by his letters patent. He has the power of presiding in person in any of the courts of judicature. Even when judgment of blood is given, this prelate may sit in court in his purple robes, though the canons forbid any clergyman to be present in such cases: hence the old saying, *Solum Dunelmense stola jus dicet et ense.* It was not till the reign of Charles II. that the bishopric sent representatives to parliament.

Durham.

Durham, the capital of the above-mentioned county, is situated in W. Long. 1. 14. N. Lat. 54. 50. It stands on a hill almost surrounded by the river Were; and is considerable for its extent and the number of its inhabitants, as well as for being the see or seat of the bishop, who is lord paramount. It stands about 280 miles north from London; being remarkable for the salubrity of its air, and the abundance and cheapness of its provisions. These circumstances have induced a great deal of good company to take up their residence at Durham, which is still further animated by the presence and court of the bishop and his clergy. The town is said to have been built about 70 years before the Roman conquest, on occasion of bringing hither the body of St Cuthbert. It was first incorporated by King Richard I. but Queen Elizabeth extended its privileges. At length, in the year 1684, it obtained a charter; in consequence of which, it is now governed by a mayor, 12 aldermen, 12 common council men, with a recorder and inferior officers. These can hold a court leet and court baron within the city; but under the style of the bishop, who, as count palatine, appoints a judge, steward, sheriffs, and other inferior magistrates. The mayor and aldermen also keep a *pie pouldres* court at their fairs, and pay a yearly toll to the bishop. They have a weekly market on Saturday, and three annual fairs. Durham is about half a mile in length, and has been by some compared to the figure of a crab, the market place exhibiting the body, and the claws being represented by the streets, which bend according to the course of the river, which almost surrounds one part of the city. They are, moreover, dark and narrow; and some of them steep and dangerous to wheel carriages. The number of inhabitants in 1811 was 6763. The houses are in general strong built, but neither light nor elegant. The most remarkable edifices are the cathedral, with six other churches, three standing in the city, and as many in the suburbs; the college; the castle, or bishop's palace; the tolbooth near St Nicholas's church; the cross and conduit in the market place; with two bridges over the Were. The cathedral was begun by Bishop Carilepho in the 11th century. It is a large, magnificent, Gothic structure, 411 feet long, and 80 in breadth, having a cross aisle in the middle 170 feet in length, and two smaller aisles at each end. On the south side is a fine cloister; on the east, the old library, the chapter house and part of the deanery; on the west, the dormitory, under which is the treasury and chantry; and on the west side is the new library, an elegant building begun by Dean Sudbury about 70 years ago, on the spot where stood the old refectory of the convent. The middle tower of the cathedral is 212 feet high. The whole building is arched and supported by huge pillars. Several of the windows are curiously painted; and there is a handsome screen at the entrance into the choir. Sixteen bishops are interred in the chapter-house, which is 75 feet long, and 33 broad, arched overhead, with a magnificent seat at the upper end for the instalment of the bishops. The consistory is kept in the chapel of the west aisle called *Galilee*, which was built by Bishop Pubsey, and had formerly 16 altars for women, as they were not allowed to advance farther than the line of marble by the side of the font; here likewise are deposited the bones of the venerable Bede, whose eulogium is written on an old parchment scroll that hangs over his tomb. The long cross aisle at the extremity of the church was formerly distinguished by nine altars, four to the north, and four to the south, and the most magnificent in the middle dedicated to the patron St Cuthbert,

Durham.

bert, whose rich shrine was in this quarter, formerly much frequented by pilgrims. The church is possessed of some old records relating to the affairs of Scotland, the kings of which were great benefactors to this cathedral. The ornaments here used for administering the divine offices, are said to be richer than those of any other cathedral in England. Before the Reformation, it was distinguished by the name *Ecclesia sanctæ Mariæ et sancti Cuthberti;* but it obtained the appellation of *Ecclesia cathedralis Christi et beatæ Mariæ*, in the reign of Henry VIII. who endowed the deanery with 12 prebendaries, 12 minor canons, a deacon, subdeacon, 16 lay singing men, a schoolmaster and usher, a master of the choir, a divinity reader, eight almsmen, 18 scholars, 10 choristers, two vergers, two porters, two cooks, two butlers, and two sacristans. On the south side of the cathedral is the college; a spacious court formed by the houses of the prebendaries, who are richly endowed and extremely well lodged. Above the college gate, at the east end, is the exchequer; and at the west, a large hall for entertaining strangers, with the granary and other offices of the convent. The college school, with the master's house, stands on the north side of the cathedral. Between the churchyard and castle is an open area called the *palace green;* at the west end of which stands the shire hall, where the assizes and sessions are held for the county. Close by is the library built by Bishop Cosin; together with the exchequer raised by Bishop Nevil, in which are kept the offices belonging to the county palatine court. There is an hospital on the east, endowed by Bishop Cosin, and at each end of it are two schools founded by Bishop Langley. On the north, is the castle built by William the Conqueror, and afterwards converted into the bishop's palace, the outward gate of which is at present the county gaol.

The city consists of three manors; the bishop's manor, containing the city liberties and the bailey, held of him by the service of castle guard; the manor of the dean and chapter, consisting of the Elvet's cross-gate, South-gate street; and the manor of Gilligate, formerly belonging to the dissolved hospital of Kepyar in this neighbourhood, but granted by Edward VI. to John Cockburn, lord of Ormistoun, and late in the possession of John Tempest, Esq.

The bishopric of Durham is deemed the richest bishopric in the kingdom; and the prebends are frequently styled the Golden Prebends of Durham. The diocese contains the whole counties of Durham and Northumberland, except the jurisdiction of Hexham in the latter. It hath also one parish in the county of Cumberland: making in the whole 135 parishes, whereof 87 are impropriate. The see is valued in the king's books at 2821l. 1s. 5$\frac{1}{4}$d. but is said to be worth about ten times that sum annually. The clergy's tenths amount to 385l. 5s. 6$\frac{1}{2}$d. It has two archdeacons, viz. of Durham and Northumberland. This see hath given to the church of Rome eight saints and one cardinal; and to the English nation one lord chief justice, five lord chancellors, three lord treasurers, one principal secretary of state, one chancellor to the university of Oxford, and two masters of the rolls.

In the neighbourhood of this city is Nevil's cross, famous for the battle fought in the year 1346, against David II. king of Scotland, who was defeated and taken prisoner.

Durham ‖ Dury.

DURIO, a genus of plants belonging to the polyadelphia class. See BOTANY *Index.*

DURNIUM, or DURNOVARIA, a town of the Durotriges in Britain; now *Dorchester*, the capital of Dorsetshire, on the Frome.

DUROBRIVÆ, in *Ancient Geography*, a town of the Catyeuchlani in Britain. Now in ruins, which lie on the Nen, between Caster and Dornford, in Northamptonshire, on the borders of Huntingdon.

DUROBRIVÆ, or *Durocobrivæ*, a town of the Trinobantes, in Britain; whose ruins are situated between Flamstead and Redburn, in Hertfordshire.

DUROBRIVES, 25 miles to the west of Durovernum, or Canterbury; from which it appears to be Rochester town: confirmed by the charter of foundation of the church, in which it is called *Durobrevis.*

DUROCASES, DUROCASSIUM, DUROCASSÆ, and DUROCASSES, a town of the Carnutes in Gallia Celtica; now Dreux. See DRUIDÆ.

DUROCORNOVIUM, in *Ancient Geography*, a town of Britain; now *Cirencester* in Gloucestershire (Camden), called *Corinium* by Ptolemy.

DUROCORTORUM, or DURICORTORA, a town of the Rhemi in Belgica; now *Rheims* in Champagne. E. Long. 4. 8. N. Lat. 49. 20.

DUROIA, in *Botany;* a genus of plants belonging to the hexandria class of plants. See BOTANY *Index.*

DUROLENUM, a town of the Cantii in Britain; now *Lenham*, in Kent (Camden); *Charing* (Talbot.)

DUROLITUM, a town of the Trinobantes; now *Leiton*, on the Ley, in Essex (Camden).

DUROTRIGES, an ancient British nation, seated in that part of the country which is now called *Dorsetshire.* Their name is derived from the two British words *Dur*, "water," and *Trigo*, "to dwell;" and it is no less evident that they got their name from the situation of their country, which lies along the sea coast. It is not very certain whether the Durotriges formed an independent state, under a prince of their own, or were united with their neighbours the Danmonii; as they were reduced by Vespasian under the dominion of the Romans, at the same time, and with the same ease, and never revolted. The peaceable disposition of the inhabitants was probably the reason that the Romans had so few towns, forts, and garrisons, in this pleasant country. Dorchester, its present capital, seems to have been a Roman city of some consideration, though our antiquaries are not agreed about its Roman name. It is most probable, that it was the Durnovaria in the 12th Iter of Antoninus. Many Roman coins have been found at Dorchester; the military way, called *Jeening-street*, passed through it; and some vestiges of the ancient stone wall with which it was surrounded, and of the amphitheatre with which it was adorned, are still visible. The country of the Durotriges was included in the Roman province called *Flavia Cæsariensis*, and governed by the president of that province, as long as the Romans kept any footing in these parts.

DURY, JOHN, a Scots divine, who travelled much, and laboured with great zeal to reunite the Lutherans with

with the Calvinists. His discouragements in this scheme started another still more impracticable; and this was to reunite all Christians by means of a new explication of the Apocalypse, which he published at Frankfort in 1677. He enjoyed then a comfortable retreat in the country of Hesse; but the time of his death is unknown: his letter to Peter du Moulin concerning the state of the churches of England, Scotland, and Ireland, was printed at London in 1658, by the care of du Moulin, and is esteemed to be curious.

DUSKY BAY, a bay of the island of New Zealand in the Southern Pacific ocean. It is in S. Lat. 45. 47. and in E. Long. 166. 18.

DUSSAULX, JOHN, a French writer of the last century. See SUPPLEMENT.

DUSSELDORF, a city of Germany, and capital of the duchy of Berg. It is situated at the conflux of the river Dussel with the Rhine, in E. Long. 6. 25. N. Lat. 51. 12. It was formerly the residence of the elector palatine. Carlstadt, or the new town, is divided into six regular quarters which open into an extensive square; and forms a beautiful addition to the old city. Dusseldorf was taken by the French in 1795. The fortifications were demolished after the peace in 1801. In 1806 it became the residence of the grand duke of Berg; but in 1815 it was made over, with the rest of the duchy, to Prussia. It contains, including the garrison, 18,000 inhabitants.

DUTENS, LOUIS, a French miscellaneous writer. See SUPPLEMENT.

DUTCHY. See DUCHY.

DUTY, in general, denotes any thing that one is obliged to perform.

DUTY, in a moral sense. See *MORAL Philosophy*.

DUTY, in polity and commerce, signifies the impost laid on merchandises, at importation or exportation, commonly called the duties of customs; also the taxes of excise, stamp duties, &c. See CUSTOMS, EXCISE, &c.

The principles on which all duties and customs should be laid on foreign merchandises which are imported into these kingdoms, are such as tend to cement a mutual friendship and traffic between one nation and another; and therefore due care should be taken in the laying of them, that they may answer so good an end, and be reciprocal in both countries; they should be so laid as to make the exports of this nation at least equal to our imports from those nations wherewith we trade, to the end that no greater number of our landholders and manufacturers should be deprived of their revenues arising from the product of the lands, and the labour of the people, by foreign importations, than are maintained by exportations to such countries. These are the national principles on which all our treaties of commerce with other countries ought to be grounded.

DUTY, in the military art, is the exercise of those functions that belong to a soldier: with this distinction, that mounting guard and the like, where there is no enemy directly to be engaged, is called duty; but their marching to meet and fight an enemy is called going on service.

DUUMVIRATE, the office or dignity of the duumviri. See the next article.

The duumvirate lasted till the year of Rome 388, when it was changed into a decemvirate.

DUUMVIRI, in Roman antiquity, a general appellation given to magistrates, commissioners, and officers, where two were joined together in the same functions.

DUUMVIRI Capitales were the judges in criminal causes: from their sentence it was lawful to appeal to the people, who only had the power of condemning a citizen to death. These judges were taken from the body of the decuriones; they had great power and authority, were members of the public council, and had two lictors to walk before them.

DUUMVIRI Municipales, were two magistrates in some cities of the empire, answering to what the consuls were at Rome: they were chosen out of the body of the decuriones; their office lasted commonly five years, upon which account they were frequently termed *quinquinales magistratus*. Their jurisdiction was of great extent: they had officers who walked before them, carrying a small switch in their hands; and some of them assumed the privilege of having lictors, carrying axes, and the fasces or bundles of rods, before them.

DUUMVIRI Navales, were the commissaries of the fleet, first created at the request of M. Decius, tribune of the people, in the time of the war with the Samnites. The duty of their office consisted in giving orders for the fitting of ships, and giving their commissions to the marine officers, &c.

DUUMVIRI Sacrorum, were magistrates created by Tarquinius Superbus, for the performance of the sacrifices, and keeping of the sibyls books. They were chosen from among the patricians, and held their office for life; they were exempted from serving in the wars, and from the offices imposed on the other citizens, and without them the oracles of the sibyls could not be consulted.

DUYVELAND, or DIVELAND, one of the islands of Zealand, in the United Provinces, lying eastward of Schonen, from which it is only separated by a narrow channel.

DWAL, in *Heraldry*, the herb nightshade, used by such as blazon with flowers and herbs, instead of metals and colours, for sable or black.

DWARF, in general an appellation given to things greatly inferior in size to that which is usual in their several kinds: thus there are dwarfs of the human species, dwarf dogs, dwarf trees, &c.

The Romans were passionately fond of dwarfs, whom they called *nani* or *nanæ*, insomuch that they often used artificial methods to prevent the growth of boys designed for dwarfs, by enclosing them in boxes, or by the use of tight bandages. Augustus's niece, Julia, was extremely fond of a dwarf called *Sonopas*, who was only two feet and a handbreadth high. We have many other accounts of human dwarfs, but most of them deformed in some way or other besides the smallness of their size. Many relations also concerning dwarfs we must necessarily look upon to be fabulous, as well as those concerning giants. The following history, however, which we have reason to look upon as authentic, is too remarkable not to be acceptable to the generality of our readers.

Dwarf.

Jeffery Hudson, the famous English dwarf, was born at Oakham, in Rutlandshire, in 1619; and about the age of seven or eight, being then but 18 inches high, was retained in the service of the duke of Buckingham, who resided at Burleigh on the Hill. Soon after the marriage of Charles I. the king and queen being entertained at Burleigh, little Jeffery was served up to table in a cold pie, and presented by the duchess to the queen, who kept him as her dwarf. From 7 years of age till 30, he never grew taller; but after 30, he shot up to three feet nine inches, and there fixed. Jeffery became a considerable part of the entertainment of the court. Sir William Davenant wrote a poem called *Jeffreidos*, on a battle between him and a turkey cock; and in 1638, was published a very small book, called the *New Year's Gift*, presented at court by the lady Parvula to the lord Minimus (commonly called *Little Jeffery*) her majesty's servant, &c. written by Microphilus, with a little print of Jeffery prefixed. Before this period, Jeffery was employed on a negotiation of great importance: he was sent to France to fetch a midwife for the queen; and on his return with this gentlewoman, and her majesty's dancing master, and many rich presents to the queen from her mother Mary de Medicis, he was taken by the Dunkirkers. Jeffery, thus made of consequence, grew to think himself really so. He had borne with little temper the teasing of the courtiers and domestics, and had many squabbles with the king's gigantic porter. At last, being provoked by Mr Crofts, a young gentleman of family, a challenge ensued; and Mr Crofts coming to the rendezvous armed only with a squirt, the little creature was so enraged, that a real duel ensued; and the appointment being on horseback with pistols, to put them more on a level, Jeffery, with the first fire, shot his antagonist dead. This happened in France, whither he had attended his mistress in the troubles. He was again taken prisoner by a Turkish rover, and sold into Barbary. He probably did not remain long in slavery; for at the beginning of the civil war, he was made a captain in the royal army; and in 1644 attended the queen to France, where he remained till the Restoration. At last, upon suspicion of his being privy to the popish plot, he was taken up in 1682, and confined in the Gatehouse, Westminster, where he ended his life, in the 63d year of his age.

In the memoirs of the Royal Academy of Sciences, a relation is given by the count de Tressau, of a dwarf called *Bebe* kept by the late Stanislaus, king of Poland, and who died in 1764, at the age of 23, when he measured only 32 inches. At the time of his birth, he measured only between eight and nine inches. Diminutive as were his dimensions, his reasoning faculties were not less scanty; appearing indeed not to have been superior to those of a well-taught pointer; but that the size and strength of the intellectual powers are not affected by the diminutiveness or tenuity of the corporeal organs, is evident from a still more striking instance of littleness, given us by the same nobleman, in the person of Monsieur Borulawski, a Polish gentleman, whom he saw at Luneville, who has since been at Paris, and who at the age of 22 measured only 28 inches. This miniature of a man, considering him only as to his bodily dimensions, appears a giant with regard to his mental powers and attainments. He is described by the count as possessing all the graces of wit, united with a sound judgment and an excellent memory; so that we may with justice say of M. Borulawski, in the words of Seneca, and nearly in the order in which he has used them, "*Posse ingenium fortissimum ac beatissimum sub quolibet corpusculo latere.*" Epist. 66.

Dwarf, Dwina.

Count Borulawski was the son of a Polish nobleman attached to the fortunes of King Stanislaus, who lost his property in consequence of that attachment, and who had six children, three dwarfs, and three well grown. What is singular enough, they were born alternately, a big one and a little one, though both parents were of the common size. The little count's youngest sister was much less than him, but died at the age of 23. The count continued to grow till he was about 30, and has at present attained his 51st year, and the height of three feet two inches. He never experienced any sickness, but lived in a polite and affluent manner under the patronage of a lady, a friend of the family, till love at the age of 41 intruded into his little peaceful bosom, and involved him in matrimony, care, and perplexity. The lady he chose was of his own country, but of French extraction, and the middle size. They have three children, all girls, and none of them likely to be dwarfs. To provide for a family now became an object big with difficulty, requiring all the exertion of his powers (which could promise but little) and his talents, of which music alone afforded any view of profit. He plays extremely well upon the guitar; and by having concerts in several of the principal cities in Germany, he raised temporary supplies. At Vienna he was persuaded to turn his thoughts to England, where it was believed the public curiosity might in a little time benefit him sufficiently to enable him to live independent in so cheap a country as Poland. He was furnished by very respectable friends with recommendations to several of the most distinguished characters in this kingdom, as the duchess of Devonshire, Rutland, &c. &c. whose kind patronage he is not backward to acknowledge. He was advised to let himself be seen as a curiosity, and the price of admission was fixed at a guinea. The number of his visitors, of course, was not very great. After a pretty long stay in London he went to Bath and Bristol; visited Dublin and some other parts of Ireland; whence he returned by way of Liverpool, Manchester, and Birmingham, to London. He also visited Edinburgh and some other towns of Scotland. In every place he acquired a number of friends. In reality, the ease and politeness of his manners and address please no less, than the diminutive, yet elegant, proportions of his figure astonish those who visit him. His person is pleasing and graceful, and his look manly and noble. He speaks French fluently, and English tolerably. He is remarkably lively and cheerful, though fitted for the most serious and rational conversation. Such is this wonderful little man—an object of curiosity really worthy the attention of the philosopher, the man of taste, and the anatomist. His life has been published, written by himself.

DWINA, the name of two large rivers; one of which rises in Lithuania, and, dividing Livonia from Courland, falls into the Baltic sea a little below Riga; the other gives name to the province of Dwina in Russia.

It runs from south to north, and discharges itself into the White sea a little below Archangel.

DYCK. See VANDYCK.

DYE, in *Architecture*, any square body, as the trunk or notched part of a pedestal: or it is the middle of the pedestal, or that part included between the base and the corniche; so called because it is often made in the form of a cube or dye. See ARCHITECTURE, N° 61.

DYER, a person who professes the art of dyeing all manner of colours. See DYEING.

DYER, *Sir James*, an eminent English lawyer, chief judge of the court of common pleas in the reign of Queen Elizabeth. He died in 1581: and about 20 years after was published his large collection of Reports, which have been highly esteemed for their succinctness and solidity. He also left other writings behind him relative to his profession.

DYER, *John*, the son of Robert Dyer, Esq. a Welsh solicitor of great capacity, was born in 1700. He passed through Westminster school under the care of Dr Freind, and was then called home to be instructed in his father's profession. His genius, however, led him a different way; for besides his early taste for poetry, having a passion no less strong for the arts of design, he determined to make painting his profession. With this view, having studied a while under his master, he became, as he tells his friend, an itinerant painter, and wandered about South Wales, and the parts adjacent; and about 1727 printed Grongar Hill. Being probably unsatisfied with his own proficiency, he made the tour of Italy; where, besides the usual study of the remains of antiquity, and the works of the great masters, he frequently spent whole days in the country about Rome and Florence, sketching those picturesque prospects with facility and spirit. Images from hence naturally transferred themselves into his poetical compositions: the principal beauties of The Ruins of Rome are perhaps of this kind; and the various landscapes in The Fleece have been particularly admired. On his return to England, he published The Ruins of Rome, 1740; but soon found that he could not relish a town life, nor submit to the assiduity required in his profession. As his turn of mind was rather serious, and his conduct and behaviour always irreproachable, he was advised by his friends to enter into holy orders; and it is presumed, though his education had not been regular, that he found no difficulty in obtaining them. He was ordained by the bishop of Lincoln, and had a law degree conferred on him.

About the same time he married a lady of Coleshill named Ensor; "whose grandmother (says he) was a Shakespeare, descended from a brother of every body's Shakespeare." His ecclesiastical provision was a long time but slender. His first patron, Mr Harper, gave him, in 1741, Calthorp in Leicestershire, of 80l. a-year, on which he lived ten years; and in April 1751 exchanged it for Belchford in Lincolnshire, of 75l. which was given him by Lord-chancellor Hardwicke, on the recommendation of a friend to virtue and the muses. His condition now began to mend. In 1752, Sir John Heathcote gave him Coningsby, of 140l. a-year; and in 1756, when he was LL. B. without any solicitation of his own, obtained for him from the chancellor Kirby-on-Bane, of 110l. In 1757, he published The Fleece, his greatest poetical work; of which Dr Johnson relates this ludicrous story. Dodsley the bookseller was one day mentioning it to a critical visitor, with more expectation of success than the other could easily admit. In the conversation the author's age was asked: and being represented as advanced in life, "He will (said the critic) be buried in woollen." He did not indeed long outlive that publication, nor long enjoy the increase of his preferments; for a consumptive disorder, with which he had long struggled, carried him off at length in 1758.

Mr Dyer's character as a writer has been fixed by three poems, Grongar Hill, The Ruins of Rome, and The Fleece; wherein a poetical imagination perfectly original, a natural simplicity connected with and often productive of the true sublime, and the warmest sentiments of benevolence and virtue, have been universally observed and admired. These pieces were put out separately in his lifetime: but after his death they were collected and published in one volume 8vo, 1761; with a short account of himself prefixed.

DYER's-Weed. See RESEDA, BOTANY and DYEING Index.

DYEING.

Definition.

1. DYEING is the art of communicating a permanent colour to any substance; but it is generally employed in a more limited sense, and is applied to the art of giving colours to wool, silk, cotton or flax, or to thread or cloth fabricated of these substances. To this more limited sense we propose to confine it in the following treatise; and for the dyeing or staining of other substances, as paper, wood, hone, leather, marble, the reader is referred to these articles.

Origin of arts.

2. Among the arts of life there are some which are essential to man even in the earliest period of his history; while others derive their origin from chance, and owe their improvement and perfection to the progress of refinement and luxury. Those arts which are connected with the means of providing food or shelter are necessary even in the rudest state of man, and are practised with more or less dexterity and success according to the abundance or scantiness of the supply with which he is furnished, and the varieties of climate which he inhabits. But those arts which have been distinguished by the name of *fine arts* can only flourish and arrive at a high degree of perfection in the more luxurious ages of refined society. To this account of the origin and progress of the arts among mankind, the art of dyeing forms a remarkable exception. Totally unconnected with the means of providing food to satisfy the urgent calls of hunger, of preparing raiment to secure the body from cold, or of procuring shelter from the storm, this art might at first sight be considered as one of those which exclusively

Origin.

belong to an age of luxury. But the history of mankind assigns to its origin a very different period. The art of dyeing seems to be almost co-eval with man. In the rudest state of his existence, his simple and scanty clothing is frequently coloured; and even the naked savage, while he is yet a houseless wanderer in the woods, has discovered the means of staining his body with different colours. And yet the art of dyeing in no respect contributes to relieve the real and primary wants of man. It renders not his raiment warmer, and it serves not to make his lodging more comfortable.

Of dyeing.

3. Whence then is the origin of this art? It depends not like others on the necessities of man, and it exists long before he is acquainted with refinement and luxury. It must therefore be traced to a different source.

We see that the desire of distinction is one of the most active principles in the human mind. This principle operates equally in the breast of the savage in the midst of his naked companions, and in that of the sage and the soldier in polished society. Man rarely rests satisfied with the solid, but frequently less obvious pre-eminence, which superior strength, genius, or learning, confers. The proofs of this superiority can be but seldom exhibited; they are often not generally understood or acknowledged, and therefore cannot always be fairly estimated. He who possesses any of those talents which give him a superiority to others, naturally wishes to be distinguished by certain marks by which he may more uniformly and more directly excite admiration and command respect. He seeks, therefore, for some adventitious circumstances, which may be regarded as a kind of symbolical representation of power and greatness; and as they are constantly present to the senses, they make a deep impression, and keep alive those feelings of admiration which are so gratifying to the vain and ambitious. Dress and its ornaments have been usually employed as external marks of distinction. Hence it is, that the chief or the warrior among rude nations is clothed with a finer and more beautiful skin; his head is decorated with flowers or feathers; or the leaves of the oak, or the laurel, simply adorn his brow. And in the progress of civilization and refinement, the diadem of gold, and the robe of purple or of scarlet, supplant these simpler decorations as characteristics of dignity and power. To increase still more the beauty and variety of those substances which are employed as clothing or as the ornaments of dress, the aid of colours has been called in; and accordingly we find that coloured clothing has been held in high estimation in all ages. This principle, therefore, the desire of distinction, seems to be the natural origin of the art of dyeing. Nature, however, furnishes the model, and may be regarded as the antetype of the art, in the gay plumage with which she has clothed the feathered tribes, and in the splendid colours and infinite variety of shades which are exhibited in her vegetable productions.

History.

4. But without indulging farther in these speculations, which are to be considered as subjects of curious investigation, rather than as topics of practical utility, let us now take a short view of the history and progress of this art.

and progress;

We have endeavoured to shew that the beauty of brilliant colours is one of the means of attracting attention, and of acquiring distinction, which mankind in every period of society have employed. Even before the use of clothing has been introduced, the rude inhabitants of savage nations applied them first to their skins. This practice existed among the Britons in the time of Cæsar; and the women of Gaul about the same period stained themselves of a brown olive colour. At this day, it is still the practice of many of the savage tribes of America, as well as of the natives of the South sea islands. But when mankind had made some progress in arts and civilization, and had begun to wear clothing, the colours which they admired were afterwards communicated to their garments. The art of dyeing, therefore, though in a rude and imperfect state, is indisputably of great antiqnity; and indeed considering its nature and origin, this might have been expected.

in India;

5. India, the nursery of the arts and sciences, which were afterwards improved and brought to perfection among other nations, seems to have given birth to the art of dyeing; and it would appear that the knowledge of dyeing cotton had advanced as far in the time of Alexander the Great as at the present time, so stationary have the arts become in that country. The beautiful colours of the Indian linens would naturally lead to the supposition that the art had reached a very high degree of perfection; but it is known that the Indian processes are so tedious, complicated and imperfect, that they would be totally impracticable in any other country.

among the Greeks,

6. It was not till the time of Alexander the Great that the art of dyeing cotton and linen, which had gradually spread from the east to the west, was known in Europe. The Greeks, however, as appears from many passages in the Iliad and Odyssey, were acquainted with the art of dyeing purple in the time of Homer. And it is supposed that they derived their knowledge of it from the Phenicians, a people who were very early celebrated for the art of dyeing. But their art seems to have been confined to wool; silk, indeed, was at that time unknown, and linen was usually worn white.

the Jews

7. Dyeing and coloured stuffs are frequently mentioned in the sacred writings. It would appear that the art had made considerable progress in the time of the patriarchs, from what is mentioned in the book of Genesis. The dyed stuffs which are described in the book of Exodus were purchased by the Jews from the Phenicians.

the Egyptians.

8. The Egyptians, according to Pliny, practised a kind of topical dyeing or calico-printing, which from his general description seems to have been similar to that which was found many ages after to exist in different parts of India, and was from thence introduced into the different countries of Europe. He says, the Egyptians began by painting on white cloths, which were no doubt of linen or cotton, with certain drugs which were themselves colourless, but possessed the property of absorbing colouring substances. These cloths were afterwards immersed in a heated dyeing liquor which was of one uniform colour, and although they were formerly colourless, yet when they were taken out, they were found to be dyed of different colours, according to the different qualities of the substances which had been applied to their different parts; and these colours could not afterwards be discharged by

by washing†. This art was probably borrowed from the natives of India.

he Tyrian urple.

9. The Tyrian purple, so celebrated among the ancients, was probably from the name discovered at Tyre, and perhaps contributed not a little to the opulence of that city. The liquor which was employed in dyeing the purple was extracted from two kinds of shell-fish, one of which, the larger, was called the *purple*, and the other was a species of whelk. Each of these species was subdivided into different varieties, and were otherwise distinguished, according to the places where they were found, and as they yielded more or less of a beautiful colour. It is in a vessel in the throat of the fish that the colouring liquor is found.

epara- n of the uor.

Each fish only afforded a single drop. When a certain quantity of the liquor had been obtained, it was mixed with a proportion of common salt, macerated together for three days, and five times the quantity of water was added. The mixture being kept in a moderate heat, the animal parts which happened to be mixed with it, separated and rose to the surface. At the end of ten days, when these operations were finished, a piece of white wool was immersed, by which means they ascertained whether the liquor had acquired the proper shade.

the ff.

Various processes were followed to prepare the stuff to receive the dye. By some it was immersed in lime water, and by others it was prepared with a kind of *fucus*, which acted as a mordant to give it a more fixed colour. Alkanet was used by some for the same purpose.

The liquor of the whelk did not alone yield a durable colour. The liquor from the other shell-fish served to increase its brightness; and thus two operations were in use to communicate this colour. A first dye was given by the liquor of the purple, and a second by that of the whelk; from which it was called by Pliny *purpura dibapha*, or purple twice dipped.

ma- cy.

10. Some kinds of purple have been found to possess great durability. Plutarch, in his life of Alexander the Great, mentions that the Greeks discovered in the treasury of the king of Persia a great quantity of purple which was 190 years old, and still retained all its beauty.

h price.

11. The small quantity of liquor which could be obtained from each shell-fish, and the tedious process in its preparation and application to the stuffs, raised the price of purple so high, that in the time of Augustus a pound of wool of the Tyrian purple dye, could not be purchased for one thousand denarii, equal to about 36l. sterling.

n by t Ro- ms.

12. The purple, which has been almost everywhere a mark of distinction attached to high birth and dignity, was worn by those who held the first offices in Rome. The emperors at last reserved to themselves the right of wearing it, and prohibited all others from using it on pain of death.

S used in eing.

13. The substances which have been discovered and used in dyeing by the moderns, and the superiority which they have obtained in many colours, have superseded the use of the purple of the ancients. The shell-fish from which the liquor is extracted, is supposed to be now as abundant as ever. Similar shell-fish have been found near Nicoya, a small Spanish town in South America, and they are at present used for dyeing cotton on the coasts of Guaiaquil and Guatimala.

The shell-fish found on the coasts of England

14. In the year 1683, Mr Cole of Bristol discovered, on the coast of England, the shell-fish which yields the purple liquor. The liquor was contained in a white vein, lying transversely in a little furrow or cleft, next to the head of the fish. He found by experiment, that letters or marks, made with this white liquor, appeared when first exposed to the air of a green colour. When exposed to the sun, it became of a deeper green, afterwards of a purplish red, and by the continued action of the sun's rays, of a deep purple red. Mr Cole sent some of the first linen marked with this liquor to Dr Plot, one of the secretaries of the Royal Society, in the year 1684. It was soon after shown to King Charles II. who greatly admired it, and desired that some of the shell-fish might be collected, and brought to town, that he might have an opportunity of seeing the liquor applied, and the successive changes of colour through which it passed.

and of France.

A species of this shell-fish was also found by Plumier at the Antilles; and Reaumur made a number of experiments on whelks, which were collected on the coast of Poitou. Duhamel found the same shell-fish in great abundance on the coast of Provence. The experiments of these philosophers on this liquor afforded the same result as those of Mr Cole. They observed that, although at first white, it becomes by the action of light, of a yellowish green, then deepens to a kind of blue, which is afterwards changed to a red. In less than five minutes, the latter is converted into a fine deep purple, having all the characters of the purple of the ancients.

Eudocia Macrembolitissa, daughter of the emperor Constantine VIII. who lived in the 11th century, while the knowledge and practice of dyeing that colour for the use and at the expence of the Greek emperors still subsisted, has given a minute account of the mode of catching the shell-fish which produced the purple. Of this operation she herself, it would appear, was an eyewitness. As it was applied at that time, it did not acquire its full lustre and perfection of colour, till it had been exposed to the action of the sun's rays.

Purple liquor found in snails.

15. A liquor which yields the same colour, and has otherwise similar properties, is found in different parts of the world. Abundance of purple snails, it is said, are found in the islands opposite to Batavia. They are boiled and eaten by the Chinese, who polish the shells, and pick out of the middle of the snail a purple-coloured substance, which they use in colouring and making red ink. Dr Peysonnel describes what he calls the naked snail, which is found in the seas of the Antilles, and affords a liquor of a beautiful purple colour. This liquor is thrown out by the animal when it is disturbed, in the same way as the cuttle-fish discharges the ink. The liquor of the snail is naturally of a purple colour, without the application of light *. Two shell-fishes, which yield a similar colouring liquor, are described by Dr Brown in his history of Jamaica. The one, he says, is frequent in the American seas, and emits on being touched a considerable quantity of viscid purple liquor, which thickens and colours water. The other is called the *purple ocean shell*, and yields a beautiful purple liquor, which seems to resemble the former. But investigations concern-

---

† *Plin.* lib.

* *Phil. Trans.* vol. i.

ing the nature and application of the purple dye from shell-fish are now to be considered merely as subjects of curiosity; because the colours which are obtained by the processes of the moderns are more beautiful, and far less expensive.

The arts lost.

16. In the 5th century, during the irruption of the northern barbarians, the arts, which had been encouraged and protected by the Romans, were lost amidst the devastations of the western empire. A few, indeed. were preserved in Italy, but they were in a state of decay; and otherwise no traces remained of knowledge, industry, or humanity. A manuscript of the 8th century is quoted by Muratori, which contains a description of some dyes, principally for skins, as well as some processes connected with other arts; but from the barbarous Latin in which it is written, no distinct notion can be formed of the nature of these processes. The arts met with a better fate in the East, where they were protected and encouraged. So late as the 12th century, articles of luxury were procured by some of the great from eastern countries.

Are revived in Italy.

17. During the time of the crusades, Venice and other cities of Italy became rich and powerful, first by supplying with provisions the Europeans who engaged in these frantic and destructive expeditions, and afterwards by establishing an intercourse with the Grecian empire. By these means the arts, which had been preserved among the Greeks, were established in Italy. In the year 1338, the city of Florence contained 200 manufacturers, who are said to have produced from 70,000 to 80,000 pieces of cloth. In the year 1300, archil was accidentally discovered by a Florentine merchant. Observing that urine produced a fine colour on certain species of moss, he made experiments, and from these learned the mode of preparing this substance. The discovery was long kept secret. His posterity, a branch of which it is said still exists, have retained the appellation of *Rucellai*, from the Spanish word which signifies that kind of moss.

Dyeing revived in Italy.

18. The arts, after being revived in Italy, continued for a long time to be cultivated and improved with increasing success. Along with these, the art of dyeing made considerable progress. The first collection of the processes employed in this art appeared at Venice in the year 1429. It was entitled *Mariegola del' arte de i tentori*. To render this description more useful and extensive, a person of the name of Giovanni Ventura Rosetti, travelled through different parts of Italy, and the neighbouring countries, where the arts had begun to flourish, that he might acquire a knowledge of the processes which were employed by different dyers. These were collected and published in 1548, under the title of *Plictho*. This treatise has been by some considered as the leading step towards the perfection which the art of dyeing has attained; for it is the first in which the different processes are collected. No mention is made either of cochineal or of indigo; so that it would appear, these dyes were either not known, or not employed in Italy previous to the time in which it was written.

19. Italy, but especially Venice, for a long time almost exclusively possessed the art of dyeing, and this seems to have contributed greatly to the prosperity of the manufactures and commerce which the Italian states long enjoyed. By degrees it was introduced into France, Holland, and Britain. The process for dyeing the true scarlet had been communicated to a person of the name of Gobelin. who established a manufactory near Paris, which still bears his name. At the time, this was considered so rash an enterprise, that it received the name of *Gobelin's folly*; but such was his success, and such was the ignorance of the times, that it was supposed he derived his knowledge of the processes he employed, from the devil!

Is introduced into France, &c.

20. The discovery of America brought the knowledge of the cochineal insect into Europe. The Spaniards observing that the Mexicans employed it in painting their houses, and in dyeing cotton, transmitted an account of the beauty of that colour to their government, whose attention was afterwards directed to encourage and promote the increase of this valuable insect from which it is obtained. The discovery of cochineal was soon followed by that of the process for dyeing scarlet, by means of a solution of tin. For this discovery we are indebted to a German chemist of the name of Kuster, or Kufler, who carried the secret to London in the year 1643. Gluck or Kloeck, a Flemish painter, having obtained possession of this secret, communicated it to Gobelin, and afterwards the knowledge of it spread throughout all Europe. The use of indigo, which was a great acquisition to the art of dyeing, was more slowly established than that of cochineal. In the reign of Queen Elizabeth, the use of this substance, as well as of logwood, was strictly prohibited in England, and, if found in any manufactory, was ordered to be burned. This, as must appear at the present time, very strange prohibition, was not withdrawn till the reign of Charles II. It met with the same fate in Saxony. In the edict in which the use of it is forbidden, it is said to be a corrosive colour, and called *food for the devil!!*

Indigo firs used.

21. In France also, some prejudice was entertained against it, and although it was not entirely prohibited, the use of it was limited to a certain proportion. The reason on which this prejudice was founded, on a narrow view of the principles of political economy, might even in the present day be admitted as specious, if not satisfactory. It was held out by those who dyed blue, and were accustomed to use pastil and woad, that the introduction of indigo would supersede the use of these substances; and it was represented that their consumption would be destroyed, and the encouragement for the productions of the country diminished.

Dyeing e- couraged in Franc

22. Previous to the administration of the celebrated Colbert, the industry and arts of France long remained in a state of languor and decay. By the wise measures which were adopted by this minister, she soon rose to distinction among the nations of Europe, and in a short time saw her commerce and manufactures greatly extended. He invited the most skilful artists, encouraged and rewarded their talents, and thus established many arts and manufactures. Among these, the art of dyeing received its share of attention. In the year 1672, he published a table of instructions for dyeing, which, although it contains many useless and improper restrictions, is on many accounts worthy of attention, and particularly the reasons which he has given for considering it as an object of consequence. As a proof of this, we may refer to the following extract.

tract from the instructions: "If, it is said, the manufactories of silk, wool, and thread, are to be reckoned among those which most contribute to the support of commerce; dyeing, which gives them that striking variety of colour, by which they resemble what is most beautiful in nature, may be considered as the soul of them, without which a body could scarcely exist.

"Wool and silk, the natural colour of which rather indicates the rudeness of former ages, than the genius and improvement of the present, would be in no great request, if the art of dyeing did not furnish attractions which recommend them, even to the most barbarous nations. All visible objects are distinguished and recommended by colours; but for the purposes of commerce, it is not only necessary that they should be beautiful, but that they should be good, and that their duration should equal that of the materials which they adorn."

stric-
ns.

23. But notwithstanding these just and liberal views, and many useful regulations, which were published for instruction in the art of dyeing, the restrictions imposed upon it, as we have already observed, were from mistaken views improper and injurious, because in this, as in every other art, these restraints infallibly operate as checks on industry and improvement. The effects of these prohibitions, however, were moderated by the facility with which they might be eluded, and by the rewards bestowed on those whose experiments promoted the progress of the art, and whose discoveries being afterwards published, served to modify the existing regulations. The effects of these prohibitions, too, were in a great measure obviated, by the judicious appointment of men of science, to whom the superintendence of arts and manufactures was entrusted. By their prudent exertions, and by the still more efficacious means of the diffusion of knowledge, this art, as well as others, has been encouraged and improved.

24. The French government continued to direct its attention to promote the plan which was thus begun by Colbert, and many eminent chemists have been employed to superintend and improve the processes of the art of dyeing. Dufay, Hellot, Macquer, and Berthollet, have been successively charged with the care of this department; and to their labours and exertions we are indebted for many valuable acquisitions which have been made in the art of dyeing, during the 18th century. Dufay was the first who entertained just views of the nature of colouring matters, and the powers by which they adhere. In the examination of certain processes he discovered great sagacity, and established the surest means which the state of knowledge at the time afforded, to ascertain the durability of a colour. Under his direction a new table of instructions, which superseded that of Colbert, was published in 1737. Hellot, who succeeded him, published in 1740 a methodical description of the processes for dyeing wool; and this treatise may be considered, even at the present day, as one of the best systems on the subject. Macquer in 1763 published a treatise on dyeing silk, in which he has given an accurate description of the processes, has discovered the combinations of the colouring principle of Prussian blue, and has endeavoured to make an application of it to the art of dyeing. Macquer died in 1784, and was succeeded in that department by the celebrated Berthollet, to whom was intrusted the superintendence of the arts connected with chemistry, and particularly that of dyeing. To his being placed in this department, we are probably indebted for the excellent work which he has published on this subject, and for different memoirs which have appeared in different periodical works. To these we must acknowledge ourselves greatly indebted for much of the information, both of the theory and practice of this art, which we propose to lay before our readers in the following treatise. He has endeavoured, he observes, to bring into one point of view the processes of industry, and the operations of nature; to take his situation between the philosopher and the artist. To the first he has shown, where it is that the phenomena of the art of dyeing and those of nature meet, and what are the principles which their discoveries have established. When these comprehensive views, we may add, are completed, the art of dyeing may be considered as perfect.

State of, in Britain.

25. The art of dyeing has been long successfully practised in Britain, although little has been done towards the investigation of the theory on which it depends. At an early period of the Royal Society, it attracted the attention of some of its members; but nothing was published on the subject. Many years afterwards, some useful observations on dyeing were published by Dr Lewis, but these were limited to a very few processes. The only work with which the British dyers were acquainted, till within these few years, was a translation of the treatise of Hellot, mentioned above.

Improved by chemistry.

26. But since the progress of chemical science has opened so wide a field of investigation; and since all the essential processes in the art of dyeing are to be considered as purely chemical, the attention of philosophers has been greatly occupied with its investigation and improvement. By their experiments and observations a great deal of new information has been accumulated, and much new light has been thrown upon the art.

Authors on dyeing.

27. The only treatise which has appeared in Sweden on this subject, is that of Scheffer, accompanied with notes by the celebrated Bergman. In Germany, experiments in different processes of dyeing have been published by Beckmann, Poerner, Vogler, and Francheville. The authors of the different treatises in France on this subject, which have greatly contributed to the improvement of the art, are D'Ambourney, D'Apligny, Haussmann, Chaptal, and Berthollet, whose works we have already mentioned. In Britain, two very valuable essays by Delaval and Henry have appeared: and to these we may add, the excellent treatise on the Philosophy of Permanent Colours, by Dr Bancroft.

In the following treatise, we propose to give a pretty full view, both of the theory and practice of dyeing, This subject naturally divides itself into two parts. In the first, we shall treat of dyeing in general, or of those departments of physical science, the knowledge and application of which may be considered as constituting the theory of the art. In the second part, we shall take a view of the different processes which are employed in communicating colours to different stuffs, or, in general terms, the practice of dyeing.

PART I. OF DYEING IN GENERAL.

Of Colours, &c.

UNDER this head we propose to take a general view of what may be regarded as the theory of dyeing; and investigate those principles of physical science which are immediately connected with the art, and by the application of which the phenomena of the art can only be accounted for, or satisfactorily explained. With this view we shall treat the subjects which come under this part in the four following chapters. In the *first*, we shall consider the nature of colours and colouring matters; in the *second*, we shall treat of the nature and operations of mordants; the *third* will include an account of the properties of the substances to which colours are communicated; and, in the *fourth*, we shall add some general observations on the operations of dyeing.

CHAP. I. *Of Colours and Colouring Matters.*

28. THE physical theory of light and vision properly belongs to optics; and the changes produced by the action of light on different substances are detailed under chemistry. In this place, therefore, we shall only make a few observations on the nature of light and colours, which are more immediately connected with the subject under consideration. For our knowledge of light and vision we are indebted to Sir Isaac Newton. It was first demonstrated by that sagacious philosopher, that the light of the sun is composed of seven rays which have different powers of refrangibility. The colours of these seven rays are red, orange, yellow, green, blue, indigo, violet. When these rays are separated by the prism, as they run gradually into each other, according to their different degrees of refrangibility, they produce every various shade of colour. The violet ray is the most refracted, the indigo next, and so on to the red, which is the least refracted of all the rays. The same rays of light also differ in their degrees of reflexibility. All known colours, and their different shades, are produced by mixing together the different rays. Thus, for instance, by mixing together red and yellow, an orange colour is obtained; yellow and blue give a green colour; and blue and red, according to their different proportions, produce a violet, purple, &c. and thus, as Sir Isaac Newton has observed, the variety of colours depends on the composition of light; for if the sun's light consisted but of one sort of rays, there would be but one colour.

Nature of light.

29. Colours in an object, the same philosopher farther observes, are nothing but a disposition to reflect this or that sort of rays more copiously than the rest; in the rays there are nothing but their dispositions to propagate this or that motion into the *sensorium*; and in the *sensorium* they are sensations of those motions under the forms of colours. In their power of reflecting light, bodies, it is well known, differ greatly from each other. Some bodies reflect it in such quantities, that the eye cannot bear it. Such, for instance, are metallic substances highly polished. Others again, as dark coloured or black substances, reflect it very feebly. It is found in general, that the quantity of light reflected from a body depends greatly on the smoothness of its surface. On this account bodies which have the smoothest surface, or are most highly polished, are the brightest: that is, they reflect the greatest quantity of light. But there is also a very great difference among bodies, in the nature or quality of the rays of light which they have the power of reflecting. When all the rays of light are equally reflected by any body, that body is said to be white; but when a very few rays only are reflected from a body, that body is said to be black, because the greater number of the rays being absorbed by the body, the few that are reflected make a very faint impression on the organ of vision. A body which has the power of reflecting the red rays only, is said to be red; a body which reflects the blue rays, is said to be blue; the body reflecting only the yellow rays, is yellow: but when any two of these rays are reflected in combination with each other, a different colour is produced; as for instance, the red and the yellow rays afford an orange colour; and, as we have already observed, the various shades of colour exhibited by different bodies, depend on the different combinations of rays reflected from their surface. Thus it appears, that colour in bodies is to be ascribed to their disposition of absorbing certain rays, and reflecting the rest. In opaque bodies, it is owing to their disposition to absorb some rays, and to reflect the rest. In transparent bodies, it is owing to their disposition to absorb certain rays, and to transmit the rest.

Nature of colours.

Of Colours, &c.

Cause of colours investigated.

30. Newton has demonstrated, that transparent bodies reflect the rays of one colour, and transmit those of another, according to the difference of their thickness or density. He observes that transparent substances, such as glass, water, air, &c. when made very thin by being blown into bubbles, or otherwise formed into plates, exhibit various colours, according to their various thinness; although at a greater thickness they appear very clear and colourless. His method of conducting these experiments was the following. He took two object-glasses, the one a plano-convex for a 14 feet telescope, and the other a large, double convex, for one of about 50 feet; and upon this laying the other with its plain side downwards, he pressed them slowly together, to make the colours successively emerge in the middle of the circles, and then slowly lifted the upper glass from the lower, to make them successively vanish again, in the same place. The colour which, by pressing the glasses together, emerged last in the middle of the other colours, would, upon its first appearance, look like a circle of a colour almost uniform from the circumference to the centre; and by compressing the glasses still more, grow continually broader, until a new colour emerged in its centre, and thereby it became a ring, encompassing that new colour; and by compressing the glasses still more, the diameter of this ring would increase, until another new colour emerged in the centre of the last, and so on, until a third, a fourth, a fifth, and other following new colours successively emerged there, and became

came rings, encompassing the innermost colour, the last of which was the black spot. And on the contrary, by lifting up the upper glass from the lower, the diameter of the rings would decrease, and the breadth of their orbit increase, until their colours reached successively to the centre, and then, as they were of considerable breadth, he could more easily discern their species than before. By proceeding in this manner, he produced 25 different-coloured, circular rings, which he divided into seven orders, because the same colour was always repeated. They are reckoned from the central colour, which was always black, in the following order:

1. Blue, white, yellow, and red.
2. Violet, blue, green, yellow, red.
3. Purple, blue, green, yellow, red.
4. Green, red.
5. Greenish blue, and red.
6. Greenish blue, and pale red.
7. Greenish blue, and reddish white.

But in the three last orders the colours were very indistinct, and terminated in perfect whiteness.

31. These colours were occasioned by the thin films of air which were included between the two glasses. For he found, he observes, by looking through the two object-glasses, that the interjacent air exhibited rings of different colours, as well by transmitting light, as by reflecting it. The film of air varies in thickness from the centre of the glasses to the circumference. In the centre where the film is thinnest the colour is black; and the other colours from the centre to the circumference are produced in their order by the gradual increase of the thickness of the film.

32. These experiments were repeated on films of water and also of glass; and it was found that the thickness of the films in these cases, reflecting any particular colour, was diminished, and this diminution appeared to be proportional to the density of the reflecting film. As there is no method of measuring the distance between the two glasses where the black spot appears, it is impossible to ascertain the absolute thickness of the films; but it certainly does not exceed the 1000th part of an inch. Newton, however, endeavoured by a mathematical investigation to measure the relative thickness of air, water, and glass, at which the several orders of colour appear. The following table exhibits the relative thickness of air which produced the coloured circles.

1. Black	1	green	$25\frac{1}{5}$
blue	$2\frac{2}{5}$	yellow	$27\frac{1}{7}$
white	$5\frac{1}{4}$	red	31
yellow	$7\frac{1}{9}$	4. Green	35
red	$8\frac{1}{2}$	red	$40\frac{1}{3}$
2. Violet	$11\frac{1}{6}$	5. Green-blue	46
blue	14	red	$52\frac{1}{2}$
green	$15\frac{1}{8}$	6. Green-blue	$58\frac{3}{4}$
yellow	$16\frac{2}{7}$	red	65
red	$18\frac{1}{3}$	7. Green-blue	71
3. Purple	21	reddish-white	77
blue	$21\frac{2}{3}$		

Newton's

33. The conclusion which Newton drew from these experiments was, that the power or disposition of the particles of bodies to reflect or transmit particular rays depended on the size and density of these particles; and proceeding on this theory he attempted to measure the size, or at least the thickness, of the particles of bodies, from the colours which they reflected or transmitted.

Supported by Delaval.

34. This subject was still farther investigated by Mr Delaval. In the year 1765, he published, in the Philosophical Transactions, an account of his "Experiments and Observations on the agreement between the specific gravities of the several metals, and their colours, when united to glass, as well as of their other preparations." In this paper, Mr Delaval treats of the difference of density, and of the colours produced by that cause; and yet he considers colours as arising from a difference of the size of the colouring particles. For since the particles of a coloured substance being separated they are removed to a greater distance from each other, and thus occupy a greater space, that substance must undergo a diminution of its specific gravity, while at the same time the size of its particles is smaller. According to Sir Isaac Newton, the refractive and reflective powers of bodies are nearly proportional to their densities, and the least refrangible rays require the greatest power to reflect them. From this, Mr Delaval supposed, that denser substances, by their greater reflective power, ought in similar circumstances to reflect the less refrangible rays; and that substances of less density should reflect rays proportionably more refrangible, and therefore appear of several colours in the order of their density. The densest bodies, he supposes, are the red; the next in density are the orange; the next are the yellow; and so, according to the order of the refrangibility of the different rays. Mr Delaval some time after extended his researches to animal and vegetable substances, and endeavoured to establish the theory of Newton by a great number of experiments, an account of which he published in an essay entitled, an Experimental Inquiry into the cause of the Permanent Colours of Opaque Bodies †.

35. According to the theory of Newton, with the exception of combustible bodies, which follow a different law, colour depends solely upon the size of the integrant particles of bodies, in which the density is the same; and upon the size and density of all bodies taken together. But the evidence for the truth of this theory can only be derived from experiment. Newton adduced but a small number of experiments in support of it. The experiments of Mr Delaval were more numerous and more varied; but they were made long before the important facts in chemical science, which have completely changed the views and opinions of philosophers, with regard to the nature and action of the constituent principles of bodies, were discovered; so that it is now universally acknowledged that they proceeded on a false hypothesis. It was supposed that alkalies enlarge, and that acids diminish, the size of the particles of bodies on which they act, without inducing any other change. This opinion, in the present state of chemical knowledge, will not readily find a place.

Is imperfect.

36. But if this theory were true, every change in the size of the integrant particles of bodies would occasion a different colour in these particles; and in all these changes, if they correspond with the theory, the

---

† *Manchester Mem.* ii. 131.

the colour produced must be precisely that colour which is the result of a diminution or increase of size.

Inconsistent with the facts.

37. But there is no such coincidence with the facts. The magnitude of the integrant particles of bodies cannot be ascertained; and there is no method by which the increase or diminution of the particles in the changes which they undergo can be measured; but the addition or abstraction of matter to particles can in many cases be distinctly determined. In the change which takes place on gold by the process of oxidation, that is, by combining with oxygen, an integrant particle of the oxide is larger than the integrant particle of gold in the metallic state; for it has united with one particle at least of oxygen. But if the theory were true, there should be a difference of colour between the oxide and the gold, which is not the case, for they are both yellow. In the amalgam of silver, a compound of silver and mercury, the colour is white, which is the colour of both metals; and yet an integrant particle of the compound must be larger than an integrant particle of either the mercury or the silver.

The same colours reflected in different orders.

38. But the same colour, it may be said, is reflected in the different orders of colours, in which the particles are of very different sizes. This circumstance, as Dr Bancroft* justly observes, proves incontestably, that although thickness or size of the particles may be one, it cannot be the only cause of the repeated variation of colour. It follows, therefore, that there must be some other cause. But besides, the most common colour remaining after an increase of the size of the integrant particles of bodies is white: and yet this colour does not appear in any of the orders except the first; its permanency, therefore, cannot be accounted for in any way which is at all compatible with this theory.

Colours of metals independent of density.

39. And in the changes of colour which are observed to follow the increase or diminution of the sizes of the particles of bodies, the order of these changes is not such as will correspond with the theory. It is obvious that the colours of metallic substances do not depend on their density. The colour of platina, the densest body known, is not red, as it should be according to the theory, but white; in this respect resembling tin, one of the metals which has the least density, and little more than one-third that of the former.

40. The size of the particles of the green oxide of iron must be increased when they enter into combination with the prussic acid. But the colour of the compound is white; and, according to the theory, it should be accompanied with a diminution of the size of the particles, which is not the case. The colour of indigo is naturally green. The addition of oxygen, which must increase the size of the particles, converts it to a blue colour. This, then, is another case incompatible with the Newtonian theory; and from these facts it must appear, that this theory is deficient in accounting for the reflection or transmission of particular rays, and the absorption of the rest. It is not sufficient for the explanation of the causes of colour. The smallness and the density of particles are not the only circumstances which ought to be taken into the account, in explaining the cause of colour in bodies. It appears, from Newton's own experiments, that we must have recourse to the chemical properties of bodies, which have a considerable influence on their colour. It cannot be supposed, that a force which acts powerfully in refracting the rays, will not also have great influence in their reflection.

Chemical changes affect the colour.

Affinity o bodies fo certain rays the cause of colour.

41. Numerous facts tend to prove that bodies have a particular affinity for the rays of light; and indeed it is entirely upon these affinities that the phenomena of light depend. Coloured bodies have a certain affinity for some of the rays of light. Those rays for which any body has a strong affinity, are absorbed by it, and retained; while the other rays, for which it has no affinity, are either reflected or transmitted, according to the nature of the body, as it may be opaque or transparent, and according to the direction of the incident ray. A red body, for instance, reflects only the red rays, because it has an affinity for all the other rays, excepting the red. It therefore absorbs them, if it be an opaque body, or transmits them if it be transparent. A green body absorbs all the rays excepting the green; a black body has a strong affinity for all the rays, and therefore they are all absorbed; while a white body, which has little affinity for any of the rays, if it be opaque, reflects, or if transparent, transmits them all.

Changes colour owing to differenc in size, & of the pa ticles,

42. The differences which exist between the particles of bodies, may be conceived to be differences in size, density, and figure; and changes in these circumstances may account for all the varieties of affinity. If then affinity depends upon these circumstances, and if the colour of bodies is to be ascribed to the affinity between their particles and the different rays of light, the cause of the colour of bodies, it seems obvious, is capable of being accounted for from the size, density, and figure of their particles. It cannot be accounted for, according to the theories of Newton and Delaval, solely on the variations in size and density.

and to n combinations.

43. If then the colour of bodies depends upon their affinity for light, and every body have some colour in consequence of the absorption of particular rays which it retains, and the reflection or transmission of all the rest, it is obvious, that it must continue of its first colour without suffering any change, till it is either saturated with the particular rays which it absorbs, or till the particles of the body have undergone some change by decomposition or combination with new substances. As many substances have been long exposed to the action of light without their colours being changed, there is no certain evidence that the changes in the colours of bodies are to be ascribed to the first cause. The light which is absorbed either escapes unchanged or under some unknown form. But the action of the second cause which has been mentioned, may be traced in almost all cases where alterations of the colours of bodies have been observed. We may take as an example of this change of colour the green oxide of iron, which readily combines with oxygen, and is converted into the red oxide. The latter oxide, in combination with the gallic acid, assumes a black colour, and with prussic acid a blue colour. In these cases, where there is a change in the composition of the body, accompanied with a change of colour, the cause of this change is obvious; because every change in the composition of a body produces some change in the affinity, and therefore in the size, density, and figure of the particles; and it is not improbable in all of these circumstances together. But if the affinity of any body

---

* *Phil. of Perm. Col.* 7.

dy for other substances has undergone a change, it is natural to suppose that its affinity for light is also in some degree altered. This, however, although it happens in many instances, is not constant and uniform; because it may happen, that the changes in the size, density, or figure of the particles of the body, are such as to render it capable of combining with, or reflecting, the same rays of light as before it suffered any chemical change. Thus it must appear, that in most cases, the permanency of the colours of bodies will depend greatly on the permanency of their composition, and on the force of the affinities which they have for other bodies, to whose action they may be exposed.

oured tters do reflect ht.

44. In the ingenious experiments of Mr Delaval, which we have already alluded to, he has shown that coloured matters do not reflect any light. "Reflective media, (he observes), act indiscriminately on all the different rays. It does not appear from the optical phenomena which have hitherto been observed, that nature affords any kind of matter endowed with a power of reflecting one sort of rays more copiously than the other sorts; consequently no reflective substances are capable of separating the differently refrangible rays, and thereby producing colours. There are several experiments and observations in Sir Isaac Newton's optics, from which it might have been inferred, that coloured light is not reflected from coloured matter, but from white or colourless matter only. Although that great philosopher supposes that all coloured bodies reflect the rays of their own colours more copiously than the rest, yet he observes that they do not reflect the light of their own colours so copiously as white bodies do. If red-lead, for instance, and white paper, be placed in the red light of the coloured spectrum, made in a dark chamber by the refraction of a prism, the paper will appear more lucid than the red-lead, and therefore reflects the red-making rays more copiously than red-lead doth *.

"If it be supposed that the red particles of the minium reflect the red rays more strongly than the rest, what reason can be assigned why minium should not exhibit the red rays as vividly as white paper, which acts indifferently on all the rays? But if it be considered that in opaque coloured bodies, the rays which are reflected from white reflective matter pass back through the transparent coloured media with which the reflective matter is covered, it will evidently appear why the coloured light reflected from white paper is more copious and bright than that which is exhibited by red-lead.

"A considerable part of the incident light is lost in passing through transparent coloured media; therefore the light reflected immediately from the white paper, must be more copious and lucid than that which has undergone a diminution in its passage to and from the reflective particles of the opaque coloured body, through the transparent coloured medium.

"When a small portion of colouring matter is mixed with a colourless medium, the mass appears tinged with colour; but when a great quantity of colouring matter is added, the mass exhibits no colour, but appears black; therefore, to attribute to colouring matter a reflective power, is to advance an inexplicable and contradictory proposition; for it is asserting that in proportion as more reflective colouring matter is opposed to the incident light, less colour is reflected; and that when the quantity of colouring matter is very great, no colour at all is reflected, but blackness is thereby produced."

Proved.

45. "From these arguments it might have been shewn, that the reflective power does not exist in colouring matter, but in opaque white substances only. Nevertheless, in this disquisition, I have not entirely relied on arguments drawn from a few known and obvious appearances, but have endeavoured, by numerous experiments, to ascertain the cause of the colours of natural as well as artificial bodies, and the manner in which they are produced.

46. "M. Euler observed, that the colours of bodies are not produced by reflection. He supposes that the coloured rays are emitted by the colorific particles. This hypothesis, however, is not agreeable to experiment; for as the colouring matter acts upon light by transmission only, it is evident that bodies do not appear coloured, either by reflecting or emitting the rays. I have not attended to any other hypotheses which are unsupported by experiments. Sir Isaac Newton, and I believe all later philosophers, except M. Euler, have attributed to colouring matter a reflective power; and the artists whose works depend upon the preparation and use of colouring materials, seem in general to have adopted the same theory. As an instance of this agreement, I have cited, from M. Hellot, one of the most skilful and intelligent authors who have treated of the art of dyeing, a passage which comprises his opinion respecting the action of the tinging particles on the rays of light (A). All the other writers on the same subject, appear to agree in that established opinion; but they seem rather to have yielded to the authority of Sir Isaac Newton and other theorists, than to have appealed to the operations of their own art, from which the real cause and origin of colours is obviously deducible †."

47. The art of dyeing consists principally in covering white substances, from which light is strongly reflected, with transparent coloured media, which, according to their several colours, transmit more or less copiously the several rays reflected from the white substances.

---

* tics, bo i. pa ii. pr 5.

† *Manch. Mem.* ii. p. 131.

(A) The passage from Hellot is the following. "At present we only know of two plants which afford a blue colour after their preparation. The one is the *isatis* or *glastum*, otherwise called *pastel* or *woad*. In the preparation of these plants, the fermentation is continued till the putrefactive process of all the parts of the plant, the root excepted, has been induced; consequently there takes place a separation of all their principles, with a new combination and arrangement of these same principles, from which results an assemblage of particles greatly divided, which being applied to any substance, reflect the light in a very different manner from what they did when those particles were combined with the other parts of the plant, previous to fermentation." *Art de la Teinture des Laines*, p. 117.

stances. The transparent coloured media themselves reflect no light; and it is evident that, if they yielded their colours by reflecting instead of transmitting the rays, the whiteness or colour of the ground on which they are applied would not anywise alter or affect the colours which they exhibit. Such an erroneous conception of the principles of the art cannot fail greatly to obstruct its progress and improvement. All colouring matter is black when viewed by incident light, and all substances inclined to blackness, in proportion as they are copiously stored with tinging particles.

Coloured matters appear black by incident light.

48. As a farther illustration of this subject, we shall make another extract from the same author. "For the purpose," he observes, "of procuring masses made up of colouring particles, I reduced several transparent coloured liquors to a solid consistence by evaporation. When a gentle heat is employed in this operation, the colouring matter, which is thus concentrated, remains unimpaired, and capable of again imparting its colour unaltered, to other liquors. In this state the colouring particles reflect no colour; and as no light is transmitted through them, they are black. Among the liquors which I evaporated, were the tinctures and infusions of the colouring particles of red, purple, blue, and yellow flowers; of logwood, Brazil-wood, fustic, turmeric, red sanders, alkanet, sap-green, kermes, and other transparent coloured liquors, which are capable of being reduced to a solid consistence, without undergoing such changes during their evaporation, as to render them opaque.

Shewn by experiment.

Effect of colours on white bodies.

49. "White paper and linen may be tinged by dipping them in the infusions of flowers of different colours; and by spreading upon those white grounds the expressed juices of such flowers, their colours may be communicated to the paper and the linen. These means of tinging are somewhat similar to the application of vegetable dyes to linen, and of transparent water colours to paper, many of which consist of the colouring matter of plants, such as indigo, litmus, gamboge, &c.

50. "The consideration of these white substances affords much insight into the manner in which the natural colours of vegetables are produced. When the colouring matter of plants is extracted from them, the solid fibrous parts, thus divested of their covering, display that whiteness which is their distinguishing character. White paper and linen are formed of such fibrous vegetable matter, which is bleached by dissolving and detaching the heterogeneous coloured particles. When these are dyed or painted with vegetable colours, it is evident that they do not differ, in their manner of acting on the rays of light, from natural vegetable bodies, both yielding their colours, by transmitting through the transparent coloured matter the light which is reflected from the white ground; for it appears, that no reflective power resides in any of their component parts, except in their white matter only *."

51. Thus then it appears, that the colouring particles with which stuffs are dyed, being transparent, the reflected light must proceed entirely from the fibres of the cloth or stuff which are covered with the transparent colouring matter. If the stuff be already of a black colour, no other colour can be communicated to it; because it has not the power of reflecting any colour, and therefore it cannot transmit any. And if the stuff were of a red, blue, or yellow colour, it could not be dyed of any other colour excepting black; because the red, blue, or yellow rays only being reflected, no other rays could be transmitted. But these observations will strictly apply only when the whole of the surface of the cloth is of one uniform colour. They point out also the importance of the cloth being of a pure white colour before it is dyed, especially when it is to be dyed any bright colour; for then the rays are copiously reflected; so that any colour may be given by combining with it any colouring matter which has the power of transmitting only particular rays.

Stuffs to dyed sho be pure white.

Colouring matter a plied to stuffs sho be minu divided.

52. As it is by the force of affinity that the colouring matter enters into combination with the stuffs which are dyed, that this chemical action be complete, it is necessary that the matter be in a state of minute division. No permanent colour could be produced by merely covering the surface of the fibres of the stuffs with the colouring substance; for unless it adhere so strongly that it cannot be separated by mechanical action, or by means of any of the processes to which dyed stuffs must be subjected, it must appear to be of little value, and the object in view is not obtained. To allow the chemical action to take place between the colouring matter and the stuffs, the former is dissolved in some liquid, for which it has a weaker attraction than for the stuffs; so that when they are immersed in the solution, the colouring matter, in consequence of the stronger attraction which it has for the stuffs than for the solvent, combines with them, and thus they are dyed; and the facility with which this combination takes place, must obviously depend on the affinity between the colouring matter and the liquid holding it in solution, and the affinity between the cloth and the colouring matter. When these two affinities balance each other, no change takes place; but when the affinity between the stuff and the colouring matter prevails, the combination is effected, and the process proceeds more or less rapidly according to the force of this affinity.

Coloure bodies c pounds.

53. Coloured bodies are compounds; and several substances enter into their composition. In all coloured bodies some of the component parts have a strong affinity for oxygen, which they attract from the atmosphere. The permanency of a colour consists in its power of resisting the action of all substances to which it is exposed. This power varies greatly according to the nature of the colour and the kind of stuff. The durability of the same colours on animal and vegetable matters is very different. But before the colour of a body can be permanent, all its component parts must be combined together by such strong affinities, that the substances which come in contact with them shall not be able to unite with any of these parts, and thus form a new compound. Should such a decomposition take place, the colour of the body cannot be permanent; and if the decomposition be suddenly effected, the colour is immediately destroyed. If the new combination proceeds slowly, the decay of the colour is also slow and gradual.

The con bination oxygen produce change colour.

54. The combination of oxygen with some of the component parts of a coloured body, is one of the principal causes of the change of colours. The action of

---

* Ibid.

Colours, &c.

of oxygen on bodies is greatly promoted in particular circumstances. With the assistance of heat, almost all coloured bodies are decomposed by means of oxygen. At the temperature of 448°, wheat flour is deprived of its white colour, becomes first brown, and then changes to black. The oxygen enters into combination with the hydrogen, one of the component parts of the vegetable matter, and in this state it is driven off. The action of light produces effects similar to those of heat. A decomposition of the colouring matter takes place by means of the light to which the body is exposed; and one of its component parts combines with oxygen. The effects of light on the colour of wood have been long observed. Wood kept in the dark retains its natural appearance; but when it is exposed to the light it becomes yellow, brown, or of some other shade. This effect is found to be subject to considerable variations in different kinds of wood, and bears some proportion to the intensity of the light. If the solution of the green part of vegetables in alcohol, which is of a fine green colour, be exposed to the light of the sun, it very soon assumes an olive hue, and in the course of a few minutes it is entirely deprived of its colour. When the light is weak the change proceeds more slowly; and if it be kept in the dark no change whatever takes place; at least it requires a great length of time. Light seems to favour the tendency to decomposition in many bodies, by producing combinations of some of their constituent principles, as when water is formed by the union of oxygen and hydrogen, or carbonic acid by the union of carbone and oxygen. Some bodies even are deprived of the whole or part of their oxygen by the action of light. Oxymuriatic acid exposed to the light, becomes common muriatic acid by losing its oxygen; and the nitrate of silver becomes black by a partial decomposition and loss of its oxygen.

55. Such then seem to be the most general causes, the action of which produces changes in the colour of coloured bodies. It is either by the decomposition of the substances, in consequence of new compounds formed by the combination of some of the constituent parts; by some of these parts combining with oxygen; or by the addition or abstraction of oxygen. And to such changes colouring matters must be subjected from their compound nature; since they are most generally derived from animal or vegetable substances. The selection of such substances as resist the action of these causes, must therefore be an object of the greatest importance in the art of dyeing. A colour too which is sufficiently permanent ought to be such as will resist the action of acids, alkalies, soap, and other substances to which dyed cloth may be exposed.

M od of
pr ng the
pe anen-
cy a co-
lou

56. There is a great difference in colours with regard to their power of resisting the action of air and light; and as it is in this that their permanency chiefly consists, independent of their lustre, it becomes an object of great importance, to be able to ascertain by easy tests the durability or goodness of any colour. In France, where the art of dyeing was more under the regulation of government than in other countries, and a distinction was established by law between dyers of durable and fading colours, the means of ascertaining the permanency of colours became of still greater consequence. For the dyer of fading colours was subject to punishment if he produced colours which were too permanent; so rigorous and capricious were the laws which regulated these matters. The observations of M. Dufay on this subject laid the foundation of the regulations which were made to ascertain this point. For this purpose he made experiments by dyeing wool of all colours, with all kinds of colouring matters; and setting entirely aside the prejudices of the dyers, he collected most of the substances which he supposed might be employed in the art, and tried a great number of them, investigating their good or bad qualities with great care.

Of Colours, &c.

Dufay's.

57. His first experiments were made on woollen yarn; but finding afterwards that pieces of white cloth were more suitable to the purpose, he employed them. And that he might distinguish between permanent and fading colours, he exposed to the action of the sun and air for the space of twelve days, patterns of all colours which he had dyed with known substances. In this time durable colours were little injured, but those which were of a fading nature were almost entirely obliterated. But as the action of the sun might be less intense in cloudy weather, and thus the test would be less severe when that happened than during twelve days of bright sunshine; to obviate this inconvenience and uncertainty, he selected one of the worst colours, that is, one on which the sun had the greatest effect in the same time. This colour served as a standard in his experiments; and whenever he exposed stuffs to the air to prove the colour, he exposed a piece of this stuff along with them. He did not calculate by the number of days, but by the change on the colour of the standard stuff. For he kept the pattern exposed to the air till it had lost as much as the standard would have done by the action of the sun during twelve days in summer. He found from these experiments that it required four or five days longer in winter than in summer to produce the same effect.

58. But by this method of exposure to the air he had another object in view. This was to discover the proper proof for each colour. By the application of this proof a stuff is tried whether its colour be permanent or not. The pattern for instance is boiled with alum, tartar, soap, vinegar, &c. and by the effect of these substances its quality is ascertained. But from the component parts of the substances employed being then unknown, and the imperfect state of chemical science, these proofs must appear now to have been extremely precarious and insufficient. Some which were applied, from their natural effects, destroyed good colours, and produced no effect whatever on bad colours.

59. As the method he employed may suggest the means of discovering others founded on more correct principles and more accurate knowledge of the substances whose action is investigated, we shall mention the ingenious process which he followed. Having observed the effects of air and light on each colour, whether it were a good or bad colour; he tried the same stuff with different proofs, and stopped as soon as he discovered one which produced the same effects as the air. He then noted the weight of the ingredients, the quantity of water, and the length of time; and thus he was certain of producing on a colour an effect similar to that which the air would have produced, on the

supposition that it was dyed in the same way with his, as was the case in France where all the processes were then regulated by law. In this way he was enabled to ascertain the qualities of any colour, by making an analysis of the ingredients of which it was composed. By means of the proofs which were invented by this ingenious chemist, as much of a colour which was not of a durable nature, could be discharged in a few minutes, as would be lost by the action of the air and light in twelve or fifteen days. But as general rules framed for such trials are liable to many exceptions, from different unavoidable causes, their application in many cases may be considered as too severe. For instance, light colours require less active proofs than those which are of a deeper dye, and are more loaded with colouring matter; in the latter case, a considerable proportion of colouring substance may be carried off without much visible change on the colour; but in the former, by means of the same active test, the colour would be entirely obliterated. Every variety of shade, therefore, would have required a separate proof. The sun and the air must always be considered as the true test; and those colours which undergo no change in a certain time by this exposure, may be considered permanent colours, although they may be greatly changed by the application of proofs. Scarlet, which is dyed with cochineal alone, assumes a purple colour when tried by means of alum: but if scarlet be exposed to the sun, it loses some of its brightness, and becomes of a deeper shade; but this shade is different from that which is produced by alum. In certain cases then the same effect is not to be expected from the action of proofs and that of air and light.

Hellot's.

60. An experiment by Hellot is added as a farther illustration of a colour resisting the effects of exposure to the air, and yet being destroyed by the action of other substances. Brazil wood, he mentions, like other woods loaded with colour, produces a fading dye. With this he prepared a red, much finer than madder reds, and as bright as those made with kermes. This red was exposed to the air for the two last months of the year 1740, in which much rain fell, and for the two first of 1741; and notwithstanding the rain and bad weather, it was so far from losing, that it gained body. Yet this red, so durable in the air, is incapable of resisting the trial by tartar. Colours then may be reckoned sufficiently durable when they resist the effects of the air, although they are decomposed or destroyed by means of powerful chemical agents. From these observations, it is therefore obvious, that the only sure mode of ascertaining the permanency of colours, is by exposing the dyed stuffs for a certain length of time to the action of light and air.

Berthollet's.

61. Berthollet[*] proposes to employ the oxygenated muriatic acid as a quick and easy method of ascertaining the degree of durability which a colour may possess; because it acts like the air itself. When a trial is to be made on any piece of stuff, all that is necessary is to put a pattern of it into the acid, along with one of a stuff which is known to have been dyed properly. The relative power of resisting its action, which appears in the two patterns, becomes the test or measure of the quality of the colour. This liquor having a very powerful action on the colouring particles, must be employed in a very diluted state. In the use of this proof, it is attended with the advantage of exhibiting nearly the shades and changes through which a stuff must pass when it comes to be acted on by the air. Still, however, the same philosopher adds, the oxygenated muriatic acid is not to be considered as an infallible test; entire confidence can only be placed in the results obtained by the action of the air and light.

Test for silk.

62. To prove the colours of silk, it has been thought sufficient to expose them to heat in acetous acid or lemon juice; and those colours which stand this test are considered as permanent. When the colours have been obtained from the woods or archil alone, they are reddened by means of a vegetable acid; but if the solution of tin has been used to dye with these substances, the colour which has been prepared in an acid liquor suffers no change from vegetable acids. Thus the colour which is the least expensive in the preparation may be reckoned good by the test, although it will prove the least permanent. For silk, therefore, the oxygenated muriatic acid should be employed; but more especially exposure to the air.

For dye-stuffs.

63. It must appear an object of much importance to the dyer to be able to estimate the relative qualities of colouring substances of the same kind. The oxygenated muriatic acid may also be employed as a test for this purpose. By its use we may ascertain the proportional quantity of colouring matter in those substances, the nature of whose colouring particles is the same; as, for instance, when different parcels of indigo are to be compared together. In this case no foreign affinity can interrupt the action of the acid. And even if it should happen, that any considerable difference exists in the nature of colouring particles supposed to be the same, the action of this acid, it is probable, would still be a measure of their comparative goodness. If then it is proposed to compare together two or more colouring substances of the same nature, and to ascertain the relative quantity and quality of the colouring particles in each, all that is necessary is to compare the quantity of the same oxygenated muriatic acid which is required to produce the same degree of change in equal weights of each. For the qualities of these substances, or the quantities of colouring particles they contain, are directly proportional to the quantities of liquor required to produce the same effect on each. In conducting this experiment it is scarcely necessary to observe, that the colouring matter of each substance should be dissolved in a proper liquor, and that all the circumstances attending the comparison should be as nearly as possible the same.

Indigo.

64. If different kinds of indigo are to be compared together, let an equal weight of each be carefully powdered and introduced into separate matrasses with eight times their weight of concentrated sulphuric acid, and let them remain for 24 hours in a heat of from 100° to 120° Fahrenheit. Each solution is then to be diluted with water, and filtered. What remains on the filter is to be collected, ground in a glass mortar, and again digested with a little more sulphuric acid. These last solutions are then to be diluted with equal quantities of water, filtered and added to its corresponding liquor. As much oxygenated muriatic acid is then to be added to each solution as will discharge the colour, or bring them to a shade of yellow:

---

[*] *Elem. of Dyeing*, i. 180.

low: Thus the qualities of the different kinds of indigo may be ascertained by the quantity of oxygenated muriatic acid which is required to discharge their colour.

65. The process is more simple to compare the qualities of those colouring matters which are soluble in water. To equal bulks of the decoction, containing the same weight of each substance, the oxygenated muriatic acid is added till they are all brought to the same shade; and the quality of the substance is proportionate to the quantity of acid required.

Chap. II. *Of Mordants.*

66. The term mordant, derived from the French word *mordre*, to bite or corrode, is applied to those substances which are employed in dyeing, to facilitate or modify the combination of the colouring particles with the stuff. This name was given to these substances, from a supposed mechanical action which they produced on the substance to which the colour was communicated; and as no equivalent word has yet been proposed, the original is retained in the English language.

portance nor- ts.

67. The knowledge of this class of substances is not less important in the art of dyeing than that of colouring matters themselves, because on their action depend the variety, brightness, and durability of colours. The action of mordants is undoubtedly owing to chemical changes, so that more extensive observation and a complete knowledge of their effects, must greatly contribute to the improvement and perfection of the art of dyeing. It is by a new series of attractions which are introduced by their action, that the colouring particles are combined with the stuff, and the qualities and degrees of the colours are affected.

68. A mordant is not always to be considered as a simple agent; for, of the different ingredients which enter into its composition, new combinations are sometimes formed, so that the substances which are immediately employed, are not the direct agents in effecting the changes, but the new compounds which are produced.

e of ication

69. Mordants are applied in different ways, according to their nature, according to the nature of the colouring matter, and that of the stuff to be dyed. Sometimes they are mixed with the colouring particles, and sometimes the stuffs to which the colour is to be communicated, are impregnated with them; and sometimes both these processes are combined. In some of the more complicated operations of dyeing, substances are successively applied to stuffs in which the action of the last only produces the effect. In such cases, there is a gradual progress of combination; but it is only by the effect of the last compound which is formed, that the colour is evolved.

rated.

70. The effects of mordants are well illustrated in many of the processes which are followed in the art of printing linen; and for the illustration of these effects, we shall extract from Berthollet a short account of some of these processes. For linens to which it is proposed to give different shades of red, the mordant employed is prepared by dissolving in eight pounds of hot water, three pounds of alum, and one pound of acetate of lead, or sugar of lead. To this solution two ounces of potash, and afterwards two ounces of powdered chalk, are to be added. Our chemical readers will readily perceive, that the first change which takes place, is the decomposition of the alum, by means of the acetate of lead. The oxide of lead combines with the acid of the alum, and forms an insoluble salt, which is precipitated. The alumina which constitutes the base of the alum, unites with the acetous acid, and forms an acetate of alumina. The chalk and potash, according to Berthollet, serve to saturate the excess of acid; but it seems more probable that the addition of these substances is found necessary, on account of new decompositions which are effected by their action. Several advantages arise from the formation of the acetate of alumina, in the future changes which are to be effected. The alumina, or earthy basis of this salt, is retained in combination with the acid, by a much weaker affinity than when combined with sulphuric acid in the state of alum. Its affinity being thus weakened, it is more easily decomposed, and unites more readily with the stuff and colouring particles. Another advantage not less important is, that the effect of the acetous acid on the colouring matter being less powerful than the sulphuric acid, the acid liquor which remains after the separation of the alumina, does not produce such hurtful effects. And besides, as the acetate of alumina does not crystallize, the mordant which is thickened with starch or gum, to prepare it for being applied to the block on which the design is engraved, retains the same uniform consistence, which would not be the case if it contained alum, the latter being disposed to crystallize.

71. Let us now trace the different steps of the operation in printing a piece of cloth. When it has been impregnated with the mordant, in the manner determined by the design, it is immersed into a madder bath. Thus the whole of the cloth is coloured; but the colours are deeper on those parts to which the mordant has been communicated; because in those parts the colouring particles of the madder have entered into combination with the alumina and the stuff, forming a triple compound. The acetous acid separated from its earthy basis remains in the bath.

72. The effect of external agents on the colouring particles in this state of combination is much less considerable than when they are in a separate state, or only combined with the stuff, without the intermediate action of another substance. It is on this property that the subsequent operations depend. Having been immersed in the madder bath, the cloth is afterwards boiled with bran, and exposed to the open air by spreading it out on the grass; and the ultimate repetition of these operations is continued till the ground is whitened. The colouring particles of the madder which have not come in contact with the alumina are completely changed by entering into new combinations; while those which have united with it remain unaltered in consequence of the stronger affinity, so that those parts of the cloth which have been impregnated with the mordant, retain the colour and exhibit the design.

73. The decomposition of the colouring particles by boiling the stuff with bran, and exposure to the air, seems to be effected in a manner similar to the destruction of the colouring matter of flax, and is to be ac-

counted for in the same way. In the process of bleaching, indeed, alkaline substances are employed. But for the purpose of discharging the superfluous colouring-matter from printed cloths, bran is preferred as a substitute; because part of the colouring-matter, even when fixed by alumina, would be destroyed by the stronger action of alkalies; but as the action of the bran is much weaker, it affects only the colouring particles which have not come in contact with the alumina, and which by the action of the air are disposed to undergo a more easy solution.

74. Let us take another example with a different mordant. If, instead of alum, a solution of iron, as the acetate of iron, be employed, similar phenomena are exhibited. The solution of iron is decomposed by the particles of colouring-matter, and a triple compound is thus formed of the colouring-matter, the oxide of iron, and the stuff. But when this mordant is employed, a great variety of shades from brown to a deep black are obtained by the use of madder; and by a combination of alum and iron, the colours produced are of a mixed nature, inclining on the one hand to red, and to black on the other. And if another substance, as dyers weed, be substituted for the madder, other colours are obtained. Indeed the great variety of shades which are communicated to printed stuffs are derived from the colouring matter of madder, dyers weed, and indigo, fixed by alumina or the oxide of iron as mordants.

75. The different substances which enter into the composition of a mordant remain in combination till a new action is induced by the application of another substance. Thus, the affinity of the stuff for one of their constituent parts produces a decomposition and new combinations. But even this effect is sometimes incomplete, or does not at all take place without the action of another affinity, namely, that of the colouring particles. We have an example of this in the mixture of alum and tartar, which is one of the most common mordants in the dyeing of wool.

76. The following experiments were made by Berthollet, to ascertain the effects of these substances as mordants. He dissolved equal weights of alum and of tartar; and he found that the solubility of the tartar was increased by the mixture. By evaporation and a second crystallization, the two salts were separated, so that no decomposition had taken place. Half an ounce of alum and one ounce of wool were boiled together for an hour, a precipitate was formed, which being carefully washed, was found to consist of filaments of wool incrusted with earth. To this sulphuric acid was added, and the solution being evaporated to dryness, crystals of alum were obtained, with the separation of some particles of carbonaceous matter. The liquid in which the wool had been boiled being evaporated, yielded only a few grains of alum; what remained would not crystallize. This being redissolved and precipitated by means of an alkali, the alumina which was thrown down was of a slate colour, became black when placed on red-hot coals, and emitted alkaline vapours. In this experiment it appears that the alum was decomposed by the wool, and part of the alumina had combined with its most detached filaments which were least retained by the force of aggregation; that part of its animal substance had been dissolved and precipitated by the alkali from the triple compound.

77. The same experiment was repeated with half an ounce of alum and two drams of tartar; but no precipitation followed. A small portion of the tartar, and some irregular crystals of alum, were obtained by crystallization: the remainder refused to crystallize; but being diluted with water, precipitated by potash, and evaporated, it yielded a salt which burned like tartar. The wool which was boiled with the alum had a harsh feel; but the other retained all its softness. The first, after being subjected to the process of maddering, had a duller and lighter tint; but the colour of the latter was fuller and brighter.

78. In the first of these experiments the wool had effected a decomposition of the alum, had united with part of the alumina; and even part of the alum which retained its alumina had dissolved some portion of the animal matter. In the second experiment it appears, that the tartar and alum, between which there seems to exist a balance of affinities, can only act on each other by the intermediate action of the wool. The principal use of the tartar seems to be to moderate the action of the alum on the wool, by which it is injured. In the aluming of silk and thread, whose action on alum is less powerful than that of wool, tartar is not found requisite.

79. Whatever be the mode adopted in aluming, or whatever be the chemical changes which are produced, its final effect is the union of the alumina with the stuff. At first this combination has probably been incomplete, and a partial separation only of the acids has taken place; but it is perfected after the cloth has been boiled with the madder, as appeared in the case of printed stuffs *.

Substances used as mordants.

80. The principal substances which are employed for the purposes of mordants in the process of dyeing, are earths, metallic oxides, and some astringent matters. Alumina, which is now one of the most important, and in most general use, was very early employed as a mordant. This earth, as has been proved by direct experiment, and which is still farther confirmed by daily practice and observation, is useful in the art of dyeing, in consequence of the affinity which exists between it, the stuffs to be dyed, and the colouring matter. The affinity of alumina for animal matters, as wool and silk, as much stronger than that for vegetable productions, as cotton and linen; and hence the difference in the facility of fixing the colours on these different substances, and in their durability.

Alum.

81. When alumina is employed as a mordant, it is always in a state of combination, either in that of alum, which is the sulphate of alumina and potash, or united with the acetous acid, forming the acetate of alumina. Alum was employed at a very early period as a mordant. It was used by the ancients as it was found native, and therefore far from being in a state of purity. But as the nature of the constituent parts of alum was long unknown, its use in dyeing, as well as that of mordants in general, can only be ranked among the discoveries of modern chemistry. Alumina is also employed for a similar purpose, in combination with the acetous acid. This combination of alumina seems to have been first introduced about the beginning of the 18th century, and its introduction, like other valuable improvements,

---

* Elem. o Dyeing, i. 34.

improvements, was owing to accident. It was first employed by the calico-printers; but at what time, or by whom it was first used, is not exactly known. In one of the earliest recipes for preparing the mixtures employed as mordants in calico-printing, which Dr Bancroft, in his investigation of this subject, informs us he examined, the substances directed to be used are alum, sal ammoniac, saltpetre, red orpiment, and kelp; and these were to be mixed with water. In another, which he observes probably followed this, these ingredients were to be dissolved in vinegar. Sugar-of-lead was afterwards added in small quantity, and among a great variety of other substances which were employed at different times, litharge and white-lead came into use. In cases where vinegar was employed as the solvent, after different decompositions had taken place, a portion of acetate of alumina was formed, and the use of it was found to be followed with good effects. The quantity of sugar-of-lead, from observing the advantages derived from it, was gradually increased, and the employment of many of the other substances which were found by experience to be useless, was omitted. As the introduction of acetate of alumina was at first owing to chance, and as the changes and decompositions which took place in its formation were entirely unknown, it is not to be wondered at that the discovery or invention of this substance as a mordant, should not be distinctly ascertained.

82. The usual method of preparing the acetate of alumina is by pouring acetate of lead into a solution of alum. Both the salts are decomposed, by an exchange of their constituent parts. The sulphuric acid and the lead having a stronger affinity than the sulphuric acid and the alumina, combine together, and fall to the bottom in the form of an insoluble powder. The alumina at the same time enters into combination with the acetous acid, and remains dissolved in the liquid. But the application and effects of this substance in dyeing have been fully illustrated in treating of mordants in general.

83. Lime is the only earth, besides alumina, which is employed in dyeing. The affinity of lime for cloth is sufficiently strong; it is, however, found to answer the purpose of a mordant less perfectly than alumina, on account of the colour, which is not so good. It is employed, either in the state of lime water, or in that of sulphate of lime dissolved in water.

84. Metallic oxides have a strong affinity for animal substances. They have also so great an attraction for many colouring matters, that they separate from the acids with which they are combined, and are precipitated in combination with the colouring matters. In consequence of these different affinities, metallic oxides are of great importance in dyeing, and hence they were early applied in that art, and are now extensively used. But besides the affinity of these oxides for the colouring particles, and for animal substances, their solutions in acids possess properties by which they are more or less fit to be employed as mordants. Thus, those oxides which easily part with their acids, such as that of tin, are capable of entering into combination with animal substances, without the aid of colouring particles. All that is necessary is to impregnate the wool or the silk with a solution of tin. Some metallic substances yield only in combination, a white and colourless basis; but there are others which, by means of their own colour, produce modifications on the peculiar colour of the colouring particles. But the effects of many metallic oxides are extremely different, according to the proportion of oxygen with which they are combined; and this proportion is variable.

Of Mordants.

85. The affinity of metallic oxides for vegetable matters is considerably weaker than that which they have for animal substances. Metallic solutions, therefore, are found not to answer so well as mordants for colours in dyeing cotton or linen. Iron, indeed, is an exception, the oxide of which, it is well known, has a strong affinity for vegetable substances. Iron moulds on cotton or linen are owing to a combination of the oxide of iron with the vegetable matter.

86. Although almost all metallic oxides have an affinity for animal and vegetable matters, and might therefore be employed as mordants, yet two only, either because they are found to answer the purpose better, or because they are cheaper, are used to any extent. These are the oxides of tin and of iron.

Oxide of tin.

87. The use of the oxide of tin seems to have been first discovered by a German chemist of the name of Kuster or Kuffler. Observing the effects of a solution of tin in nitric acid, in giving a more vivid colour to stuffs dyed with cochineal, he was led to the discovery of the method of producing what has since been denominated *cochineal scarlet*. This discovery has been ascribed by others to Drebel, a Dutch chemist: and Macquer, who is of this opinion, supposes that the first solutions of tin were made with nitro-muriatic acid; but Dr Bancroft thinks that there is good reason to believe, that nitric acid only was used for some years for this purpose. According to Mr Delaval, the use of tin in dyeing was known to the ancients; and he supposes that the tin which the Phœnicians carried from Britain, was employed in this way, because he thinks that it is necessary to the production of red colours, whether from animal or vegetable matter. Dr Bancroft, however, has proved, that this opinion is founded in mistake.

88. About the year 1543, Kuster brought his secret to London, and it appears that it was first employed for this purpose at Bow. Hence the scarlet colour thus produced was denominated in this country the *Bow dye*. It seems too, that this mode of dyeing scarlet was very early introduced into Holland. A Frenchman of the name of Gobelins, received an account of the process from a Flemish painter called Kloeck, to whom it had been communicated by Kuster himself, and established it in France. Hence the Bow dye of England was known in other parts of Europe under the names of Dutch scarlet, scarlet of the Gobelins.

89. We have mentioned above, that the effects of metallic oxides as mordants in dyeing, depend on the different proportions of oxygen with which they may be combined. Thus, there are two oxides of tin containing different proportions of oxygen; the one contains 30 parts of oxygen in the 100, and the other contains 40. The oxide having the smaller proportion of oxygen, being exposed to the air, combines with a new portion of oxygen, and is soon converted into the oxide with the greater proportion, or the white oxide. It is this

this last which is the mordant, for if the other were applied to the stuff, it would soon be converted into the white oxide, by combining with an additional portion of oxygen.

90. Tin was first used as a mordant dissolved in nitric acid; but this preparation was found not to answer well, because the nitric acid readily converted the tin to the state of white oxide, in which state it is incapable of dissolving it. A precipitation of the tin took place, to prevent which, different substances were added, as common salt, or sal ammoniac; and thus a nitro-muriatic acid was produced, by which means the white oxide of tin was held in solution. It appears, however, that it was a considerable time before this method came into general use. Hellot, in an account of the process employed in his time for dyeing scarlet at Carcassonne, mentions that the tin was dissolved only in diluted nitric acid, adding that a Mr Baron was the first in that city who employed nitro-muriatic acid for the solution of tin, to prevent the precipitation of the oxide.

Preparation.

91. The ordinary solution of tin is made with that species of nitric acid called single aquafortis, and as it is usually prepared, it is found capable of dissolving about $\frac{1}{8}$ part of its weight of granulated tin. To each pound of aquafortis from one to two ounces of sea salt, or, what is deemed preferable by some, of sal ammoniac, are added. The acid is commonly diluted with a little water. The solutions which are made most slowly, and with the least separation of vapours, are found to succeed best. Two ounces of granulated tin are usually allowed for each pound of aquafortis; and the metal should be added at different times to moderate the rapidity of the solution. The water added to the acid should be weighed or measured, that a solution of the same strength may be always obtained. Eighteen or 20 pounds of this solution (B) are required to give a full cochineal scarlet to 100 pounds of woollen cloth.

92. But in the dyeing of scarlet, according to the ordinary process, a quantity of tartar is dissolved in the water, along with the nitromuriate of tin; and if the tartar be employed in sufficient quantity, the mordant is not to be considered as a nitromuriate of tin, but a tartrate or combination of tin with tartaric acid, in consequence of the decomposition which takes place, when these substances are brought to act on each other; for the nitromuriatic acid enters into combination with the potash or the tartar, while the acid of the tartar forms a compound with the oxide of tin.

93. It has been proposed by Haussman to employ the acetate of tin as a mordant for cotton and linen, instead of the nitromuriate. The acetate of tin is prepared by mixing together acetate of lead and nitromuriate of tin; and as the affinity between metallic oxides and vegetable substances is less powerful than the affinity between these oxides and animal matters, this mordant has been found preferable for cotton and linen stuffs; for the affinity of the oxide of tin for the acetous acid being weaker than for the nitromuriatic acid, it is more easily decomposed.

94. Dr Bancroft * tried the solution of tin in sulphuric acid, but found that it would not answer, on account of its destructive action on the cochineal colour; but he found afterwards, that, by the use of muriatic acid combined with $\frac{1}{4}$ its weight of sulphuric acid, good effects were obtained. The proportions which he employed were about 14 ounces of tin in a mixture of two pounds of sulphuric acid of the ordinary strength, with about 3 pounds of muriatic acid. This preparation may be made in the cold; but the solution is very rapidly promoted with a sand heat. The solution of tin made in these proportions, Dr Bancroft observes, is perfectly transparent and colourless; and in the space of three years, during which time he kept a solution of it, no precipitation had taken place. It produces, he adds, full twice as much effect as the dyer's *spirit*, or nitromuriatic solution of tin, and at less than one-third of the expence.

Oxide of iron.

95. Iron exists in two states of combination with oxygen. In the state of green oxide it contains the smaller proportion of oxygen, and in that of red oxide the greater proportion. In the last state it can only be employed as a mordant in dyeing; for if it be applied in the state of green oxide, in consequence of its strong affinity for oxygen, it attracts it from the atmosphere, and is soon converted into red oxide. The difficulty of removing iron spots or mould from cotton or linen shows with what force of affinity the red oxide of iron adheres to cloth. Iron is employed as a mordant in two states of combination, either in that of sulphate or acetate of iron. The sulphate of iron is generally employed for wool. The stuff is immersed in the solution of the salt in water. In this state it may be also used for cotton; but it is more commonly preferred in the state of acetate of iron. This is the combination of iron with the acetous acid, and it is usually prepared by dissolving iron in vinegar or sour beer; and the longer it is retained in the solution, it is found to act more powerfully as a mordant, because it is then in a state of more complete oxidation.

96. Some other saline bodies are also employed as mordants, to facilitate the combination of the colouring matter with the cloth, or to produce greater variety of shades of colour. Among these substances may be mentioned common salt, sal ammoniac, acetate of lead, sulphate and acetate of copper, sulphate of zinc.

Animal and vegetable matters.

97. Besides the mordants obtained from the class of salts, vegetable and animal substances also serve a similar purpose. In the process for dyeing the Turkey red, which will be afterwards described, the cotton stuffs should be impregnated with an animal substance, as oil; and the astringent principle is often employed as a medium of combination between colouring particles and stuffs. Tan, or the astringent principle, having a strong affinity for cloth, is found extremely useful as a mordant. It is commonly prepared by infusing nut-galls in water. The cloth is immersed in this solution, and allowed to remain till it is sufficiently impregnated with the tan. Sumach, which is the shoots of the *Rhus coriaria* Lin. a shrub which grows in the southern parts of

---

* *Philos. of Perm. Col.* 289.

(B) This solution is called *spirit* by the dyers in this country.

Mor- nts.

of Europe, is often used and prepared in the same way as the nut galls.

ts of ants e co- ou

98. Mordants have a very considerable effect on the colour; and, by varying the mordant, very different colours, and a great variety of shades, may be obtained from the same colouring matter. Some mordants themselves may be considered as communicating a colour without the addition of any colouring substance; and although, when the latter is added, a new set of affinities is brought into action, yet there is little doubt that the mordant also has a considerable share in fixing the shades of colour. Let us take an example in dyeing with cochineal. When the aluminous mordant is employed, the colour produced is crimson; but when the oxide of iron is substituted for the alumina, the colour obtained is black. The effect is obviously produced by a change in the action of the affinities between the colouring matter and the mordant, and the colouring matter and light. In the use of mordants, therefore, it is necessary to attend to their combined effects with the colouring matter employed, and to be able to communicate particular colours to stuffs with any degree of certainty, to know the amount of that effect.

99. Even in the mode of applying mordants, the variety of shades may be greatly multiplied. Different effects, for instance, are produced by previously impregnating the stuff with the mordant, or by mixing it with the bath. Different effects also arise from using heat, or, as the stuff is more or less rapidly dried; and this must appear to be the case, if we consider the different affinities which are in action, and the change on the action of these affinities in these different circumstances, as well as in others which can scarcely be appreciated. The combination of these substances which have an affinity for the stuff, and the decompositions which are the result of that combination, are greatly facilitated by the evaporation of the water or other liquid which held these substances in solution; because by its affinity, which is opposed to the action of the affinity between these substances and the stuff, the affinity of the latter produces a more limited effect. But in dyeing, the process should proceed slowly, that the substances may not be separated before their mutual affinities have begun to operate.

100. Considerable differences must be observed in the mode of employing the mordant, as the force of affinity between the stuff and the colouring matter is greater or less. When this affinity is strong, the mordant and the colouring substance may be mixed together; the compound thus formed, immediately enters into combination with the stuff. But if the affinity between the stuff and the colouring particles be weak, the compound formed of the latter and the mordant may separate, and a precipitation take place, before it can be attached to the stuff; and hence it is in these cases, that the mordant which is to serve as the medium of union between the stuff and the colouring matter, must be combined with the former, before the application of the latter. It is from these differences that different processes must be followed in fixing colouring matters on animal and vegetable productions; as for instance, in dyeing wool or silk black, or with cochineal.

Of Substances to be coloured.

101. In estimating the effects of mordants, and in judging of the most advantageous manner of applying them, it is necessary to attend to the combinations which may be formed, either by the action of the ingredients of which they are composed, or, by that of the colouring matter and the stuff. It is necessary also, to take into consideration the circumstances which may tend to bring about these combinations with more or less rapidity, or that may render them more or less perfect. The action which the liquor in which the stuff is immersed may have, either on its colour or texture, must also be considered; and to be able accurately to judge of the extent of this action, we must know the proportions of the principles of which the mordant is composed; which of these principles remains in an uncambined state in the liquor, and the proportion or quantity which is thus separated.

Chap. III. *Of the Nature and Properties of the Substances to which Colours are communicated in the Processes of Dyeing.*

102. In the more limited sense to which we have here restricted the art of dyeing, the substances to which colours are usually communicated by means of this art, are wool, silk, cotton, flax, and hemp. Of these, the two first are animal substances, and the three latter are derived from the vegetable kingdom. These two classes of bodies present striking differences, not only in structure, but also in their composition and chemical properties.

Difference between animal and vegetable matters.

103. Animal substances are distinguished from those which have a vegetable origin, by the nature of their constituent parts. The former contain a large proportion of azote, which exists sparingly in the latter. Hydrogen, or the base of hydrogen gas or inflammable air, is found in greater abundance in animal matters, than in vegetable productions. In the distillation of animal and vegetable substances, the difference of their constituent parts is not less remarkable. The former afford a large proportion of ammonia, or volatile alkali; the latter yield very little, and sometimes give out an acid substance. Animal matters afford much oil, while vegetable substances sometimes do not afford it in any perceptible quantity. From the nature of their component parts, animal substances produce a bright flame in burning; and their combustion is accompanied with a penetrating odour, which is owing to the formation and emission of ammonia and oil. Animal matters run rapidly into the putrefactive process, while vegetable substances more slowly undergo the changes which are induced by the vinous or acetous fermentation.

104. The constituent principles of animal substances have a stronger tendency than those which enter into the composition of vegetable matters, to assume the elastic form. On this account the cohesive force existing between the particles of the former is inferior to that of the particles of the latter. Hence animal matters are more disposed to combine with other substances, more liable to be destroyed by different agents, and to enter into combination with colouring particles. Thus, animal substances are destroyed by the caustic fixed alkalies, and they are decomposed by the nitric and sulphuric

phuric acids. The action of acids and alkalies on silk is less powerful than upon wool, and it is less disposed to combine with the particles of colouring matter. In this respect it bears some resemblance to vegetable substances; but on vegetable matters, the action of alkalies and acids is less powerful than on animal substances; and the action of acids is more feeble on cotton than on flax or hemp. It is even decomposed with considerable difficulty by means of nitric acid.

In the four following sections, we shall consider the peculiarities of these substances at greater length.

SECT. I. *Of Wool.*

Structure.

105. Wool, which is well known as the covering of sheep, derives its value from the length and fineness of its filaments. The filaments of wool are considerably elastic, for they may be drawn out beyond their usual length, and when the force is removed, they recover it again. The surface of the filaments of wool or hair is not perfectly smooth; for although no roughness or inequality can be discovered by the microscope, yet they seem to be formed of small laminæ placed over each other in a slanting direction, from the root of the filament towards its point, resembling the arrangement of the scales of a fish, which cover each other from the head of the animal to its tail; or perhaps they consist of zones placed over each other, as is observed in the horns of animals. This peculiarity of structure of the filaments of hair and wool is proved by a simple experiment. If a hair be laid hold of by the root in one hand, and drawn between the fingers of the other hand, from the root towards the point, scarcely any friction or resistance is perceived, and no noise is heard; but if it be grasped by the point, and passed in the same manner between the fingers from the point towards the root, a resistance is felt, and a tremulous motion is perceptible to the touch, while the ear is sensible to a slight noise. Thus it appears, that the texture of the surface of hair or wool is not the same from the root towards the point, as it is from the point towards the root. This is farther confirmed by another experiment. If a hair be held between the thumb and forefinger, and they are rubbed against each other in the longitudinal direction of the hair, it acquires a progressive motion towards the root. This effect depends not on the nature of the skin of the finger, or on its texture, for if the hair be turned, and the point placed where the root formerly was, the motion is reversed, that is, it will still be towards the root.

Felting.

106. On this peculiarity of structure, which was observed by M. Monge, depend the processes of felting and fulling, to which hair and wool are subjected, for different purposes. In the process of felting, the flocculi of wool are struck with the string of the bow, by which the filaments are separately detached, and dispersed in the air. These filaments fall back on each other in all directions on the table, and when a layer of a certain thickness is formed, they are covered with a cloth, on which the workman presses with his hands in all parts. By this pressure the filaments of wool are brought nearer to each other; the points of contact are multiplied; the progressive motion towards the root is produced by the agitation; the filaments entangle each other; and the laminæ of each filament, taking hold of those of the other filaments, which are in an opposite direction, the whole is retained in the state of close contexture.

Fulling

107. Connected with this operation is that of fulling. The roughness on the surface of the filaments of wool, and their tendency to acquire a progressive motion towards the root, produces considerable inconvenience in the operations of spinning and weaving. These inconveniences are obviated by covering the filaments with a coat of oil, which fills up the cavities, and renders the asperities less sensible. When these operations are finished, the stuff must be freed from the oil, which would prevent it from taking the colour with which it is to be dyed. For this purpose it is taken to the fulling-mill, where it is beaten with large beetles, in a trough of water, through which clay has been diffused. The clay unites with the oil, which being thus rendered soluble in the water, is carried off by fresh portions of water, conveyed to it by proper apparatus. In this way the stuff is scoured; but this is not the sole object of the operation. By the alternate pressure of the beetles, an effect similar to that of the hands in the operation of felting, is produced. The filaments composing a thread of warp or woof, acquire a progressive motion, are entangled with the filaments of the adjoining threads; those of the latter into the next, and so on, till the whole threads are felted together. The stuff is now contracted in all its dimensions, and participating both of the nature of cloth and of felt, may be cut without being subjected to ravel; and when employed to make a garment, requires no hemming. In a common woollen stocking web, after this operation, the stitches, when one happens to slip, are now no longer subject to run, and the threads of the warp and woof being less distinct from each other, the whole stuff is thickened, and forms a warmer clothing.

Importa of wool.

108. The various manufactures of which wool constitutes the basis, are justly regarded among the most important to man in civilized society. Accordingly, the production of fine wool, and the causes which retard or improve the breed of sheep from which it is obtained, have greatly occupied the attention of economists and philosophers in our own, as well as in other countries. The wool of different breeds of sheep, in different countries, it is well known, possesses very different qualities, both with regard to the fineness of the filament, and the colour. Some is of a white, or yellow, and some of a reddish, and black colour. Excepting the wool of the breed of sheep in Andalusia, the Spanish wool was formerly all of a brownish black colour. This was preferred by the native Spaniards; and even at this day, the dress of some religious orders in Roman Catholic countries, consists of cloth manufactured from this wool, and retaining its natural colour. But for the purposes of dyeing, white wool is now always preferred, because it is found susceptible of receiving better and more durable colours.

Scourin

109. Wool is naturally covered with a kind of grease or oil, which is found to preserve it from insects or moths, and on this account this greasy matter is not removed, or the wool is not scoured, till it is to be dyed or

Of Sub-
ances to
colour-
ed.

or spun (c). The process for scouring wool is the following. It is put for about a quarter of an hour into a kettle, with a sufficient quantity of water, to which a fourth part of putrid urine has been added. It is then heated to such a degree as the hand can bear, occasionally stirred, and after being taken out, is allowed to drain. It is then put into a basket, and exposed to a stream of running water, and moved about till the grease is so completely separated, that it no longer renders the water turbid. After being drained, it is sometimes found to lose by this operation above one-fifth of its weight. It is almost unnecessary to observe, that the more carefully and completely this process is performed, the better the wool is fitted to receive the colouring matter. Our chemical readers will readily perceive the nature of the changes which are effected in this process of scouring. The ammonia, or volatile alkali, which exists in the urine, combines with the oil of the wool, and forms a soap, which being soluble in water, is dissolved, and carried off.

ing.

110. Wool is either dyed in the fleece, or after it is spun into threads, or when it has been manufactured into cloth. For the purpose of forming cloths of mixed colours, it is dyed before it is spun; for the purposes of tapestry, it is dyed in the state of thread; but most commonly it is subjected to this process after it has been manufactured into cloth. In these different states, the quantity of colouring matter which is taken up is very different. The proportion is largest when it is dyed in the fleece, because then the filaments being more separated, a greater surface is exposed to the action of the colouring particles. For a similar reason the quantity of colouring matter taken up is greater when in the state of thread or yarn, than when it is formed into cloth. But cloths themselves must vary greatly in this respect, according to their different qualities. Their different degrees of fineness, or closeness of texture, will produce considerable variations; and besides, the difference in the quantity and dimensions of the substances to be dyed, the different qualities of the ingredients employed in the process, and the different circumstances in which it is performed, should be a caution against trusting to precise quantities, regulated by weight or measure, which are recommended according to general rules. According to the fineness of the texture of the wool, and the nature of the colouring matter employed, it is found to be more or less penetrated with this matter. The coarse wool from the thighs and tails of some sheep, receives colours with difficulty, and the finest cloth is never completely penetrated with the scarlet dye. The interior of the cloth appears always, when cut, of a lighter shade, and sometimes even white.

SECT. II. *Of Silk.*

Ori

111. Silk, which forms the basis of one of the richest and most splendid parts of dress, among the wealthy and luxurious, in civilized society, is the production of different species of insects. The *phalæna bombyx*, or silk-worm, which is a native of China, attracted the attention of mankind in that country, from the earliest ages. The honour of having first collected and prepared silk from the cocoons or balls in which it is wound up by the insect, during its metamorphosis, is ascribed by the Chinese historians, to the wife of an emperor. The *phalæna atlas*, Lin. which is also a native of China, is said to form larger cocoons, and to yield a stronger silk. The silk-worm was first carried from China to Hindostan, and afterwards to Persia. Silk seems not to have been known to the Greeks or Romans till the time of Augustus. Its nature and origin were little understood, and for many ages it was so scarce, that it could only be purchased at a price which was equal to its weight in gold. The emperor Aurelian, it is said, from a principle of economy, resisted the urgent solicitations of his empress, who wished to have a silken robe, alleging the extravagance of the expence. About the middle of the sixth century, two monks returned from India to Constantinople, and brought with them a considerable number of silk-worms, with instructions for managing and breeding them, as well as for collecting, preparing, and manufacturing the silk. Establishments were thus formed at Corinth, Athens, and other parts of Greece. The crusades, which greatly contributed to the diffusion of different kinds of knowledge, by the intercourse which took place between different countries, proved useful in disseminating the knowledge of rearing the silk-worm, and preparing and manufacturing its valuable productions. Roger, king of Sicily, about the year 1130, returning from one of these frantic expeditions, brought with him from Athens and Corinth, several prisoners, who were acquainted with the management of silk-worms, and the manufacturing of silk. Under their superintendance, manufactories were established at Palermo and Cagliari in Sicily. This example was soon adopted, and followed in different parts of Italy and Spain. In the time of James I. an attempt was made to establish the silk-worm in England. For this purpose the culture of the mulberry-tree, on which the insects feed, was strongly recommended by that prince to his subjects; but the attempts which were made have been hitherto unsuccessful.

Scouring.

112. The fibres of silk are covered with a coating or natural varnish of a gummy nature. To this are ascribed its stiffness and elasticity. Besides this varnish, the silk which is usually met with in Europe is impregnated with a substance of a yellow colour, and for most of the purposes to which silk is applied, it is necessary that it should be deprived, both of the varnish and of the colouring matter. On this account it must be subjected to the operation of scouring; but for silks which are to be dyed, this process should not be carried so far as for those which are merely to be whitened; and different colours, it is observed, require different degrees of this operation. The quantity of soap constitutes the chief difference. A hundred pounds of silk boiled in a solution of 20 lbs. of soap for three or four hours, adding new portions of water during the evaporation, are sufficiently prepared for receiving common colours.

(c) According to an observation of Reaumur, rubbing any stuff with greasy wool, is sufficient to preserve it from moths.

colours. For blue colours, the proportion of soap must be increased; and scarlet, cherry-colour, &c. require a still greater proportion, for the ground must be whiter for these colours.

Process, when employed white.

113. Silk which is to be employed white, must undergo three operations. In the first the hanks are immersed in a hot but not boiling solution of 30lbs. of soap to 100 of silk. When the immersed part is freed from its gum, which is known by its whiteness, the hanks are shaken over, as the workmen term it, so that the part which was not previously immersed may undergo the same operation. They are then wrung out as the process is completed. In the second operation the silk is put into bags of coarse cloth, each bag containing 20 or 30 lbs. These bags are boiled for an hour and a half, in a solution of soap prepared as before, but with a smaller proportion of soap; and that they may not receive too much heat, by touching the bottom of the kettle, they must be constantly stirred during the operation. The object of the third operation is to communicate to the silk different shades, to render the white more agreeable. These are known by different names, as China-white, silver-white, azure-white, or thread-white. For this purpose a solution of soap is also prepared, of which the proper degree of strength is ascertained by its manner of frothing by agitation. For the China-white, which is required to have a slight tinge of red, a small quantity of anatto is added, and the silk is shaken over in it till it has acquired the shade which is wanted. In other whites, a blue tinge is given by adding a little blue to the solution of soap. The azure-white is communicated by means of indigo. To prepare the azure, fine indigo is well washed two or three times in moderately warm water, ground fine in a mortar, and boiling water poured upon it. It is then left to settle, and the liquid part only, which contains the finer and more soluble parts, is employed.

114. Some use no soap in the third operation; but when the second is completed, they wash the silks, fumigate with sulphur, and azure them with river water, which should be very pure. But all these operations are not sufficient to give silk that degree of brightness which is necessary, when it is to be employed in the manufacture of white stuffs. For this purpose it must undergo the process of sulphuration, in which the silk is exposed to the vapour of sulphur; for an account of which see Bleaching. But before the silk which has been treated in this way is fit for receiving colours, and retaining them in their full lustre, the sulphur which adheres to it must be separated by immersion and agitation for some time in warm water, otherwise the colours are tarnished and greatly injured.

Mode of extracting its colouring matter.

115. It has long been an object of considerable importance, to deprive silk of its colouring matter, without destroying the gum, on which its stiffness and elasticity depend. A process for this purpose was discovered by Beaumé, but as it was not made public, others have been led to it by conjecture and experiment. The following account, given by Berthollet, is all that has transpired concerning this process. A mixture is made with a small quantity of muriatic acid and alcohol. The muriatic acid should be in a state of purity, and particularly should be entirely free from nitric acid, which would give the silk a yellow colour. In the mixture, thus prepared, the silk is to be immersed. One of the most difficult parts of the process, especially when large quantities are operated upon, is to produce a uniform whiteness. In dyeing the whitened silk, there is also considerable difficulty to prevent its curling, so that it is recommended to keep it constantly stretched during the drying. The muriatic acid seems to be useful in this process, by softening the gum, and assisting the alcohol to dissolve the colouring particles which are combined with it. The alcohol which has been impregnated with the colouring matter may be again separated from it and purified, that it may serve for future operations, and thus render the process more economical. This may be done by means of distillation with a moderate heat, in glass or stone-ware vessels.

Aluming.

116. The preparation with alum is a very important preliminary operation in the dyeing of silk. Without this process, few colours would have either beauty or durability. Forty or fifty pounds of alum, previously dissolved in warm water, are mixed in a vat, with forty or fifty pailfuls of water; and to prevent the crystallization of the salt, the solution must be carefully stirred during the mixture. The silk being previously washed and beetled, to separate any remains of soap, is immersed in this alum liquor, and at the end of eight or nine hours is wrung out, and washed in a stream of water. A hundred and fifty pounds of silk may be prepared in the above quantity of liquor; but when it begins to grow weak, which may be known by the taste, 20 or 25 lbs. of dissolved alum are to be added, and the addition repeated till the liquor acquires a disagreeable smell. It may then be employed in the preparation of silk intended for darker colours, till its whole strength is dissipated. This preparation of silk with alum must be made in the cold; for when the liquor is employed hot, the lustre is apt to be impaired.

Sect. III. *Of Cotton.*

Origin.

117. Cotton is the down or wool contained in the pods of a shrubby plant, which is a native of warm climates. Of this genus of plants (*Gossypium* Lin.) there are four species, one of which only is perennial; the other three are annual plants; but of these there are many varieties, occasioned by the difference of soil or temperature in which they are produced. The principal differences among cottons consist in the length and fineness of the filaments, and in their strength and colour.

Structure.

118. The peculiar structure of the fibres of cotton is not well known. According to the microscopic observations of Leeuwenhoeck, they have two sharp sides, to which are ascribed the irritation and inflammation of wounds and ulcers, when they are dressed with cotton instead of lint. This peculiarity of structure, it is also supposed, may occasion some difference in the conformation, and number of the pores, on which alone the disposition of cotton to admit and retain colours better than linen, seems to depend. In this respect, however, it is inferior to wool and silk, because, on account of its vegetable nature, its affinity for colouring matter is less powerful.

Has a less affinity than wool for colouring matter.

119. It is well known that silk, cotton, and linen have a weaker affinity for colouring matter than wool. Le Pileur d'Apligny attempts to explain this by supposing

Of Sub-auces to colour-ed.

that the pores of these substances are smaller than those of wool, and that the colouring particles enter them less easily and freely. But according to the observation of Dr Bancroft, the reverse of this seems to be the fact; for there is little difficulty in making silk, cotton, and linen, imbibe colouring matter, even when it is applied cold, without any artificial dilatation of the pores, which is always necessary in the dyeing of wool. The only real difficulty is to make them retain the colours after the matter has been imbibed; because being admitted so readily into their undilated pores, the particles cannot be afterwards compressed and retained by the contraction of these pores, as is the case with wool. It requires double the quantity of cochineal which is necessary for wool to communicate a crimson colour to silk; a certain proof that it can take up a greater quantity, and consequently that the pores are sufficiently large and accessible. Unbleached cotton is always preferred for dyeing Turkey red; because in this state the colour is found to be most permanent; and this is ascribed to the pores or interstices being less open than after it has undergone the process of bleaching. The same thing is observed of raw or unscoured silk. It is found to combine more easily with the colouring matter, and to receive a more permanent colour in this state than after it has been scoured and whitened. "The openness of cotton and linen (says Dr Bancroft), and their consequent readiness to imbibe, both colouring particles, and the earthy or metallic bases employed to fix most of them, are circumstances upon which the art of dyeing and calico-printing is in a great degree founded *." But is not this too mechanical an explanation of the phenomenon? Might it not rather be alleged that it is owing to a difference of affinities which exists between the particles of colouring matter and the substance which is separated from the silk or cotton by the process of bleaching or scouring? This substance probably acts the part of a mordant; and having a stronger affinity for the stuff and for the colouring matter than the stuff has for the latter, the colour communicated is more durable when silk or cotton is dyed in the unbleached or unscoured state.

Prepara-tio for dy g.

120. To prepare cotton stuffs for receiving the dye, several operations are necessary. It must first undergo the process of scouring. By some it is boiled in sour water, or in alkaline ley. It should be kept boiling for two hours, then wrung out, and rinsed in a stream of water till the water comes off clear. The stuffs to be prepared should be soaked for some time in water, mixed with not more than $\frac{1}{10}$th part of sulphuric acid, and then carefully washed in a stream of water, and dried. In this operation the acid combines with a portion of calcareous earth and iron, which would have interrupted the full effect of the colouring matter in the process of dyeing.

Al ing.

121. Aluming is another preliminary process in the dyeing of cotton. The alum is to be dissolved in the manner already described, in preparing silk. Each pound of cotton stuff requires four ounces of alum. By some a solution of soda, about $\frac{1}{16}$th part of the alum, and by others a small quantity of tartar and arsenic are added. The thread is to be impregnated by working it in small quantities with this solution. The whole is then put into a vessel, and the remaining part of the liquor is poured upon it. In this state it is left for 24 hours, after which it is removed to a stream of water, and allowed to remain for an hour and a half, or two hours, to extract part of the alum. It is then to be washed. By this operation, cotton is found to gain an addition of about $\frac{1}{40}$th part of its weight.

Galling.

122. The operation of galling is another preparatory process in the dyeing of cotton stuffs. The quantity of astringent matter employed must be proportioned to its quality, and the amount of the effect required. Powdered galls are boiled for two hours in a proportion of water, regulated by the quantity of thread to be galled. This solution being reduced to such a temperature as the hand can bear, is divided into a number of equal parts, that the thread may be wrought pound by pound. The whole stuff is then put into a vessel, and the remaining liquor poured upon it, as in the former process. It is then left for 24 hours, if it is to be dyed black, but for other colours, 12 or 15 hours are found sufficient. It is then wrung out and dried.

In the galling of cotton stuffs, which have already received a colour, the precaution should be observed of performing this operation in the cold, otherwise the colour is subject to injury.

123. Berthollet informs us, that cotton which had been alumed acquired more weight in the galling than that which had not previously undergone that process; for although alum adheres but in small quantities to cotton, it communicates to it a greater power of combining, both with the astringent principle, and with the colouring particles. This, we may add, may be considered as a good instance of the action of intermediate affinities, and of the advantage to be derived to the art of dyeing, from investigating and observing this action.

SECT. IV. *Of Flax.*

Origin.

124. Flax and hemp nearly resemble each other in their general properties; and so far as relates to the process of dyeing, what is said of the one may be applied to the other. Flax or lint is obtained from the bark of *Linum usitatissimum*, and hemp from that of *Cannabis sativa*.

Watering.

125. Before flax is properly prepared to receive the dye, it must be subjected to several processes. One of the most important is that of watering, by which the fibrous parts of the plant are separated, and brought to that state in which they can be spun into threads. As the quantity and quality of the product depend much on this preliminary operation, it becomes of the greatest consequence that it be properly conducted. During this process, carbonic acid and hydrogen gas are given out. The extrication of these gases is owing to a glutinous juice which holds the green colouring part of the plant in solution, and which is the medium of union between its cortical and ligneous parts, undergoing a certain degree of putrefaction. This substance seems to resemble the glutinous part which is held dissolved in the juice obtained from plants by pressure; is separated from the colouring particles by means of heat; readily becomes putrid, and by distillation affords ammonia. But although it is held in solution with the expressed juice, it would appear that it cannot be separated from the cortical parts completely, by means of water; and hence it happens, that hemp or flax

---

* ilos. of P manent C ers, 71.

watered in too strong a current, has not the requisite softness and flexibility. But on the other hand, if the water employed in this operation be stagnant and in a putrid state, the hemp or flax becomes of a brown colour, and loses its firmness. In the one case, the putrefactive process is interrupted; in the other it is continued too long, and carried too far. This process, therefore, is performed with the greatest advantage in places near the banks of rivers, where the water may be changed so frequently as to prevent such a degree of putrefaction as would be injurious to the flax, as well as prejudicial to the workmen, from noxious exhalations; and, at the same time, not so frequently as to retard or interrupt those changes which are necessary for rendering the glutinous substance soluble in water.

126. By the process of watering flax, and by drying before and after that process, the green coloured particles undergo a similar change to that which is observed in the green substance of the plants exposed to the action of air and light. The next part of the process, therefore, after watering, is to spread it out upon the grass, and thus expose it for some time to the air and sun. By this means the colour of the lint is improved, and the ligneous part becomes so brittle, that it is easily separated from the fibrous part. This operation, as is well known, is usually performed by machinery.

Structure.

127. The fibres of lint possess no perceptible degree of elasticity, and they appear to be perfectly smooth. No ronghness or ineqnality can be detected by the feel, and no asperities can be perceived, even with the assistance of the microscope. Experience shows, that it produces no irritation on wounds or sores which are dressed with it, as is known to happen from a similar application of cotton stuffs.

Preparations for dyeing.

128. Flax which is intended for dyeing must be subjected to a similar series of operations with cotton, in the different processes of scouring, aluming and galling. A repetition of the mode of performing these operations is therefore unnecessary.

Chap. IV. *Of the Operations of Dyeing.*

129. Before we proceed to the detail of the processes of dyeing, we shall throw out a few hints on the operations in general, some of which may perhaps be useful to the practical dyer.

Advantages of large manufactories.

130. The works which are carried on in extensive manufactories, it has been observed, are followed with advantages which are unknown to those which are conducted ou a limited scale or in a detached manner. By the subdivision of labour, each workman directing his attention to one or a few objects, acquires a great facility and perfection of execution, by which means the saving of time and labour becomes considerable. This principle is particularly applicable to the art of dyeing, because the preparation which remains after one operation may often be advantageously employed in another. A bath from which the colouring matter has been in a great measure extracted in the first operation, may be used as a ground for other stuffs, or with the addition of a fresh portion of ingredients may form a new bath. The galls which have been applied to the galling of silk may answer a similar purpose for cotton or wool. From this it must appear that the limitations and restrictions under which the art of dyeing labours in some countries must tend to obstruct its progress and improvement. An extensive plan of operations, by which the different branches of the art are connected together, would effectually prevent the loss of ingredients, time, fuel, and labour.

Dye-hous

131. A dye-house, which should be set down as near as possible to a stream of water, should be spacious and well lighted. It should be floored with lime and plaster; and proper means should be adopted to carry off water or spent baths by forming channels or gutters, so that every operation may be conducted with the utmost attention to cleanliness.

Caldrons.

132. The size and position of the caldrons are to be regulated by the nature and extent of the operations for which they are designed. Excepting for scarlet and other delicate colours, in which the tin is used as a mordant, in which case tin vessels are preferable, the caldrons should be of brass or copper. Brass, being less apt than copper to be acted on by means of chemical agents, and to communicate spots to the stuffs, is fitter for the purpose of a dyeing vessel. It is scarcely necessary to say that it is of the greatest consequence that the coppers or caldrons be well cleaned for every operation; and that vessels of a large size should be furnished at the bottom with a pipe and stop-cock for the greater conveniency of emptying them: and there must be a hole in the wall or chimney above each copper to admit poles for the purpose of draining the stuffs which are immersed, so that the liquor may fall back into the vessel, and no part may be lost.

Apparatu for silk.

133. Dyes for silk, where a boiling heat is not found necessary, are prepared in troughs or backs, which are long copper or wooden vessels. The colours which are used for silk are extremely delicate. They must therefore be dried quickly, that they may not be long exposed to the action of the air, and there may be no risk of change. For this purpose, it is necessary to have a drying room heated with a stove. The silk is stretched on a moveable pole, which by the dyers is called a shaker. This is hung up in the heated chamber, and kept in constant motion to promote the evaporation.

For stuffs of cloth.

134. For pieces of stuffs, a winch or reel must be constructed; the ends of which are supported by two iron forks which may be put up at pleasure in holes made in the curb on which the edges of the copper rest. The manipulations in dyeing are neither difficult nor complicated. Their object is to impregnate the stuff to be dyed with the colouring particles, which are dissolved in the bath. For this purpose, the action of the air is necessary, not only in fixing the colouring particles, but also in rendering them more vivid; while those which have not been fixed in the stuff are to be carefully removed. In dyeing whole pieces of stuff, or a number of pieces at once, the winch or reel mentioned above must be employed. One end of the stuff is first laid across it, and by turning it quickly round, the whole passes successively over it. By turning it afterwards the contrary way, that part of the stuff which was first immersed, will be the last in the second immersion, and thus the colouring matter will be communicated as equally as possible.

For wool.

135. In dyeing wool in the fleece, a kind of broad ladder

ladder with very close rounds, called by the dyers of this country, a *scraw*, or *scray*, is used. This is placed over the copper, and the wool is put upon it, for the purpose of draining and exposure to the air, or when the bath is to be changed. If wool is dyed in the state of thread, or in skains, rods are to be passed through them, and the hanks turned upon the skain sticks in the liquor. This is called *shaking over*. When silk or thread is in the same state, it undergoes a similar operation.

136. To separate the superabundant colouring particles, or those which have not been fixed in the stuff, silk or thread, after being dyed, it must be wrung out. This operation is performed with a cylindrical piece of wood, one end of which is fixed in the wall, or in a post. This operation is often repeated a number of times successively, for the purpose of drying the stuffs more rapidly, and communicating a brighter lustre.

137. When, after a certain quantity of fresh ingredients is added to a liquor, and it is stirred about, it is said to be *raked*, because it is mixed with the rake.

138. In dyeing, one colour is frequently communicated to stuffs, with the intention of applying another upon it, and thus a compound colour is produced. The first of these operations is called *giving a ground*.

139. When it is found necessary to pass stuffs several times through the same liquor, each particular operation is called a *dip*.

140. A colour is said to be *rosed*, when a red colour having a yellow tinge, is changed to a shade inclining to a crimson or ruby colour; and the conversion of a yellow red to a more complete red, is called *heightening* the colour.

141. In addition to these general remarks, we might give more minute details of the different operations which are employed in dyeing; but as we cannot presume that they would be of much advantage to the practical dyer, we shall not indulge ourselves in useless description. "Although the manipulations of dyeing," says Berthollet, "are not very various, and appear extremely simple, they require very particular attention, and an experienced eye, in order to judge of the qualities of the bath, to produce and sustain the degree of heat suited to each operation; to avoid all circumstances that might occasion inequalities of colour, to judge accurately whether the shade of what comes out of the bath suits the pattern, and to establish the proper gradations in a series of shades *."

142. We shall conclude this chapter with a few observations on the qualities and effects of different kinds of water, which may be considered as one of the most essential agents in the art of dyeing. It is almost unnecessary to say, that water which is muddy, or contains putrid substances, should not be employed; and indeed no kind of water which possesses qualities distinguished by the taste, ought to be used. Water which holds in solution earthy salts, has a very considerable action on colouring matters, and it is chiefly by means of these salts. Such, for instance, are the nitrates of lime and magnesia, muriate of lime and magnesia, sulphate of lime, and carbonate of lime and of magnesia.

143. These salts which have earthy bases, oppose the solution of the colouring particles, and by entering into combination with many of them, cause a precipitation, by which means the colour is at one time deeper, and at other times duller and more faint than would otherwise be the case. Waters impregnated with the carbonates of lime and magnesia, yield a precipitate when they are boiled; for the excess of carbonic acid which held them in solution is driven off by the heat; the earths are thus precipitated, and adhering to the stuffs to be dyed, render them dirty, and prevent the colouring matter from combining with them.

144. It is of much consequence to be able to distinguish the different kinds of water which come under the denomination of *hard water*, that they may be avoided in the essential operations of dyeing; but to detect different principles contained in such waters, and to ascertain their quantity with precision, require great skill, and very delicate management of chemical operations, which the experienced chemist only can be supposed to possess. For the methods to be followed when such accuracy is required, we must refer to the analysis of mineral waters, of which a full view is given in the treatise on chemistry, and content ourselves with mentioning some simple tests which are of easy application.

145. One of these tests is the solution of soap, by which it may be discovered whether water contain so large a portion of any of these saline matters as may be injurious to the processes. Salts which have earthy bases, have the property of decomposing soap by the action of double affinity. The acid of the salt combines with the alkali of the soap, and remains in solution, while the earth of the salt and the oil of the soap enter into combination, and form an earthy soap which is insoluble in water, and produces the curdling appearance which is the consequence of this new combination. Water, then, which is limpid and not stagnant, which has no perceptible taste or smell, and has the property of dissolving soap without decomposition, may be considered as sufficiently pure for the processes of dyeing. All waters which possess these qualities will be found equally proper for these purposes.

Method of purifying.

146. But, as it is not always in the power of the dyer to choose pure water, means of correcting the water which would be injurious to his processes, and particularly for the dyeing of delicate colours, have been proposed. Water in which bran has been allowed to become sour, is most commonly employed for this purpose. This is known by the name of *sours*, or sour water. The method of preparing sour water is the following. Twenty-four bushels of bran are put into a vessel that will contain about 10 hogsheads. A large boiler is filled with water, and when it is just ready to boil, it is poured into the vessel. Soon after the acid fermentation commences, and in about 24 hours the liquor is fit to be applied to use. Water which is impregnated with earthy salts, after being treated in this way, forms no precipitate by boiling. It is probable that the sour water decomposes the carbonate of lime and magnesia, because the vegetable acid which is formed during the fermentation, combines with the earthy basis, and sets the carbonic acid at liberty.

147. Some of the substances, with which waters are impregnated, or those which are merely diffused in them in a state of very minute division, may be separated by means of mucilaginous matters. The mucilage coagulates

coagulates by means of heat, and carrying with it the earths separated by boiling, as well as those substances which are simply mixed with the water, and render it turbid, rises to the surface, and forming a scum, may be easily removed.

148. Saline matters having earthy bases, which in general are injurious in dyeing, may in some cases be useful, because by their action, modifications of different colours may be produced. A water of this kind, for instance, would have the effect of communicating to the colour of cochineal a crimson shade.

149. River water, which is apt to be impregnated with earthy salts, may, at different times, contain very different proportions of these salts; and although the dyer may follow exactly the same process, he may be surprised to find considerable variations in the shades of his colours. This arises from the different degrees of impregnation with these saline matters which the water undergoes, as the bed of the river is of greater or less extent, or the waters flow over those places from which they derive these earthy salts. To obtain the same result in the process, therefore, it would be necessary to make certain variations according to the state of impregnation of the water.

PART II. OF THE PRACTICE OF DYEING.

150. IN the preceding part, we have endeavoured to give a general view of the principles on which the art of dyeing depends. We have considered the physical and chemical properties of colours and colouring matters, the nature of the substances to which colours are communicated, and the agents or means by which this is effected; and from the experiments and observations of philosophers, whose investigations have been directed to this subject, it appears that these changes are entirely owing to chemical affinities, by which decompositions are effected, and new combinations formed, among the constituent parts of the substances employed. A precise and full knowledge of the effects of these chemical agents would render the theory of dyeing complete; and although much has been already done by the chemical philosophers whom we have had occasion frequently to quote, yet experiments and observations are still wanting to form a theory of this art on fixed and rational principles. This, it is obvious, can only be done by chemical investigations. To the practical dyer, therefore, the study of chemical science must be essentially requisite, as this only can be his true guide in estimating and managing the complicated changes in the different processes of his art. It is only by the application of the principles of chemistry that this art can be improved and perfected. But the application of these principles must be made by the practical dyer himself, not by the chemist in his laboratory, or during an occasional visit to the manufactory. For in the complicated processes of dyeing conducted on an extensive scale, a thousand circumstances will be overlooked by the most acute and discerning chemist, which will not escape the habitual observation of the philosophical artist. Convinced ourselves of the incalculable advantages which the art of dyeing may derive from chemical science, and the innumerable resources which ingenuity and address may discover in the proper application of its principles towards the improvement of the different processes of this art, we shall not be thought, we hope, too sanguine in looking forward to a degree of perfection which is little to be expected from its present state.

Importance of chemistry in dyeing.

The processes of the art of dyeing form the subject of the second part of this treatise, the consideration of which we are now to enter upon.

Division of colours.

151. Colours have been usually distributed by dyers into two classes. These have been denominated *simple* and *compound* colours. Simple colours, which are commonly reckoned four in number, are such as cannot be produced by the mixing together different colours. Colours denominated compound may be produced by the mixture of any two of the simple colours in different proportions. Thus red, yellow, and blue are incapable of being produced by any combination of others, and are therefore considered as simple colours. Blue and red, which compose a purple, blue and yellow, a green, and red and yellow, an orange, are compound colours; but none of these, by any composition whatever, will afford a red, yellow, or blue.

Dr Ban croft's.

152. Dr Bancroft, in his elaborate treatise on the philosophy of permanent colours, divides colouring matters into two classes. The first includes those colouring substances which, being in a state of solution, may be permanently fixed on any stuff without any mordant, or the intermediate action of earthy or metallic bases. In the second class are comprehended those matters which cannot be fixed without the action of mordants. The first he has denominated *substantive* colours; because the colour is fixed without the aid of any other body; and the second *adjective;* because they become permanent only with the addition of a mordant. The celebrated purple produced by the liquor obtained from shell-fish and indigo, are examples of substantive colours. Prussian blue and cochineal are adjective colours.

The usual division of colours into simple and compound seems to form an arrangement equally convenient and perspicuous. We shall therefore adopt it in the following chapters. In the first we shall treat of *simple* colours; in the second of *compound* colours; and to these we shall add a third chapter on topical dyeing, or calico printing.

CHAP. I. *Of Simple Colours.*

Simple lours.

153. SIMPLE colours, we have already observed, are such as cannot be produced by the mixture of other colours. They are the foundation of all other colours, and therefore come naturally to be first treated of. The simple colours are four, viz. 1. Red. 2. Yellow. 3. Blue. 4. Black. To these a fifth is added by some; namely, brown, or fawn colour; although it may be produced by the combination of other colours. The nature of the colouring substances which are employed to

to produce these colours, and the processes by which they are fixed on the several stuffs, will form the subject of the four following sections.

Sect. I. *Of Red.*

154. Red colours, from different degrees of intensity, have received different names, as crimson, scarlet, besides a great variety of shades which are less striking, and come under no particular denomination. In this section we shall treat of the nature and properties of the substances which are employed in dyeing red, and then give an account of the different processes which are followed in fixing these colouring matters on animal and vegetable productions.

1. *Of the Substances employed in Dyeing Red.*

The colouring matters which are principally employed in dyeing red, are *madder*, *cochineal*, *kermes*, *lac*, *archil*, *carthamus*, *brazil wood*, and *logwood*.

155. Madder is very extensively employed in dyeing. It is the root of a plant (*rubia tinctorum*, Lin.) of which there are two varieties. It is cultivated in different parts of Europe, and the best, it is said, is brought from Zealand. Madder, as it is prepared for dyeing, is distinguished into different kinds. What is called *grape madder*, is obtained from the principal roots; the *none grape* is produced from the stalks, which by being buried in the earth, are converted into roots, and are called layers. When the roots are gathered, these layers are separated, with such of the fibres of the roots as do not exceed a certain degree of thickness, as well as those which are too thick; the latter containing a great deal of woody matter. The best roots are about the thickness of a goose quill, they have some degree of transparency; are of a reddish colour, and have a strong smell, and a smooth bark. When the madder is gathered, it must be dried, to render it fit for being reduced to powder, and being preserved. This operation is performed in warm climates in the open air. In Holland, stoves are employed for the same purpose; but when treated in this way, it is often injured, from too great a degree of heat, and being mixed with particles of soot. The superiority of madder from the Levant is ascribed to its having been dried in the open air.

156. The roots being dried, and the earthy matters which adhere to them being separated, by shaking them in a bag, or beating them lightly on a wooden hurdle, they are reduced to powder by means of manual labour, or with the aid of machinery. All the parts of madder do not yield the same colouring matter. The outer bark, and the ligneous part within, give a yellowish dye, which injures the red. These parts may be separated, in consequence of the different degrees of facility with which they are reduced to powder. The outer bark and woody parts are more easily powdered than the parenchymatous parts, which contain the fine red dye. To effect the separation of these different parts, three operations are performed. After the first, the madder is passed through a sieve, by which, what is called the *short* madder, (*courte* of the French), intended for tan, and inferior colours, is obtained. What remains is again ground and sifted. What the French call *mirobèe*, is obtained by this operation. A third operation of the same kind affords the *robèe* or finer kind of madder.

157. The result of the experiments of D'Ambourney show, that the fresh root of madder may be used with as much advantage in dyeing, as when it is dried and powdered. Four pounds of fresh madder, he observed, are equal to one of the dry, although in drying it loses seven-eighths of its weight. When the fresh roots are to be used, they are to be well washed in a current of water, immediately after they are taken out of the ground, and afterwards cut into pieces and bruised. In dyeing with the fresh roots, allowance should be made for the quantity of water which they contain, so that a smaller proportion should be put into the bath. Beckmann seems to be of the same opinion with regard to the use of the fresh roots of madder, and yet he has frequently observed that it is more fit for dyeing after it has been preserved for two or three years.

158. The madder which is cultivated in the neighbourhood of Smyrna, and in the island of Cyprus, affords a brighter red than the European madder, and therefore it is preferred in the preparation of the *Adrianople red*. This is known by the name *lizari*. Berthollet informs us that it is cultivated in Provence in France, and Beckmann has been very successful in raising it at Gottingen.

Properties.

159. The colouring matter of madder is soluble in alcohol, and by evaporation a deep-red residuum is formed. In this solution sulphuric acid produces a fawn-coloured precipitate; fixed alkali, one of a violet colour, and the sulphate of potash, a precipitate of a fine red. Alum, nitre, chalk, acetate of lead, and muriate of tin, afford precipitates in the solution of madder in alcohol, of various shades. The colouring matter of madder is also soluble in water. By maceration in several portions of cold water successively, the last receives only a fawn colour, which appears entirely different from the peculiar colouring particles of this substance. It resembles what is extracted from woods and other roots, and perhaps exists only in the ligneous and cortical parts. By repeated boiling, Berthollet exhausted the madder of all its colouring particles which are soluble in water. It still retained, however, a deep colour, and yielded a considerable quantity of colouring matter to an alkali. There was an inconsiderable residuum, which still remained coloured. The pulp, therefore, appears entirely composed of colouring matter, part of which is insoluble in simple water. When oxymuriatic acid is employed in sufficient quantity, to change an infusion of madder from red to yellow, it produces a small portion of a pale-yellow precipitate; the supernatant liquor is transparent, and retains more or less of a deep yellow colour, according to the proportion and strength of the acid. Double the quantity of acid is required to discharge the colour of a decoction of madder of what is necessary to destroy that of the same weight of Brazil wood. This shows that the colouring matter of madder is more durable than that of Brazil wood. The infusion of madder in water is of a brownish orange colour. The colouring matter may be extracted, either by cold or hot water; in the latter the colour is most beautiful. The decoction is of a brownish colour. The colouring matter of madder

der cannot be extracted without a great deal of water.— Two ounces of madder require three quarts of water. Alum forms, in the infusion of madder, a deep brownish red precipitate; the supernatant liquor is yellowish, inclining to brown. Alkaline carbonates precipitate from this last liquor a lake of a blood-red colour; with the addition of more alkali, the precipitate is redissolved, and the liquor becomes red. Calcareous earth precipitates a darker and browner coloured lake than alkalies. Carbonate of magnesia forms a clear blood-red precipitate, which by evaporation produces a blood-red extract, soluble in water. The solution of this extract is employed as a red ink, but it becomes yellow by exposure to the sun. Metallic salts also form precipitates in a solution of madder. The precipitate with acetate of lead is of a brownish red colour; with nitrate of mercury and sulphate of manganese, a purplish brown; with sulphate of iron, a fine bright brown.

Cochineal.

History.

160. Cochineal, which furnishes a valuable dye stuff, and about the nature of which there was at first a good deal of uncertainty, is an insect. It is produced on different species of the *cactus*, or Indian fig. The most perfect variety of the cochineal insect, is that which breeds on the *cactus coccinillifer*, Lin. To this plant the Mexican Spaniards gave the name of *nopal*. When the Spaniards first arrived in Mexico, they saw the cochineal employed by the native inhabitants, in communicating colours to some part of their habitations, ornaments, and in dyeing cotton. Struck with its beautiful colour, they transmitted accounts of it to the Spanish ministry, who about the year 1523, ordered Cortes to direct his attention to the propagation of this substance. The inhabitants of Europe were long mistaken concerning the nature and origin of cochineal, by supposing it to be the grain or seed of a plant. This opinion was first contradicted in a paper published in the third volume of the Philosophical Transactions in 1668; and four years afterwards, Dr Lister, in the seventh volume of the same work, throws out a conjecture, that cochineal may be a sort of kermes. Different opinions concerning the origin of this substance were entertained, till about the beginning of the year 1757, Mr Ellis obtained some of the joints of the plant on which the insects breed, from South Carolina, and presented them the same year to the Royal Society. These specimens, Mr Ellis observes, were full of the nests of this insect, in which it appeared in its various states, in the most minute when it walks about, to the state when it becomes fixed, and wrapt up in a fine web, which it spins about itself. With the assistance of the microscope, Mr Ellis discovered the true male insect in the parcels which had been sent to him from America; and in August 1756, in consequence of Mr Ellis's discovery, Dr Garden caught a male cochineal fly, which he observes is rarely to be met with. He supposes that there may be 150 or 200 females for one male. These discoveries proved indisputably, that the cochineal is an animal production *.

161. The body of the female insect is flat on the belly, and hemispherical on the back, and transversely wrinkled. The skin is dark brown; it has no wings, but is furnished with six short brown legs. The body of the male, which is of a deep red colour, is rather long, and covered with two wings, extending horizontally, and crossing a little upon the back. It has two small antennæ, and six legs which are larger than those of the female. It has a fluttering kind of motion. The life of the male is only of a month duration, but the fecundated female lives a month longer. The female is sometimes oviparous and sometimes viviparous; but this is not a peculiarity confined to this insect. It belongs to some others, and seems to be regulated by the temperature and season of the year. The female cochineal insect adheres to the same spot of the tree on which it is produced during her whole life. At soon as the female is delivered of its numerous progeny, it becomes a mere husk and dies. In Mexico it is therefore an object of great importance to prevent this, and to collect them in the fecundated state. For this purpose they are picked from the plants, put into a linen bag, which is immersed in hot water, to destroy the life of the young insects, and then carefully dried. In this state they are imported into Europe.

Variet

162. There are two kinds of cochineal. The best, or domesticated kind, is called by the Spaniards, *grana fina*. This variety breeds upon the *cactus coccinillifer*, or nopal; and being of a larger size, and containing a greater proportion of colouring matter, it is always preferred. The other variety is the *grana sylvestra* of the Spaniards, or wild cochineal. It is produced from other species of the *cactus*. It is smaller than the other, and as it is covered with a downy matter, produced by the insect to defend itself against the cold, this increases the weight, but is of no use in dyeing. An equal weight of the wild cochineal yields a smaller quantity of colouring matter, and is therefore less valuable. It ought, however, to be observed, that it can be reared with greater facility, and at much less expence; and when it is bred upon the nopal, it acquires double the size, and has a smaller quantity of downy matter for its covering, so that it approaches, by this management, to the nature of fine cochineal.

163. As the quantity of cochineal consumed in Europe is very great (D), and as the Spaniards have hitherto enjoyed the exclusive advantages of rearing and supplying the market with this valuable substance, it has become an object with other nations to share them. Attempts have therefore been made to form establishments for rearing these insects in those colonies whose soil and climate seem suitable for the purpose.

164.

---

* *Philo Trans.*

(D) The average quantity, says Dr Bancroft, of fine cochineal annually consumed in Europe, amounts to about 3000 bags, or 600,000 lbs. weight, of which about 1200 bags, or 240,000 lbs. weight may be considered as the present annual consumption of Great Britain. A greater quantity comes to the kingdom, but the surplus is again exported to other countries. These 1200 bags may be supposed to cost 180,000l. sterling, valued at 15s. per lb. which has been about the average price for some years past. *Philosophy of Permanent Colours*, p. 258.

mpts ulti- e it.

164. One of the most successful of these attempts was made by M. Thiery de Menonville, in 1777. He exposed himself to great danger, by going to Mexico that he might observe the mode of rearing the cochineal insect, and procure that valuable production, to plant it in St Domingo. He proceeded by the Havannah to La Vera Cruz, where he was informed that the finest cochineal insects were reared at Guaxaca, 70 leagues distant. On the pretence of ill health, he received permission to use the baths of the river Magdalene: but instead of accepting this privilege, which was not his object, he directed his course, not without much difficulty and danger, to Guaxaca; where having obtained the information he wanted, and having purchased a quantity of nopals, covered with the insects of the fine or domestic breed, which he pretended were of great use in preparing an ointment for his feigned disorder, the gout, he put them into boxes along with other plants, and succeeded in bringing them away without notice or suspicion. On his return, he was driven by a storm into the bay of Campeachy, where he found a living cactus of a species which was fit for the nourishment of the fine cochineal. He returned in safety towards the end of the same year, to St Domingo, with his prize, and immediately formed a plantation of nopals, with the view of propagating both varieties of the cochineal. Soon after his return, he found the wild kind living naturally on the *cactus pereskia*, a native of that island. Unfortunately, however, for the establishment, Thiery de Menonville died in the year 1780, through disappointment and vexation, it is said, at seeing his patriotic endeavours so little assisted, and his services so sparingly rewarded by government; and soon after his death, the fine cochineal perished. But the discovery of the wild kind in St Domingo was not neglected. M. Bruley succeeded in his attempts to rear this species of cochineal. A posthumous work of Thiery de Menonville was published by the Royal Society of arts and sciences at Cape Françoise, containing minute instructions with regard to every thing respecting the cultivation of the nopal, and the other species of cactus, which may be more or less successfully substituted for breeding or rearing the cochineal. Of this Berthollet has given an extract in the 5th volume of the Annales de Chimie. Some of our own countrymen, a few years ago, succeeded in procuring some of the fine cochineal insects; and attempts have been made, with what success we know not, to rear them in the East Indies.

roperties.

165. Fine cochineal, if it has been properly prepared and kept, ought to be of a gray colour, with a shade of purple. The gray colour is owing to a powder with which it is naturally covered, and part of which it still retains. The colouring matter extracted by the water in which the insect has been killed, produces the purple shade. In a dry place, cochineal may be kept for a long time, without losing any of its properties. Hellot made experiments on cochineal 130 years old, and found that it produced the same effect as if it had been quite new. Cochineal yields its colouring matter to water; and the decoction, which is of a crimson colour, inclining to violet, may be kept for a long time, without losing its transparency, or becoming putrid. If this decoction be evaporated, and the residuum or extract be digested in alcohol, the colouring part dissolves, and leaves a residuum of the colour of wine lees, of which fresh alcohol cannot deprive it. The alcohol of cochineal affords, by evaporation, a transparent residuum of a deep red, which, being dried, has the appearance of a resin. A small quantity of sulphuric acid added to the decoction of cochineal, produces a red colour, inclining to yellow, and a small quantity of a beautiful red precipitate. With muriatic acid the same change is produced, but there is no precipitate. A solution of tartar converts the decoction to a yellowish red colour. A precipitate of a pale red colour is slowly formed, and the supernatant liquor remains yellow; but with the addition of an alkali becomes purple. With the yellow liquor, solution of tin forms a rose-coloured precipitate; solution of alum brightens the colour of the infusion, gives it a redder hue, and produces a crimson precipitate. With a mixture of alum and tartar the colour is brighter, more lively, and inclines to a yellowish red. Muriate of tin occasions a copious sediment of a beautiful red. The supernatant liquor is colourless and transparent, and no change is produced on it by adding an alkali. Sulphate of iron forms a brown violet precipitate, and the supernatant liquor remains clear, with a slight darkish hue. Sulphate of zinc gives a deep violet precipitate; the supernatant liquor remains colourless and transparent. The precipitate with sulphate of copper is of a violet colour, and forms slowly: the supernatant liquor is also violet and transparent. Acetate of lead gives a purple violet precipitate, and the supernatant liquor remains limpid.

166. The experiments of Berthollet and Bancroft shew, that the colouring matter of cochineal is not entirely extracted by means of water. Dr Bancroft found, that after the whole of it which could be extracted by water was obtained, by adding a little potash to the seemingly exhausted sediment, and pouring on it fresh boiling water, it yielded a new quantity of colouring matter, equal to one-eighth of what had been given out to the water; and Berthollet found the same effect produced with the addition of tartar; from which he concludes that tartar favours the solution of the colouring part of the cochineal.

Kermes.

167. Kermes (E), another animal substance, which is extensively employed in dyeing, is an insect, (*coccus ilicis*, Lin.) which breeds on a species of oak (*quercus coccifera*, Lin.) which grows in most of the southern parts of Europe, and in many parts in Asia. Kermes was known to the ancients, under the names of *coccum scarlatinum*, *coccus bapticus*, *coccus infectorius*, *granum tinctorium*. Kermes is chiefly obtained from Languedoc, Spain, and Portugal. The insects are collected in the month of May or June, when the female, which alone

History.

(E) This word is supposed to have been derived from the Arabic language, and signifies a *little worm*, *vermiculus*; and from this we have the word *vermilion*, the pigment in the manufacture of which it is the principal ingredient.

Of Simple Colours.

alone is useful, is distended with eggs. To destroy the young insects, the kermes is exposed to the steam of vinegar for about half an hour, or steeped in vinegar for 10 or 12 hours. They are afterwards dried on linen cloths, and brought to market.

Properties.

168. When the living insect is bruised, it gives out a red colour. The smell is somewhat pleasant; the taste is bitter and pungent. It gives out its colouring matter both to water and alcohol, to which also it imparts its smell and taste. The colour is also retained in the extract which is obtained, both from the tincture, and from the infusion. Kermes is one of the most ancient dyeing drugs; and although the colours which it communicates to cloth are less bright and vivid than those of cochineal, and on that account it has been less extensively employed in dyeing since the latter was known, yet they have been found to be exceedingly permanent. The fine blood-red colour which is to be seen on old tapestries in different parts of Europe, was produced from kermes, with an aluminous mordant, and seems to have suffered no change, though some of them are 200 or 300 years old. The colour obtained from kermes was formerly called scarlet in grain, because it was supposed that the insect was a grain; and from the chief manufactory having been at one time in Venice, it was called *Venetian scarlet.*

Lac.

169. *Lac* is an animal production which has been long known in India, and used for dyeing silk and other purposes. It is the *nidus* of the *coccus lacca*, Lin. and is generally produced on the small branches of the *croton lacciferum.* Three kinds of lac are well known in commerce: 1. Stick lac is the substance or comb, in its natural state, forming a crust on the small branches or twigs. Seed lac is said to be only the above, separated from the twigs, and reduced into small fragments. Mr Hatchett, who has examined this substance with his usual skill and precision, found the best specimens considerably deprived of their colouring matter *. According to the information which he received from Mr Wilkins, the silk dyers in Bengal produce the seed lac by pounding crude lac into small fragments, and extracting part of the colouring matter by boiling. 3. Shell lac is prepared from the cells, liquefied, strained, and formed into thin transparent laminæ. There is also a fourth kind called *lump lac*, which is obtained from the seed lac by liquefaction, and afterwards formed into cakes. The best lac is of a deep red colour; when it is pale, and pierced at the top, the value is greatly diminished, for then the insects have left their cells, and it can no longer be of use as a dye stuff.

History.

Properties.

170. The decoction of powdered stick lac in water, gives a deep crimson colour. With one-fifth of borax, lac becomes more soluble in water. Pure soda, and carbonate of soda, completely dissolve the different kinds of lac, and produce a deeper colour than that which is obtained by means of borax. Pure potash speedily dissolves all the varieties of lac; the colour approaches to purple. Pure ammonia and carbonate of ammonia readily act on the colouring matter of lac. Alcohol dissolves a considerable part of the lac; and according to Geoffroy, yields a fine red colour. When the solution is heated it becomes turbid. Sulphuric acid dissolves the colouring matter of lac, as well as muriatic and acetic acids. In the use of lac in dyeing, it has been considered superior to kermes, because it is able to bear the action of a solution of tin, without the colour being changed to yellow.

Archil.

171. Archil is a vegetable substance of great use in dyeing. It is employed in the form of a paste, which is of a red violet colour. It is chiefly obtained from two species of *lichen*, *roccella*, and *parellus*, Lin. The first, which is called *Canary archil*, because the lichen from which it is prepared grows abundantly in the Canary islands, is most valued. It is prepared by reducing the plant to a fine powder, which is afterwards passed through a sieve, and slightly moistened with stale urine. The mixture is daily stirred, each time adding a certain proportion of soda in powder, till it acquire a clove colour. It is then put into a wooden cask, and urine, lime-water, or a solution of sulphate of lime, (*gypsum*,) is added in sufficient quantity to cover the mixture. In this state it is kept; but to preserve it any length of time, it is necessary to moisten it occasionally with urine. By a similar preparation, other species of lichen may be used in dyeing. In this country the *lichen omphalodes* and *tartareus* are frequently employed for dyeing coarse cloths.

Proper

172. Archil gives out its colouring matter to water, ammonia, and alcohol. The infusion of archil is of a crimson colour, with a shade of violet. The addition of an acid converts it to a red colour. Fixed alkalies only render it of a deeper shade; because its natural colour has been already modified by the ammonia with which it is combined in the preparation. Alum produces in the solution of archil a dark-red precipitate; the supernatant liquor is of a yellowish red colour. With solution of tin a reddish precipitate is formed, which subsides slowly; and the liquor retains a slight tinge of red. This infusion loses its colour in a few days if it be entirely excluded from the air. To cold marble the aqueous infusion of archil communicates a fine violet colour, or blue inclining to purple. The affinity between the stone and the colouring matter is so strong, that it resists the action of the air longer than colours which it gives to other substances. The colour thus communicated to marble, has remained for two years unchanged.

Singul change

173. Archil is also soluble in alcohol. This tincture is employed for making spirit of wine thermometers. A singular phenomenon was observed by the Abbé Nollet when the tincture was excluded from the air. In a few years it was entirely deprived of its colour. The contact of air restored the colour; but it was again destroyed when deprived of it.

Carth

174. Carthamus, or bastard saffron, a vegetable substance used in dyeing, is the flower of an annual plant which is cultivated in Spain, Egypt, and the Levant. There are two varieties of this plant, the one with larger, the other with smaller leaves. The variety with larger leaves is cultivated in Egypt.

Prepar tion.

175. The method of preparing the flowers of carthamus in Egypt, as it is described by Hasselquist, is the following. After being pressed between two stones, to squeeze out the juice, they are washed several times with salt water, pressed between the hands, and spread out on mats in the open air to dry. In the day time they are covered, that they may not dry too fast with the heat of the sun, but they are left exposed to the dew of the night. When they are sufficiently dry, they are put

---

* Phil. Trans. 1804.

Simple ours.

put up, and kept for sale, under the name of *saffranon*. Care should be taken afterwards, not to keep it in too dry a place; for unless it is a little moist, its properties are considerably impaired.

Perties.

176. Carthamus contains two colouring substances, a yellow substance, which is soluble in water; and as it is of no use, it is extracted by the process mentioned above, by squeezing the flowers between stones till no more colour can be pressed out. The flowers become reddish in this operation, and lose nearly one half of their weight. The other colouring matter, which is red, is soluble in alkaline carbonates, and it is precipitated by means of an acid. A vegetable acid, as lemon juice, has been found to produce the finest colour. Next to this, sulphuric acid produces the best effect, provided too great a quantity, which would alter and destroy the colour, be not employed. The juice of the berries of the mountain-ash, or *rowan tree*, (*sorbus aucuparia*, Lin.) is recommended by Scheffer as a substitute for lemon juice, and it is thus prepared. The berries are bruised in a mortar with a wooden pestle, and the expressed juice, after it has been allowed to ferment, is bottled up. The clear part, which is most acid, becomes fitter for use the longer it is kept; but this operation requires a period of some months, and can only be conducted in summer.

Pra a- on ou

177. From the colouring matter extracted by means of an alkali, and precipitated with an acid, is procured the substance called *rouge*, which is employed as a paint for the skin. The solution of carthamus is prepared with crystals of soda, and precipitated with lemon juice which has stood some days to settle. After being dried on delft plates with a gentle heat, the precipitate is separated, and ground accurately with talc which has been previously reduced to a very subtile powder; and on the fineness of the talc depends the difference between the cheaper and dearer kinds of *rouge*.

ra oo

178. Brazil wood is of very extensive use in dyeing. It is the wood of the *cæsalpinia crista*, Lin. and is a native of America and the West Indies. It is known under different names, according to the place where it is produced; as, *Fernambouc*, *Braziletto*, *wood of St Martha*, and of *Sapan*. It has a very hard wood, and has so much density as to sink in water. When fresh cut, it is of a pale colour, but becomes reddish by exposure to the air; and it has a sweetish taste.

ropties.

179. The colouring matter of Brazil wood is soluble in water, and the whole of it may be extracted by continuing the boiling for a sufficient length of time. The decoction is of a fine red colour. The residuum, which is black, yields a considerable portion of colouring matter to alkalies. The colouring matter is also soluble in alcohol, and in ammonia, and the colour is deeper than that of the aqueous solution. The tincture of Brazil wood in alcohol gives to hot marble a red colour, which afterwards changes to violet. The fresh decoction yields, with sulphuric acid, a small portion of a red precipitate, inclining to fawn colour. Nitric acid first produces a yellow colour, but by adding more, a deep orange. Oxalic acid produces a precipitate of an orange red. Tartar furnishes a small precipitate: with the addition of a fixed alkali, the decoction becomes of a deep crimson or violet colour. Ammonia gives a brighter purple: alum produces a copious red precipitate, inclining to crimson. Sulphate of iron occasions a black colour in the tincture, with a copious precipitate of the same colour. Sulphate of copper also produces an abundant precipitate, the liquor remaining transparent, and of a brownish red. A copious precipitate, of a fine deep red, is produced with acetate of lead, and that obtained with muriate of tin is abundant, and of a fine rose colour. With the addition of corrosive sublimate, a light precipitate, which is of a brown colour, is obtained. The liquor remains transparent, and of a fine yellow colour. Brazil wood, which has been changed to a yellow colour by means of tartar and acetous acid, with a solution of nitro-muriate of tin, yields a copious rose-coloured precipitate; and if to the solution, rendered yellow by an acid, a greater quantity of the same acid, or a stronger acid, as the sulphuric, be added, the red colour is restored. Some salts also possess the property of restoring the red colour of Brazil wood, which has been destroyed by means of acids *. The decoction of Brazil wood, which is called juice of Brazil, is found to answer better for the process of dyeing, when it has been kept some time, and has even undergone some degree of fermentation, than when it has been fresh prepared. The colour, by keeping, becomes of a yellowish red.

Logwood.

180. Logwood, sometimes called India or Campeachy wood, (*Hæmatoxylon Campeachianum*, Lin.) is a tree which grows to a considerable size in Jamaica, and the eastern shore of the bay of Campeachy. Its specific gravity is greater than that of water; it has a fine grain, and is susceptible of a fine polish.

Properties.

Logwood yields its colouring matter, which is a fine red, readily and copiously to alcohol. It is more sparingly soluble in water, and the decoction inclines a little to violet or purple. When it is left some time to itself, it becomes yellowish, and at length black. It becomes yellowish also by the action of acids; alkalies produce a deeper colour, and convert it to a purple or violet. Sulphuric, nitric, and muriatic acids form a small proportion of precipitate, which separates slowly: the precipitate formed with sulphuric acid is of a dark red; with muriatic, a lighter red, and with the nitric, *feuille mort*. With sulphuric or muriatic acids, the supernatant liquor is of a deep red colour; with nitric it is yellowish, and in all transparent. Oxalic acid produces a precipitate of a light marone colour; the liquor remains transparent, and is yellowish red. Acetic acid produces a similar effect, but the colour of the precipitate is somewhat deeper. A similar precipitate is obtained by means of tartar; but the liquor, which is more inclined to yellow, remains turbid. No precipitate is produced by means of fixed alkali; the decoction becomes of a deep violet, which is afterwards converted to a brown colour. Alum yields a copious precipitate, of a lightish violet colour; the colour of the liquor remains the same, and it is nearly transparent. A copious, dark red precipitate is produced with alum and tartar; the liquor is yellowish red and transparent. Sulphate of iron occasions a bluish black colour; a copious precipitate of the same colour is formed, and the liquid remains long turbid. With sulphate of copper, a very copious precipitate, of a dark brown colour, is obtained; the liquor, which is also of a deep brown, or yellowish red, remains transparent. Acetate of lead yields a black precipitate, with

---

* Jour. de Phys. 1785.

with a slight tinge of red; the colour of the liquor is like that of pale beer, and it remains transparent. Nitro-muriate of tin gives a precipitate of a fine violet or purple colour; the liquor remains clear and colourless.

2. *Of the Processes for Dyeing Wool Red.*

181. All red colouring matters with which we are acquainted, come under that class of colours to which Dr Bancroft has given the name of *adjective* colours; that is, such colours as require the aid of mordants to render them permanent. Red colours, we have already observed, are of various shades, according to the nature and proportion of the colouring matters employed. Hence we have madder red, scarlet, crimson, and other shades.

Madder-red.

182. *Madder Red.*—Madder is only employed for dyeing coarse woollen stuffs, and the following is the process. The stuffs are first boiled for two or three hours with alum and tartar: they are then left to drain, slightly wrung out, put into a linen bag, and carried into a cool place, where they are to remain for some days. The quantities and proportions of the alum and tartar are varied according to the views of the dyer, and the shade of colour which is wanted. Some recommend five ounces of alum and one ounce of tartar to each pound of wool. By increasing the proportion of tartar to a certain degree, a deep and permanent cinnamon colour, instead of a red, is produced. This arises from the yellow tinge which is induced by means of the acid on the colouring particles of the madder. Others propose to diminish the proportion of tartar, and to employ only a seventh part. In conducting the process of dyeing with madder, the bath should not be brought to the boiling point, because at that temperature the fawn-coloured particles would be dissolved, and a different shade obtained from that which is desired. When the water is at that degree of temperature which the hand can bear, Hellot recommends the addition of half a pound of grape madder for every pound of wool to be dyed. It is then to be well stirred before the wool is introduced, which must remain for an hour without boiling, excepting for a few minutes towards the end of the process, that the combination of the colouring particles with the stuff may be more certain.

Process.

Rosing.

183. Madder reds are sometimes rosed, as it is called, with archil and Brazil wood. In this way they become more beautiful and velvety, but this brightness is not permanent. But madder reds, even when they are most perfect, are far inferior to those obtained from lac and cochineal, and even to that produced by kermes; but as the expence of the materials is comparatively small, they are employed, as we have already observed, for coarse stuffs.

Proportion of madder.

184. Different authors recommend different proportions of madder. Poerner proposes to employ one-third of the weight of the wool, while Scheffer limits the quantity to one-fourth. In one process, Poerner added to the alum and tartar, a quantity of solution of tin, equal in weight to the tartar, and after two hours boiling, allowed the cloth to remain in the bath, which had been left to cool for three or four days. He then dyed it in the usual way, and thus obtained a fine red. According to another process, he prepared the cloth by the common boiling, and dyed it in a bath slightly heated, with a larger proportion of madder, tartar, and solution of tin. The cloth remained 24 hours in the bath, and when it had become cold, he put it into another bath, made with madder only, where it remained for 24 hours. By this process he got a fine red, somewhat brighter than the common, but inclining a little to yellow. Scheffer informs us that he obtained an orange red by boiling wool with a solution of tin, and one-fourth of alum, and then by dyeing with one-fourth of madder. A cherry colour is obtained, according to Bergman, by dyeing with one part of a solution of tin, and two of madder, without previously boiling the wool. By exposure to the air, this colour becomes deeper. By boiling the wool for two hours with one-fourth of sulphate of iron, then washing it, and afterwards immersing it in cold water with one-fourth of madder, and then boiling for an hour, the result is a coffee colour. But if the wool has not been soaked, and if it be dyed with one part of sulphate of iron and two of madder, the colour is a brown approaching to red.

Different mordants.

185. When sulphate of copper is employed as the mordant, the madder dye yields a clear brown, inclining somewhat to yellow; and a similar colour may be produced by dyeing the wool simply soaked in hot water, with one part of sulphate of copper, and two of madder. But when this mordant and dye-stuff are used in equal proportions, the yellow is somewhat more obscure, approaching to green; and in both these instances, exposure to the air does not produce a darker colour. Berthollet informs us that he employed a solution of tin in various ways, both in the preparation and the application of the madder; and by the use of different solutions of tin, he found, that although the tint was somewhat brighter than what is obtained by the common process, it was always more inclined to yellow or fawn colour.

Scarlet.

186. *Scarlet.*—The finest and most splendid of all colours is scarlet. This, like other colours, is of various shades, according to the quality and proportion of the colouring matter employed. The scarlet dye is communicated to woollen stuffs by means of cochineal, the history and properties of which we have already detailed. The Mexicans, as appears from their history, employed alumina as the basis or mordant, to fix the colour of cochineal; and previous to the discovery of the solution of tin, the use of the same substance seems to have prevailed in Europe. The fine colour obtained from the latter, received, as we have already mentioned, different names in different places; as that of *bow dye* in England, *scarlet of the Gobelins* in France, and in Holland *Dutch scarlet.*

Process.

187. In the process for dyeing scarlet, two operations are necessary. The first is denominated the boiling, and the second is distinguished by the name of finishing or reddening. The operation of boiling, which is the first part of the process, is conducted in the following manner. For 100 pounds of cloth, 6 pounds of pure tartar are added to the water, which is made pretty warm. The bath is then to be briskly stirred, and when the heat has increased a little more, half a pound of powdered cochineal is to be added, and the whole is then to be well mixed. The next moment five pounds of a very clear solution of tin are to be poured

Boiling.

Simple lours.

poured in, and carefully mixed. When the bath begins to boil, the cloth is introduced, and briskly moved for two or three turns: after which it is moved more slowly. The boiling having continued for two hours, the cloth is taken out, exposed to the air, and carried to the river to be well washed.

R dening.

188. In the preparation of the second bath, which is for the reddening, the boiler is to be emptied, and when the bath has just reached the boiling point, five pounds and three quarters of cochineal, previously powdered and sifted, are to be added. These are to be carefully mixed; and after having ceased stirring, when a crust has formed on the surface, and opened of itself in several places, 13 or 14 pounds of solution of tin are poured in. Should the bath, during the boiling, rise above the edge of the boiler, it may be cooled with a little cold water. This solution being well mixed, the cloth is put in, and two or three times quickly turned. It is then boiled in the bath for an hour, taking care to keep it under the surface. It is afterwards taken out, exposed to the air, and when it has cooled, washed in the river and dried.

Pr ortion o gre- di s.

189. There are no determinate proportions of cochineal and solution of tin in either of these operations. Hellot informs us, that some dyers employ two-thirds of solution of tin, and one-fourth of cochineal, in the boiling or first operation, and the other one-third of the solution of tin with the remaining three-fourths of the cochineal in the second operation, or the reddening. He adds farther, that the use of tartar gives a greater degree of permanency to the colour, provided the proportion do not exceed one half the weight of the cochineal employed. According to Berthollet, several dyers at present adopt this practice. Tartar, he observes, promotes the solution of the colouring matter; and this effect is greater when it is ground with the cochineal, after which it is found that the residuum is more completely exhausted. But this consideration is of inferior consequence, when the operations are successively performed, because any colouring matter that may remain in the residuum, is employed in the next operation. It ought not, however, to be overlooked, that the tartar communicates to the colour a rosey hue.

Sh er pro s.

190. It is the practice of some dyers not to remove the cloth out of the boiling. They merely refresh it, and perform the operation of reddening in the same bath. When this is done, the infusion of cochineal, made in a separate vessel, and mixed with the proper proportion of solution of tin, is added. By conducting the process in this way the scarlet is supposed to be equally fine, and there is a considerable saving of time and fuel.

Bri ter ed.

191. To give scarlet the bright lively red which, as it approaches to the colour of fire, has been distinguished by the name of *fiery scarlet*, a yellow tinge is communicated by boiling fustic in the first bath, or by adding a little turmeric to the cochineal. A larger proportion of the solution of tin also produces this yellow shade, but it renders the cloth harsh, and limits the action of the colouring matter. The use of fustic or turmeric, therefore, although the colour obtained from them is not permanent, is preferable to an excess of the solution of tin. When these substances are used, the inside of the cloth, when it is cut, appears yellow; but in the ordinary processes, the cochineal, it is found, does not penetrate the cloth, for when no other substance is employed, the cloth is internally white.

Of Simple Colours.

Tin and copper boilers.

192. The use of tin boilers is recommended in dyeing scarlet. When copper boilers are employed, the acid acts on the metal, and thus forming a solution, injures the beauty of the colour. Tin boilers, however, are attended with several inconveniences. It is difficult to procure them of sufficient size, and they are apt to be melted by the incautious continuance of the fire, after they have been emptied. In the use of copper boilers, there are several necessary precautions. They must be kept very clean; the acid liquor should not be allowed to remain in them for any length of time, and some contrivance should be adopted to prevent the cloth from touching the metal, either by using a net, or a wicker basket.

Different proportion of ingredients.

193. Different proportions of materials, we have observed, are recommended by different authors. For the boiling, Scheffer directs an ounce and a half of solution of tin, with an equal quantity of starch, and as much tartar, to every pound of cloth. The effect of the starch is to give more uniformity to the colour. When the water boils, a dram of cochineal is to be added; it is then to be well stirred, and after the wool is introduced, to be boiled an hour, taken out, and washed. The proportions for the reddening bath, in which the wool is to be boiled half an hour, are half an ounce of starch, three-fourths of an ounce of solution of tin, half an ounce of tartar, and 7 drams of cochineal. In Scheffer's process, it may be observed, the proportion of solution of tin is smaller than in that of Hellot, but the quantity of tin in the solution of the former is greater than in that of the latter.

Poerner's process.

194. Poerner has described three principal processes, according to the variety of the shade of the scarlet. He uses no cochineal in the boiling; the materials of which are one ounce and six drams of tartar, and an equal weight of solution of tin, the latter being added after the tartar is dissolved, for every pound of cloth. As soon as the boiling has commenced, the cloth is introduced, and it is boiled for two hours. For the reddening of the first process he employs two drams of tartar and one ounce of cochineal, adding gradually afterwards two ounces of solution of tin. For the reddening of the second process, the same quantity of cochineal and solution of tin, without any tartar, is employed. In the reddening of the third process, two drachms of tartar with one ounce of solution of tin, one ounce of cochineal, and two ounces of common salt, are directed to be used. The colour produced in the first process has the deepest shade; that of the second is more lively, while that of the third is paler and brighter.

Different shades.

195. By the use of tartar in the reddening in different proportions, various shades of scarlet may be obtained. When it is employed, the shade is deeper and fuller; but when it is entirely omitted, the scarlet approaches to an orange colour. The shade of colour also is subject to considerable variety, from the different degrees of strength of the solution of tin. To ascertain this effect, Berthollet made a number of experiments. He found that a solution of tin composed of sixteen parts of nitric acid, two of muriate of ammonia,

monia, and three of tin, produced a deeper shade than when the proportions of the acid and muriate of ammonia were equal, with only two parts of tin. The last proportions, he observes, succeeded best. Four parts of water were mixed with the solution. When the proportion of muriate of ammonia amounted only to half a part, the colour was brighter, and inclining to orange.

Use of common salt.

196. Common salt has the effect of increasing the brightness of scarlet, while it is also attended with the advantage of causing the colour to penetrate deeper into the cloth. It seems difficult to explain why common salt, which gives a deeper shade to the colour of the infusion of cochineal, and indeed produces a similar effect on colours in general, should diminish the intensity of the colour of scarlet. The proportion of common salt mentioned above (194) is, according to Poerner, the greatest that can be employed. When less is used, the shade, though lighter, is more agreeable. By adding five ounces of white sugar to the ingredients of the second process, a fine colour, which is always lighter than that of the first process, will be obtained. The colour, it is said, is more permanent, and the shade more agreeable, when the cloth is left 24 hours in the boiler after it has cooled.

Process of dyeing scarlet with cochineal

197. It has been generally supposed, Dr Bancroft observes, that after the discovery of the effects of tin on the cochineal colour, to produce a scarlet, it was only necessary to apply the colour so produced as a dye to wool; or that a nitric or nitro-muriatic solution of tin might change the natural crimson of cochineal to a scarlet. This opinion, however, he considers to be quite erroneous; for the nitric solution of tin invariably produces with cochineal a crimson or rose colour, and not a scarlet, unless other means are employed to incline the cochineal colour to a yellow shade. This effect is produced by means of the tartar, which seems to have been accidentally stumbled upon, and has been for many ages used, without knowing its true effect. Tartar was long employed with the aluminous mordant, in the preparation of the ordinary boiling liquor for woollen cloths; and it is probable that its good effects being observed in this combination, the use of it was continued after the introduction of the solution of tin; and the more so, after the result of the combination was observed in the brilliancy of the colour which was produced. Dr Bancroft has particularly directed his attention to the process for dyeing scarlet; and in the progress of his investigations, he has found that it is by no means absolutely necessary to follow the usual process which we have described above. He has often, he says, produced that colour very well at a single boiling, by mixing the whole quantity of tartar, solution of tin, and cochineal together; the affinity of the wool for the colouring matter, and for the oxides of tin, being sufficiently strong to combine with them readily, and to retain them permanently. The only objection to simplifying the process in this manner is, that the colouring matter of the dyeing liquor is less perfectly exhausted than when two operations are performed. He farther adds, that he has often produced a beautiful scarlet, by preparing and boiling the cloth with the whole quantity of solution of tin and tartar at once, and afterwards dyeing it unrinsed, with the whole of the cochineal, dissolved only in pure water. In this way he found the colouring particles completely taken up; that the liquor had become quite colourless, and that the cloth had received a durable dye.

long stationary.

Dr Bancroft's experiments

Scarlet a compound colour.

198. "It is remarkable," says Dr Bancroft, "that during the 18th century, no considerable improvement has been made in the process for dyeing scarlet; a circumstance which is the more extraordinary, since the pre-eminent lustre and costly nature of this dye, have rendered it an object of particular attention, not only to dyers, but to eminent chemists, by whose researches we might have expected that at least every obvious improvement therein would have been long since attained." To attain this object, this ingenious philosopher instituted a set of experiments about the year 1786. Having, by repeated affusions of boiling water, extracted the whole of the colouring matter from powdered cochineal, he found that the addition of a little potash to the seemingly exhausted sediment, and a fresh quantity of boiling water, extracted a new portion of colouring matter, equal to about one-eighth of what had been given out to the pure water. He repeatedly extracted this colouring matter by means of potash, and afterwards dyed small pieces of cloth scarlet with it, which he found similar to other pieces dyed with the more soluble colouring matter of cochineal. It was in the course of these inquiries that he perceived scarlet to be a compound colour, consisting of about three-fourths of pure crimson or rose colour, and one-fourth of pure bright yellow. He conceived, therefore, that when the natural crimson of the cochineal is made scarlet, by the usual process, there must be a change produced, equivalent to a conversion of one-fourth of the colouring matter of cochineal from its natural crimson to a yellow colour. From this he concludes that there might be a great saving of cochineal, by substituting a cheaper substance, which at the same time might yield a better yellow colour. It was therefore his object to combine with this crimson or rose colour, a suitable portion of a lively golden yellow, capable of being permanently fixed, and reflected by the same basis. Such a yellow he had discovered in quercitron bark, (*quercus nigra*, Lin.) which will be afterwards described; and it had the advantage, not only of being the brightest, but also the cheapest, of all the yellows which he had tried.

199. With the view of diminishing the quantity of cochineal employed in producing a scarlet dye, Dr Bancroft made a number of experiments under the authority of government. In these experiments, the mordant used was the ordinary dyers spirit, or the nitro-muriate of tin; but he found that they were not attended with the advantages which he expected. In some of his earliest experiments, he observes, that the solution of tin by means of sulphuric acid destroyed the cochineal colour, and this naturally led him to reject the use of this acid, till accident brought him to dissolve a quantity of tin in muriatic acid, combined with one-fourth of sulphuric acid. The application of this solution in dyeing, was not accompanied with the corrosive effects of the muriate and nitro-muriate which he had employed in the experiments above alluded to, and which proved unsuccessful. After trying different proportions of these acids, he found the following to answer best. In a mixture of 2lbs. of sulphuric acid of the ordinary strength, and about 3lbs. of muriatic acid,

acid, he dissolved about 14 oz. of tin. The muriatic acid is first poured on a large quantity of granulated tin, in a large glass receiver, and the sulphuric acid is then slowly added. The solution is more rapidly promoted by means of a sand heat, but it will take place in the cold, requiring only a greater length of time. This murio-sulphate of tin is transparent and colourless, and may be kept for several years without any precipitation. It produces twice the effect of the dyers spirit, at less than one-third of the expence, and raises the colours not only more than the dyers spirit, but also full as much as the tartrate of tin, without converting the crimson of cochineal to a yellowish shade.

D Ban-'s pro-ces

200. In the use of this solution of tin as a mordant, to produce the compound scarlet colour with the cochineal crimson and quercitron yellow, Dr Bancroft recommends the following process. "Nothing," says he, "is necessary but to put the cloth, suppose 100 lb. weight, into a proper tin vessel, nearly filled with water, in which about eight pounds of the murio-sulphuric solution of tin have been previously mixed, to make the liquor boil, turning the cloth as usual through it, by the winch, for a quarter of an hour; then turning the cloth out of the liquor, to put into it about four pounds of cochineal, and two pounds and a half of quercitron bark in powder, and having mixed them well, to return the cloth again into the liquor, making it boil, and continue the operation as usual until the colour be duly raised, and the dyeing liquor exhausted, which will be the case in about fifteen or twenty minutes; after which the cloth may be taken out and rinsed as usual. In this way the time, labour, and fuel, necessary for filling and heating the dyeing vessel a second time, will be saved; the operation finished much more speedily than in the common way; and there will be a saving of all the tartar, as well as of two-thirds of the cost of spirit, or nitro-muriatic solution of tin, which for dyeing 100 lb. of wool, commonly amounts to 10s.; whereas 8 lb. of the muriosulphuric solution will only cost about 3s. There will be moreover a saving of at least one-fourth of the cochineal usually employed (which is generally computed at the rate of one ounce for every pound of cloth), and the colour produced will certainly not prove inferior in any respect to that dyed with much more expence and trouble in the ordinary way. When a rose-colour is wanted, it may be readily and cheaply dyed in this way, only omitting the quercitron bark, instead of the complex method now practised of first producing a scarlet, and then changing it to a rose by the volatile alkali contained in stale urine, set free or decomposed by potash or by lime: and even if any one should still unwisely choose to continue the practice of dyeing scarlet without quercitron bark, he need only employ the usual proportions of tartar and cochineal, with a suitable quantity of the murio-sulphate of tin, which, while it costs so much less, will be more effectual than the dyers spirit.

Saving of cochineal.

201. "Several hundreds of experiments warrant my assertion, that at least a fourth part of the cochineal generally employed in dyeing scarlet, may be saved by obtaining so much yellow as is necessary to compose this colour from the quercitron bark; and indeed nothing can be more self-evident, than that such an effect, *cæteris paribus*, ought necessarily to result from this combination of different colouring matters, suited to produce the compound colour in question. Let it be recollected that the cochineal crimson, though capable of being changed by tartar towards the yellow hue on one hand, is also capable by other means of being changed towards a blue on the other, and of thereby producing a purple without indigo or any other blue colouring matter: yet I am confident that nobody would believe a pound of cochineal so employed capable alone of dyeing as much cloth, of any particular shade of purple, as might be dyed with it, if the whole of its colouring matter were employed solely in furnishing the crimson part of the purple, whilst the other (blue) part thereof was obtained from indigo. To say that a pound of cochineal alone could produce as much effect or colour as a pound of cochineal and a pound of indigo together, would be an improbability much too obvious and palpable for human belief; and there certainly would be a similar improbability in alleging that a pound of cochineal, employed in giving another compound colour (scarlet), could alone produce as much effect as a pound of cochineal and a pound of quercitron bark, when the colour of this last was employed only in furnishing one of the component parts of the scarlet, for which a considerable portion of the colouring matter of the cochineal must otherwise have been expended, which certainly happens in the new mode of dyeing scarlet, because the colour produced with an addition of the quercitron yellow inclines no more towards a yellow, than the scarlet produced by yellowing a part of the cochineal colour in the usual method with tartar. I retain, therefore, at this moment, as much confidence as I ever had in the reality and importance of my proposed improvements in this respect (F).

Advantages of this process.

202. "The scarlet composed of cochineal crimson and quercitron yellow, is moreover attended with this advantage, that it may be dyed upon wool and woollen yarn without any danger of its being changed to a rose or crimson, by the process of fulling, as always happens to scarlet dyed by the usual means. This last being in fact nothing but a crimson or rose colour, yellowed by some particular action or effect of the tartar, is liable to be made crimson again by the application of many

---

(F) "Of the benefit which I formerly expected to obtain by employing potash to extract a part of the cochineal colour, which water alone did not appear capable of extracting, it must be remarked that I have some time since convinced myself of its being an illusion; for, by repeated trials, I have found that the solid parts of powdered cochineal remaining after it has been boiled with the solution of tin, as in the common dyeing process, yield no colour worth notice, upon the application of potash, the solution of tin enabling the water to extract the colour sufficiently; so that in truth there is no such waste of cochineal colour as I had supposed in the usual way of employing that drug."

many chemical agents, (which readily overcome the changeable yellow produced by the tartar), and particularly by calcareous earths, soap, alkaline salts, &c. But where the cochineal colouring matter is applied and fixed merely as a crimson or rose colour, and is rendered scarlet by superadding a very permanent *quercitron yellow*, capable of resisting the strongest acids and alkalies, (which it does when dyed with solutions of tin), no such change can take place, because the cochineal colour having never ceased to be crimson, cannot be rendered more so, and therefore cannot suffer by those impressions or applications which frequently change or spot scarlet dyed according to the present practice."

Effect of candle light on this scarlet dye.

203. "There is also a singular property attending the compound scarlet dyed with cochineal and quercitron bark; which is, that if it be compared with another piece of scarlet dyed in the usual way, and both appear by day-light exactly of the same shade, the former, if they be afterwards compared by candle-light, will appear to be at least several shades higher and fuller than the latter; a circumstance of some importance, when it is considered how much this and other gay colours are generally worn and exhibited by candle-light during a considerable part of the year."

Effects of murio-sulphuric solution of tin.

204. "To illustrate more clearly the effects of the murio-sulphuric solution of tin with cochineal in dyeing, I shall state a very few of my numerous experiments therewith; observing, however, that they were all several times repeated, and always with similar effects.

"1st, I boiled one hundred parts of woollen cloth in water, with eight parts of the murio-sulphuric solution of tin, during the space of ten or fifteen minutes; I then added to the same water four parts of cochineal, and two parts and a half of quercitron bark in powder, and boiled the cloth fifteen or twenty minutes longer; at the end of which it had nearly imbibed all the colour of the dyeing liquor, and received a very good, even, and bright scarlet. Similar cloth dyed of that colour at the same time in the usual way, and with a fourth part more of cochineal, was found upon comparison to have somewhat less body than the former; the effect of the quercitron bark in the first case having been more than equal to the additional portion of cochineal employed in the latter, and made yellow by the action of tartar."

"2d, To see whether the tartrite of tin would, besides yellowing the cochineal crimson, contribute to raise and exalt its colour more than the murio-sulphate of that metal, I boiled one hundred parts of cloth with eight parts of the murio-sulphuric solution, and six parts of tartar, for the space of one hour; I then dyed the cloth, unrinsed, in clean water, with four parts of cochineal, and two parts and a half of quercitron bark, which produced a bright aurora colour, because a double portion of yellow had been here produced, first by the quercitron bark, and then by the action of tartar upon the cochineal colouring matter. To bring back this aurora to the scarlet colour, by taking away or changing the yellow produced by the tartar, I divided the cloth whilst unrinsed into three equal parts, and boiled one of them a few minutes in water slightly impregnated with potash; another in water with a little ammoniac; and the third in water containing a very little powdered chalk, by which all the pieces became scarlet; but the two last appeared somewhat brighter than the first, the ammoniac and chalk having each rosed the cochineal colour rather more advantageously than the potash. The best of these, however, by comparison, did not seem preferable to the compound scarlet dyed without tartar, as in the preceding experiment; consequently this did not seem to exalt the cochineal colour more than the murio-sulphate of tin; had it done so, the use of it in this way would have been easy, without relinquishing the advantages of the quercitron yellow."

"3d, I boiled one hundred parts of woollen cloth with eight parts of the murio-sulphuric solution of tin, for about ten minutes, when I added four parts of cochineal in powder, which, by ten or fifteen minutes more of boiling, produced a fine crimson. This I divided into two equal parts, one of which I yellowed or made scarlet by boiling it for fifteen minutes with a tenth of its weight of tartar in clean water; and the other, by boiling it with a fortieth part of its weight of quercitron bark, and the same weight of murio-sulphuric solution of tin; so that in this last case there was an addition of yellow colouring matter from the bark, whilst in the former no such addition took place, the yellow necessary for producing the scarlet having been wholly gained by a change and diminution of the cochineal crimson; and the two pieces being compared with each other, that which had been rendered scarlet by an addition of quercitron yellow, was, as might have been expected, several shades fuller than the other."

"4th, I dyed one hundred parts of woollen cloth scarlet, by boiling it first in water with eight parts of murio-sulphate of tin, and twelve parts of tartar, for ten minutes, and then adding five parts of cochineal, and continuing the boiling for fifteen minutes. This scarlet cloth I divided equally, and made one part crimson, by boiling with a little ammoniac in clean water; after which I again rendered it scarlet, by boiling it in clean water, with a fortieth of its weight of quercitron bark, and the same weight of murio-sulphate of tin; and this last, being compared with the other half to which no quercitron yellow had been applied, was found to possess much more colour, as might have been expected. A piece of the cloth, which had been dyed scarlet by cochineal and quercitron bark, as in the first experiment, being at the same time boiled in the same water with ammoniac, did not become crimson, like that dyed scarlet without the bark.

205. "In this way of compounding a scarlet from cochineal and quercitron bark, the dyer will at all times be able, with the utmost certainty, to produce every possible shade between the crimson and yellow colours, by only increasing or diminishing the proportion of bark. It has indeed been usual at times, when scarlets approaching nearly to the aurora colour were in fashion, to superadd a fugitive yellow either from turmeric, or from what is called young fustic (*Rhus Cotinus*); but this was only when the cochineal colour had been previously yellowed as much as possible by the use of tartar, as in the common way of dyeing scarlet; and therefore that practice ought not to be confounded

confounded with my improvement, which has for its object to preclude the loss of any part of the cochineal crimson, by its conversion towards yellow colour, which may be so much more cheaply obtained than the quercitron bark. By sufficient trials, I have satisfied myself that the cochineal colours, dyed with the murio-sulphuric solution of tin, are in every respect at least as durable as any which can be dyed with any other preparation of that metal; and they even seem to withstand the action of boiling soap suds somewhat longer, and therefore I cannot avoid earnestly recommending its use for dyeing rose and other cochineal colours, as well as for compounding a scarlet with the quercitron bark."

206. Dr Bancroft afterwards tried a great variety of earthy and metallic salts, as mordants, for the purpose of fixing the colour of cochineal on wool; and he found that, besides the metallic oxides and solutions, the aluminous, calcareous and siliceous earths, as well as magnesia and barytes, might be employed with different success in dyeing with the colouring matter of cochineal: but for the detail of these experiments which he has given, we refer our readers to the treatise itself [*].

207. To produce different shades of scarlet, and the other colours which are derived from it, all that is necessary, is to vary the proportions of cochineal, tartar, and solution of tin; and for the shades which incline most to yellow, the addition of quercitron bark, or fustic, is requisite. The use of the tartar is to deepen the colour, and the solution of tin produces a shade of orange. When the shade of colour required to be communicated to the stuff is light, the time of continuing the process must be shortened [†].

208. *Crimson.*—The processes which are employed to dye wool a crimson colour, are two. The stuff is either dyed crimson at once, or the crimson shade is communicated to it, after being previously dyed of a scarlet colour. To dye crimson by a single process, a solution of two ounces and a half of alum, and an ounce and a half of tartar for every pound of stuff, is employed for the boiling, and the stuff is afterwards to be dyed with an ounce of cochineal. It is usual also to employ solution of tin, but in smaller proportion than for dyeing scarlet. The processes employed, it is scarcely necessary to observe, must vary, according as the shade wanted is deeper or lighter, or more or less distant from scarlet. Common salt is also employed by some in the boiling. To render the crimson deeper, and to give it more bloom, archil and potash are frequently used; but this bloom, it ought to be observed, is extremely fugacious. By adding tartar and alum, the boiling for crimson is sometimes prepared after a scarlet reddening, and it is said that the colour possesses more bloom, when both the boiling and reddening are made after scarlet, than when the crimson is dyed in a fresh bath prepared on purpose. In dyeing these colours, the wild cochineal may be employed, but as it contains a smaller proportion of colouring matter, the quantity must be greater.

209. Different substances, as the alkalies, alum, and earthy salts in general, convert the colour of scarlet to crimson, which is the natural colour of cochineal. To effect this, the stuff previously dyed scarlet is boiled for an hour in a solution of alum, the strength of which is to be regulated by the depth of shade required. In conducting this process, it is necessary to observe, that water impregnated with earthy salts has a considerable effect in varying the shade; so that the quantity of alum employed must be proportioned to the purity of the water. Hellot tried soap, soda, potash, and some other substances, and although they produced the crimson, yet it was of a deeper shade, and had less lustre, than what was produced by means of alum. Ammonia produced a good effect; but from its great volatility, a considerable proportion must be put into the bath, moderately heated, with a little sal ammoniac, and an equal quantity of potash. By this process the stuff became of a bright rosy colour, and thus rendered a smaller quantity of cochineal necessary. Poerner directs the stuff, previously dyed scarlet, to remain 24 hours in a cold solution of sal ammoniac and potash.

Of Simple Colours.

Half-grain crimson, &c.

210. To produce crimsons, as well as scarlets, in half grain, madder is to be substituted for half the quantity of the cochineal; or in other proportions, according to the shade desired. The same boiling is given as for scarlet in grain, and the other parts of the process are to be conducted as for reddening the scarlet or crimson. Even the common madder red assumes a greater degree of lustre, when the boiling is made after the reddening for scarlet [‡].

3. *Of the Processes for dyeing Silk Red.*

Different processes with madder.

211. *Madder red.*—The colour which is obtained from madder does not possess sufficient brightness for dyeing silk. We shall here, however, describe some of the processes which are employed for this purpose. That of De la Folie, is the following. Half a pound of alum is to be dissolved in each quart of hot water, and two ounces of potash are afterwards to be added. When the effervescence has ceased, and the liquor has become clear, the silk must be kept in it for two hours, after which it is to be washed, and put into the madder-bath. The silk which is dyed in this way becomes more beautiful by means of the soap proof. The process of Scheffer is somewhat different. For each pound of scoured silk, he directs a solution of four ounces of alum, and six drams of chalk, to be prepared. When the sediment has formed, the solution is to be decanted, and having become quite cold, the silk is immersed in it, and left for 18 hours. It is then taken out, and dried, and afterwards dyed with an equal weight of madder. The colour thus obtained is of a dark shade. Mr Guliche describes another process. For every pound of silk he proposes a bath of four ounces of alum and one ounce of solution of tin. When the liquor has become clear, it is decanted, and the silk carefully soaked in it for 12 hours, after which it is to be immersed in a bath with half a pound of madder softened by boiling, with an infusion of galls in white wine. The bath is to be kept moderately hot for an hour, and then made to boil for two minutes. The silk being taken from the bath is to be washed in a stream of water, and dried in the sun. The colour thus obtained is very permanent. By leaving out the galls it is clearer. The brightness of the first colour may be considerably increased, by passing the stuff through a bath of Brazil-wood, to which one ounce of solution of tin is added.

[‡] *Ibid.* ii. 198.

In this way the colour becomes extremely beautiful and durable.

Process with Brazil wood.

212. Silk is sometimes dyed with Brazil wood, and the colour thus obtained has been distinguished by the name of *false crimson*, to distinguish it from the more durable colour which is produced by cochineal. The silk, after being boiled with soap, is to be alumed. It is then to be refreshed at the river, and dipped in a bath more or less charged with Brazil juice, according to the depth of shade required. If pure water be employed, the colour will be too red for crimson; but to remedy this, the stuff may be passed through a weak alkaline solution, or a little alkali may be added to the bath, or the stuff may be washed in hard water till it has acquired the proper shade. To deepen the shade of false crimsons, or dark reds, the solution of logwood is added to the Brazil bath, the silk being previously impregnated with the latter; or a little alkali may be added, according to the shade required.

With cochineal.

213. The crimson produced by cochineal is called *grain crimson*, to distinguish it from false crimson. The silk, being well cleansed from the soap at the river, is to be immersed in an alum liquor of the full strength, and to remain for a night. It is then to be washed, and twice beetled at the river. The bath is prepared by filling a long boiler two-thirds with water, to which are added, when it boils, from half an ounce to two ounces of powdered white galls for every pound of silk. When it has boiled for a few moments, from two to three ounces of cochineal, also powdered and sifted, for every pound of silk, are put in, and afterwards one ounce of tartar to every pound of cochineal. When the tartar is dissolved, one ounce of solution of tin is added for every ounce of tartar. In the preparation of this solution of tin, the following proportions are recommended by Macquer. For every pound of nitric acid two ounces of sal ammoniac, six ounces of fine grain tin, and twelve ounces of water are employed. When these ingredients are mixed together, the boiler is to be filled up with cold water, and the proportion of the bath for every pound of silk is about eight or ten quarts of water. In this the silk is immediately immersed, and turned on the winch, till it appear to be of a uniform colour. The fire is then increased, and the bath is kept boiling for two hours, taking care to turn the silk occasionally. The fire is afterwards put out, and the silk put into the bath, where it is allowed to remain for a few hours longer. It is then taken out, washed at the river, twice beetled, wrung, and dried. Two processes are recommended by Scheffer and Macquer. In that of the former, a greater proportion of cochineal is employed in the dye-bath; but, in that of the latter, a yellow ground is previously communicated to the silk. The colour which is thus obtained resists the action of soap, and is more durable than that which is produced by means of carthamus.

214. To obtain other shades of red, the above processes must be varied. If, after the silk has been wrung out of the solution of tin, it is steeped for a night in a cold solution of alum, in the proportion of one ounce to a quart of water, wrung and dried, then washed and boiled with cochineal, it will only appear of a pale poppy-colour; but a fine poppy-red may be produced by steeping it twelve hours in the solution of tin, diluted with eight parts of water, then left all night in the solution of alum, washed, dried, and passed through two baths of cochineal, taking care to add to the second bath a small quantity of sulphuric acid. The same colour may be produced by dyeing the silk previously with anotta, and then passing it successively through a number of baths prepared with an alkaline solution of carthamus, to which lemon juice has been added, till it acquire a fine cherry-colour. To brighten the colour, the silk, after being dyed, may be immersed in hot water acidulated with lemon juice.

Poppy red.

Cher &c.

215. Other shades of red, as a cherry-red, and flesh-red, are also produced by means of carthamus. For a cherry-red, it is not necessary that the stuff be previously dyed with anotta, and the proportion of colouring matter is smaller. A flesh-red colour is obtained by adding a little soap to the bath, which has the effect of softening the colour, and of retarding the action of the colouring matter on the stuff. To produce dark shades, it is sometimes usual to mix archil, and by this means the expence is diminished.

Scarle

216. Those who have produced a colour on silk which comes nearest to scarlet, Berthollet observes, begin with dyeing the silk crimson. It is then dyed with carthamus, and lastly it is dyed yellow without heat. By this process a fine colour is obtained; but the dye of the carthamus is not permanent, as it is destroyed by the action of the air, and the colour becomes deeper. The following is Dr Bancroft's process. In a solution of murio-sulphate of tin, diluted with five times its weight of water, the silk is to be soaked for two hours; and after being taken out, it is to be wrung and partially dried. It is then to be dyed in a bath prepared with four parts of cochineal, and three of quercitron bark. In this way a colour approaching to scarlet is obtained. To give the colour more body, the immersion may be repeated both in the solution of tin, and in the dyeing bath; and the brightness of the scarlet is increased by means of the addition of carthamus. A lively rose-colour is produced by omitting the quercitron bark, and dyeing the silk with cochineal only; and by adding a large proportion of water to the cochineal, a yellow shade is obtained, which changes the cochineal to the compound scarlet colour *.

Rose-lour.

4. *Of the Process of dyeing Cotton and Linen Red.*

Madd red.

217. Madder is most commonly employed for dyeing cotton and linen a red colour; and indeed in this kind of dyeing it is the most useful of all colouring matters. The affinity of the colouring matter of madder for cotton is stronger than for linen; but it has been found that the processes which are most successful in dyeing the one are the most preferable for the other. There are two kinds of madder reds: the one is called *simple* madder red; and the other, which is much brighter, has been distinguished by the name of *Turkey* or *Adrianople* red, because it comes from the Levant, and has rarely been equalled in brightness and permanency. In communicating this beautiful red colour to cotton, by means of madder, a great many useless and ridiculous directions have been given. According to some processes, the period of a month is scarcely sufficient to finish all the operations which are considered as indispensably necessary for obtaining this dye.

---

* Phil Perm. 312.

Of Simple Colours.

218. The principal mordants which are employed in dyeing cotton with madder, are oil, gall-nuts, and alum. The colouring matter of madder cannot be fixed on cotton, till the latter has been impregnated with oil. A cold soapy liquor is formed by a combination of oil and a weak solution of soda. By the use of this alkaline ley the oil is diluted and divided, and can be easily and equally applied to all the parts of the cotton. According to Chaptal, potash produces the same effect as soda; and attention to this is of some importance, from the difference of price of the two substances. All kinds of soda or oil are not fit for this preliminary preparation. The soda must be in the caustic state, and its causticity must be the effect of calcination; because if it has been rendered caustic by means of lime, it becomes of a brown colour. The soda also should contain little muriate, for when this neutral salt prevails, the combination of the oil and the soda is greatly retarded. The most proper oil is not of a fine kind, but that which contains a large portion of the extractive principle. As the ley of soda is only employed for the purpose of diluting and conveying the oil equally to all the parts of the cotton, there must be a perfect combination of the oil and the soda. Indeed this is of so much importance, that many place the whole secret of a strong colour in the choice of good oil and soda. From this it follows, that the oil should be in excess, otherwise it would abandon the stuff in washing, and the colour would remain dry.

219. The cotton, being impregnated with oil, is subjected to the operation of galling. The use of gall-nuts is attended with several advantages. 1. The gallic acid which they contain decomposes the saponaceous liquor with which the cotton is impregnated, and fixes the oil on the stuff. 2. The other properties which the galls possess, predispose the cotton to receive the colouring matter. 3. The astringent principle unites with the oil, and forms with it a compound, which on drying becomes black, is not very soluble in water, and has a strong affinity with the colouring matter of madder.

220. From these principles some practical observations may be deduced. 1. Gall-nuts furnish the most proper astringent matter for this kind of dye. 2. To effect a speedy and perfect decomposition, the galls ought to be strained as hot as possible. 3. The galled cotton should be speedily dried, for otherwise it might assume a black colour, which would injure the brightness of the red. 4. The process of galling should be performed in dry weather, because when the weather is moist, the astringent principle produces a black colour, and dries slowly. 5. The cotton should be pressed together with great care, that the decomposition may be equally effected at every point of the surface. 6. It is necessary to attend to the proportion between the gall-nuts and the soap, for if the former predominate the colour is black, and if the soap is in excess, the portion of oil uncombined with the astringent principle, escapes in the washings, and impoverishes the colour.

221. Alum is also employed as a mordant in dyeing cotton red. This substance not only heightens the red of madder, but contributes also, by its decomposition, and the fixation of its alumina, to give solidity to the colour. When cotton, after it has been galled, is immersed in a solution of alum, it immediately changes its colour, and becomes gray. No precipitate appears in the bath, because the operation takes place in the tissue of the cloth itself. But if the solution of alum be employed at too high a temperature, part of the galls escapes from the stuff, and the decomposition of the alum is then effected in the bath. This, which should be guarded against, must obviously diminish the proportion of the mordant, and render the colour poorer.

Application of the mordant.

222. This mordant, which is the most complicated known in dyeing, requires great attention in its application. In this, indeed, consists the whole difficulty of dyeing cotton a madder or Turkey red. In this mordant there is a combination of three principles, oil, the astringent principle, and alumina; and on their proper combination, the perfection of the colour depends. When any one of them is employed separately, the colour is neither so bright, nor so completely fixed.

Process for dyeing red at Astracan.

223. After these preliminary observations, we shall now give a fuller detail of some of the processes which are followed in dyeing cotton Turkey red. The following is that which is practised at Astracan, of which an account has been given by Professor Pallas.

Preparation.

"The cotton to be dyed red is first washed exceedingly clean in running water, and, when the weather is clear, hung up on poles to dry. If it does not dry before the evening, it is taken into the house, on account of the saline dews so remarkable in the country around Astracan, and again exposed to the air next morning. When it is thoroughly dry it is laid in a tub, and fish oil is poured over it till it is entirely covered. In this state it must stand all night, but in the morning it is hung up on poles, and left there the whole day; and this process is repeated for a week, so that the cotton lies seven nights in oil, and is exposed seven days to the atmosphere, that it may imbibe the oil and free itself from all air. The yarn is then again carried to a stream, cleaned as much as possible, and hung up on poles to dry.

The mordant.

224. "After this preparation, a mordant is made of three materials, which must give the grounds of the red colour. The pulverized leaves of the sumach are first boiled in copper kettles; and when their colouring matter has been sufficiently extracted, some powdered galls are added, with which the liquor must be again boiled; and by these means it acquires a dark dirty colour. After it has been sufficiently boiled, the fire is taken from under the kettle, and alum put into the liquor yet hot, where it is soon dissolved. The proportion of these three ingredients I cannot determine with sufficient accuracy, because the dyers make use of different quantities at pleasure. The powder of the sumach leaves is measured into the kettle with ladles; the water is poured in according to a gauge, on which marks are made to shew how high the water must stand in the kettle to soak six, eight, ten, &c. puds of cotton yarn. The galls and alum are added in the quantity of five pounds to each pud of cotton. In a word, the whole mordant must be sufficiently yellow, strong, and of an astringent taste.

225. "As soon as the alum is dissolved, no time must be lost in order that the mordant may not be suffered to

to cool. The yarn is then put into hollow blocks of wood shaped like a mortar, into each of which such a quantity of the mordant has been poured as may be sufficient to moisten the yarn without any of it being left. As soon as the workman throws the mordant into the mortar, he puts a quantity of the yarn into it, and presses it down with his hand till it becomes uniformly moistened, and the whole cotton yarn has struck. By this it acquires only a pale yellow colour, which however is durable. It is then hung up on poles in the sun to dry, again washed in the stream, and afterwards dried once more.

226. "By the yellow dye of the sumach leaves, the madder dye becomes brighter and more agreeable; but the galls damp the superfluous yellow, and together with the alum prepare the yarn for its colour. Some dyers however omit the use of these leaves altogether, and prepare their mordant from galls and alum only, by first boiling the galls in due proportion with the requisite quantity of water, then dissolving the alum with boiling water in a separate vessel, afterwards pouring both liquors together into a tub, and suffering the cotton to remain in them an hour, or an hour and a half; after which it is dried gradually, then washed, and again dried once more. By this process the yarn acquires a dirty reddish colour.

Madder dye.

227. "The next part of the process is to prepare the madder dye. The madder, ground to a fine powder, is spread out in large troughs, and into each trough is poured a large cup full of sheep's blood, which is the kind that can be procured with the greatest facility by the dyers. The madder must be strongly mixed in it by means of the hand, and then stand some hours in order to be thoroughly soaked by it. The liquor then assumes a dark red appearance, and the madder in boiling yields more dye.

228. "After this process water is made hot in large kettles, fixed in brick-work; and as soon as it is warm the prepared red dye is put into it, in the proportion of a pound to every pud of cotton. The dye is then suffered to boil strongly; and when it is boiled enough, which may be tried on cotton threads, the fire is removed from under the kettle, and the prepared cotton is deposited near it. The dyer places himself on the edge of the brick-work that encloses the kettle; dips the cotton yarn, piece by piece, into the dye; turns it round, backwards and forwards; presses it a little with his hands; and lays each piece, one after the other, in pails standing ready for the purpose. As soon as all the cotton has received the first tint, it is hung up to dry: as the red, however, is still too dull, the yarn which has been already dyed once, and become dry, is put once more into the dyeing kettle, and must be left there to seethe for three hours over a strong fire, by which it acquires that beautiful dark red colour which is so much esteemed in the Turkey yarn. The yarn is now taken from the dye with sticks; the superfluous dye which adheres to it is shaken off; the hanks are put in order, and hung up, one after another, to dry. When it is thoroughly dry, it is washed in the pure stream and again dried. The only fault of the Astracan dyers is, that the colour is sometimes brighter and sometimes darker, probably because they do not pay sufficient attention to the proportions, or because the madder is not always of the same goodness.

Boiling. ley of so

229. "In the last place, the above-mentioned soda (kalakar) is dissolved with boiling water in tubs destined for that purpose; and it is usual here to allow twenty pounds of soda to forty pounds of cotton, or half the weight. Large earthen jars, which are made in Persia of very strong clay, a yard and a half in height, almost five spans wide in the belly, and ending in a neck a span and a half in diameter, enclosed by means of cement in brick-work over a fire-place, in such a manner that the necks only appear, are filled with the dyed cotton yarn. The ley of dissolved soda, which is blackish and very sharp, is then poured over it till the jars be filled; and some clean rags are pressed into their mouths, that the uppermost skains of yarns may not lie uncovered. A fire is then made in the fire-place below, and continued for 24 hours; and in the mean time the steam which arises from the jars is seen collected among the rags in red drops. By this boiling the dye is still more heightened, and is made to strike completely; every thing superfluous is removed, and all the fat matter which still adheres to the yarn is washed out: nothing more is then necessary for completing the dye of the yarn but to rinse it well several times in running water, and then to dry it.

The san colour b other means.

230. "That the dye of madder might be made very penetrating by other methods, and through the means of other oily and resinous substances, is shewn by the process of the Tungusians to dye horse, goat's and reindeer's hair, which they use for ornamenting their dresses, of a beautiful red colour, with the roots of the cross-wort, or northern madder (*galium*), and narrow-leaved woodroof (*asperula tinctoria*), which have a resemblance to those of madder. They boil the fresh or dried roots with about the same quantity of agaric (*agaricus officinarum*), which, as is well known, is abundant in resinous gummy particles, and is used by the people of Jakut instead of soap; they then lay in it the white hair which they wish to dye, and suffer it to seethe slowly until it be sufficiently red. Cotton cloth is dyed with madder at Astracan in the same manner: but many pursue a fraudulent process, by dyeing with red wood, and then sell their cloth as that which has been dyed in the proper manner."

The Gr cian m thod.

231. The processes which are employed in the Grecian manufactories for dyeing Turkey red, as they have been described by C. Felix, in a memoir in the French annals of chemistry, are somewhat different from the above. "In these manufactories," he observes, "the workmen dye at one time a mass of skains weighing thirty-five occas (G); each occa being equal to about fifty ounces. The first process is that of cleaning the cotton, for which purpose three leys are employed; one of soda, another of ashes, and a third of lime. The cotton is thrown into a tub, and moistened with the liquor of the three leys in equal quantities; it is then boiled in pure water, and washed in running water.

Prepara tion.

(G) Equal to 109 lb. 6 oz.

Simple olours.

ond h.

232. "The second bath given to the cotton is composed of soda and sheep's dung dissolved in water. To facilitate the solution, the soda and dung are pounded in a mortar. The proportions of these ingredients employed, are, one occa of dung, six of soda, and forty of water. When the ingredients are well mixed, the liquor expressed from them is strained, and being poured into a tub, six occas of olive oil are added to it, and the whole is well stirred till it becomes of a whitish colour, like milk. The cotton is then besprinkled with this water, and when the skains are thoroughly moistend, they are wrung, pressed, and exposed to dry. The same bath must be repeated three or four times, because it is this liquor which renders the cotton more or less fit for receiving the dye. Each bath is given with the same liquor, and ought to continue five or six hours. It is to be observed that the cotton, after each bath, must be dried without being washed, as it ought not to be rinsed till after the last bath. The cotton is then as white as if it had been bleached in the fields.

233. "The bath of sheep's dung is not used in our manufactories (H); it is a practice peculiar to the Levant. It may be believed that the dung is of no utility for fixing the colours; but it is known that this substance contains a great quantity of volatile alkali, in a disengaged state, which has the property of giving a rosy hue to the red. It is therefore probable that it is to this ingredient that the red dyes of the Levant are indebted for their splendour and vivacity. This much, at any rate, is certain, that the Morocco leather of the Levant is prepared with dog's dung; because it has been found that this dung is proper for heightening the colour of the black. The bath of dung is followed by the process of galling.

G ng an lum- in

234. "The galling is performed by immersing the cotton in a bath of warm water, in which five occas of pulverised gall-nuts have been boiled. This operation renders the cotton more fit for being saturated with the colour, and gives to the dye more body and strength. After the galling comes aluming, which is performed twice, with an interval of two days, and which consists in dipping the cotton into a bath of water in which five occas of alum have been infused, mixed with five occas of water alkalized by a ley of soda. The aluming must be performed with care, as it is this operation which makes the colouring particles combine best with the cotton, and which secures them in part from the destructive action of the air. When the second aluming is finished, the cotton is wrung; it is then pressed, and put to soak in running water, after being inclosed in a bag of thin cloth.

Of Simple Colours.

Dyeing.

235. "The workmen then proceed to the dyeing.—To compose the colours they put in a kettle five occas of water and thirty-five occas of a root which the Greeks call *ali-zari*, or painting colour, and which in Europe is known under the name of *madder*. The madder, after being pulverised, is moistened with one occa of ox or sheep's blood. The blood strengthens the colour, and the dose is increased or lessened according to the shade of colour required. An equal heat is maintained below the kettle, but not too violent; and when the liquor ferments, and begins to grow warm, the skains are then gradually immersed, before the liquor becomes too hot. They are then tied with packthread to small rods, placed crosswise above the kettle for that purpose, and when the liquor boils well, and in an uniform manner, the rods from which the skains were suspended are removed, and the cotton is suffered to fall into the kettle, where it must remain till two-thirds of the water is evaporated. When one-third only of the liquor remains, the cotton is taken out and washed in pure water.

Alkaline bath.

236. "The dye is afterwards brought to perfection by means of a bath alkalized with soda. This manipulation is the most difficult and the most delicate of the whole, because it is that which gives the colour its tone. The cotton is thrown into this new bath, and made to boil over a steady fire till the colour assumes the required tint. The whole art consists in catching the proper degree: a careful workman, therefore, must watch with the utmost attention for the moment when it is necessary to take out the cotton, and he will rather burn his hand than miss that opportunity. It appears that this bath, which the Greeks think of so much importance, might be supplied by a ley of soap; and it is probable that saponaceous water would give the colour more brightness and purity.

Methods of improving the colour.

237. "When the colour is too weak, the Levantines know how to strengthen it by increasing the dose of the colouring substances; and when they wish to give it brightness and splendour, they employ different roots of the country, and, in particular, one named *sussari*, specimens of which I have sent to France. The alizari, which is the principal colouring matter employed in the Greek dye-houses, is collected in Natolia, and is brought to Greece from Smyrna: some of it comes also from Cyprus and Mesopotamia. The superiority of this Levantine plant to the European madder is acknowledged by all those acquainted with the art of dyeing, and may arise from two causes: the manner in which it is cultivated, and the method employed for its desiccation (I)."

238. To

(H) The French manufactories.

(I) "The chief manufactories (continues our author), for dyeing spun cotton red, established in Greece, are in Thessaly. There are some at Baba, Rapsani, Tournavos, Larissa, Pharsalia, and in all the villages situated on the sides of Ossa and Pelion. These two mountains may be considered as the alembics that distil the eternal vapours with which Olympus is crowned, and which distribute them throughout the beautiful valleys situated around them. Of these valleys, that of Tempe has at all times been distinguished by the beauty of its shady groves and of its streams. These streams, on account of their limpidness, are very proper for dyeing, and supply water to a great number of manufactories, the most celebrated of which are those of Ambelakia.

"Ambelakia, on account of the activity which prevails in it, has a greater resemblance to a town of Holland than a village of Turkey. This village, by its industry, communicates life and activity to all the neighbouring country, and gives birth to an immense trade, which connects Germany with Greece in a thousand ways. Its population, Papillon's process.

238. To these processes we shall add the account of another, which was long successfully practised at Glasgow by Mr Papillon, a native of France, and was communicated by him, for a suitable premium, to the commissioners and trustees for manufactures in Scotland, to be by them published for the benefit of the public, at the end of a certain term of years. This transaction took place in 1790, and the period having expired, the trustees announced it to the public in 1803. The process, which consists of nine different steps, is the following.

Step I.

For 100 lib. cotton you must have
100 lib. of Alicante barilla,
20 lib. of pearl ashes,
100 lib. quicklime.

The barilla is mixed with soft water in a deep tub, which has a small hole near the bottom of it, stopped at first with a peg.—This hole is covered in the inside with a cloth supported by two bricks, that the ashes may be prevented from running out at it, or stopping it up while the ley filters through it.

Under this tub is another to receive the ley; and pure water is repeatedly passed through the first tub to form lees of different strength, which are kept separate at first until their strength is examined. The strongest required for use must swim or float an egg, and is called the ley of six degrees of the French hydrometer, or peseliqueur. The weaker are afterwards brought to this strength, by passing them through fresh barilla. But a certain quantity of the weak, which is of 2 degrees of the above hydrometer, is reserved for dissolving the oil, and gum, and the salt, which are used in subsequent parts of the process. This ley of 2 degrees is called the weak barilla liquor, the other is called the strong.

Dissolve the pearl-ashes in 10 pails, of 4 gallons each, of soft water, and the lime in 14 pails.

Let all the liquors stand till they become quite clear, and then mix ten pails of each.

Boil the cotton in the mixture five hours, then wash it in running water and dry it.

Step II. *Bainbie*, or *Gray Steep*.

Take a sufficient quantity (20 pails) of the strong barilla water in a tub, and dissolve or dilute in it 2 pails full of sheep's dung, then pour into it 2 quart bottles of oil of vitriol, and 1 lib. of gum arabic, and 1 lib. of sal ammoniac, both previously dissolved in a sufficient quantity of the weak barilla water, and lastly, 25 lib. of olive oil, which has been previously dissolved or well mixed with 2 pails of the weak barilla water.

The materials of this steep being well mixed, tramp or tread down the cotton into it, until it is well soaked; let it steep 24 hours, and then wring it hard and dry it.

Steep it again 24 hours, and again wring and dry it.

Steep it a third time 24 hours, after which wring and dry it, and lastly wash it well and dry it.

Step III. *The White Steep*.

This part of the process is precisely the same with the last, in every particular, except that the sheep's dung is omitted in the composition of the steep.

Step IV. *Gall Steep*.

Boil 25 lib. of galls bruised in 10 pails of river water until 4 or 5 are boiled away; strain the liquor into a tub, and pour cold water on the galls in the strainer, to wash out of them all their tincture.

As soon as the liquor is become milk-warm, dip your cotton hank by hank, handling it carefully all the time, and let it steep 24 hours.

Then wring it carefully and equally, and dry it well without washing.

Step V. *First Alum Steep*.

Dissolve 25 lib. of Roman alum in 14 pails of warm water, without making it boil, skim the liquor well, and add 2 pails of strong barilla water, and then let it cool until it be lukewarm.

Dip your cotton and handle it hank by hank, and let it steep 24 hours, and wring it equally and dry it well without washing.

Step VI. *Second Alum Steep*,

Is performed in every particular like the last, but after the cotton is dry, you steep it 6 hours in the river, and wash and dry it.

Step

---

population, which has been tripled within these fifteen years, amounts at present to 4000, and all these people exist by dyeing. None of those vices or cares produced by idleness are known here. The hearts of the inhabitants are pure, and their countenances unclouded. Servitude, which degrades the countries watered by the Peneus, has not ascended to these hills: no Turk can reside or live among these people; and they govern themselves, like their ancestors, by their *protoyeros* and their own magistrates. Twice have the savage mussulmans of Larissa, envious of their ease and happiness, attempted to scale their mountains in order to plunder their houses; and twice have they been repulsed by hands which suddenly quitted the shuttle to assume the musket.

"All hands, and even those of the children, are employed in the dye-houses of Ambelakia; and while the men dye the cotton, the women are spinning and preparing it. The use of wheels is not known in this part of Greece: all the cotton is spun on a distaff: the thread, indeed, is certainly not so round or equal, but it is softer, more silky, and more tenacious; it is less apt to break, and lasts longer; it is also more easily whitened, and more proper for being dyed. It is a pleasing spectacle to see the women of Ambelakia, each spinning from a distaff, and sitting conversing together on the threshold of their doors; but as soon as a stranger appears, they instantly retire and conceal themselves in their houses, manifesting, like Galatea, in their precipitate retreat, a desire of flying and of shewing themselves:

Et fugit ad salices, et se cupit ante videri."

STEP VII. *Dyeing Steep.*

The cotton is dyed by about 10 lib. at once, for which take 2½ gallons of ox blood, and mix it in the copper with 28 pails of milk-warm water, and stir it well; then add 25 lib. of madder, and stir all well together. Then having beforehand put the 10 lib. of cotton on sticks, dip it into the liquor, and move and turn it constantly one hour, during which you gradually increase the heat, until the liquor begin to boil at the end of the hour. Then sink the cotton, and boil it gently one hour longer; and, lastly, wash it and dry it.

Take out so much of the boiling liquor, that what remains may produce a milk-warm heat with the fresh water with which the copper is again filled up, and then proceed to make up a dyeing liquor as above, for the next 10 lib. of cotton.

STEP VIII. *The Fixing Steep.*

Mix equal parts of the gray steep liquor, and of the white steep liquor, taking 5 or 6 pails of each. Tread down the cotton into this mixture, and let it steep six hours, then wring it moderately and equally, and dry it without washing.

STEP IX. *Brightening Steep.*

Ten lib. of white soap must be dissolved most carefully and completely in 16 or 18 pails of warm water; if any little bits of the soap remain undissolved, they will make spots in the cotton. Add four pails of strong barilla water, and stir it well. Sink your cotton in this liquor, keeping it down with cross sticks, and cover it up and boil it gently two hours, then wash and dry it, and it is finished.

VESSELS.

The number of vessels necessary for this business is greater in proportion to the extent of the manufactory; but, in the smallest work, it is necessary to have four coppers of a round form.

1*st*, The largest, for boiling and for finishing, is 28 inches deep by 38 or 39 wide in the mouth, and 18 inches wide in the widest part.

2*d*, The second, for dyeing, is 28 deep, by 23 or 24 in the mouth.

3*d*, The third, for the alum steep, is like the second.

4*th*, The fourth, for boiling the galls, is 20 deep, by 28 wide.

A number of tubs or larger wooden vessels are necessary, which must all be of fir, and hooped with wood or with copper.

Iron must not be employed in their construction, not even a nail; but where nails are necessary, they must be of copper.

By the pail is always understood a wooden vessel, which holds four English gallons, and is hooped with copper.

In some parts of the above process, the strength of the barilla liquor or liquors is determined, by telling to what degree a peseliqueur or hydrometer sunk in them.

The peseliqueur is of French construction. It is similar to the glass hydrometer used by the spirit-dealers in this country; and any artist who makes these instruments, will find no difficulty in constructing one with a scale similar to that employed by M. Papillon, when he is informed of the following circumstances:

1*st*, The instrument, when plunged in good soft water, such as Edinburgh pipe water, at temperature 60 degrees, sinks to the 0, or beginning of the scale, which stands near the top of the stem.

2*d*, When it is immersed in a saturated solution of common salt, at the same temperature of 60 degrees, it sinks to the 26th degree of the scale only, and this falls at some distance from the top of the ball.

This saturated solution is made by boiling, in pure water, refined sea or common salt, till no more is dissolved, and by filtering the liquor when cold through blotting paper.

It should also be observed, that whenever directions are given to dry yarn, to prepare it for a succeeding operation, that this drying should be performed with particular care, and more perfectly than our dryest weather is in general able to effect. It is done therefore in a room heated by a stove to a great degree.

Haussmann's process for madder red.

239. There is still another process, which is recommended by Haussmann. This process, (says he) obtains a beautiful and durable red. He makes a caustic ley of one part of common potash dissolved in four of boiling water, and a half part of quicklime, which is afterwards slaked in it. He then dissolved one part of powdered alum in two of boiling water, and to this solution, while it was yet warm, he added that of the caustic ley. The solution of alumina being left at rest, formed, on cooling, a precipitate of sulphate of potash. A 33d part of linseed oil was then mixed with the alkaline solution of alumina, which then formed a milky saponaceous liquid. When the mixture is to be used, it ought to be well shaken, because the oil separates. The stuffs of cotton or linen must be successively immersed in it, and equally pressed, and must be dried under shelter from rain in summer, and in a warm place in winter; and being left in that state for 24 hours, are then washed in pure running water, and again dried. The same process in the immersion in alkaline ley is again to be repeated, taking care to introduce first those stuffs which were last in the first solution. The whole of the mixture should be consumed each time, as it would attract carbonic acid from the air, and suffer the alumina to be precipitated.

240. Two immersions in the alkaline solution of alumina mixed with linseed oil, afford a beautiful red: but by impregnating the stuffs a third, or even a fourth time, in the same manner, the most brilliant colours are obtained. The intensity of the colour is in proportion to the quantity of madder. A quantity of madder equal in weight to the stuffs, will yield a red, which, by clearing becomes of a rosy shade; and shades of crimson of different degrees of brightness are obtained, by using two, three, or four times the weight of madder; but unless the water employed in the processes contains some portion of lime, the addition of the chalk should never be omitted.

Scarlet with cochineal.

241. The scarlet colour communicated to cotton by means of cochineal, is far from being permanent; but if this colour is wished to be communicated to cotton, Dr Bancroft recommends to steep the cotton, previously moistened, for half an hour, in a diluted solution of murio-

murio-sulphate of tin, and then having wrung the cotton, to plunge it into water, in which as much potash has been dissolved as will neutralize the acid adhering to the cotton, so that the oxide of tin may be more copiously fixed on the fibres of the cotton. The stuff being afterwards rinsed in water, may be dyed with cochineal and quercitron bark, in the proportion of four pounds of the former, to two and a half or three pounds of the latter. A full bright colour is thus given to the cotton, which will bear slight washings with soap, and exposure to the air. Indeed the yellow part of the colour derived from quercitron bark will bear long boiling with soap, and will resist the action of acids.

Crimson.

242. With the aluminous mordant, as it is usually applied by calico printers for madder reds, cotton dyed with cochineal receives a beautiful crimson colour, which will bear several washings, and resist the weather for some time. It is not, however, to be considered as a fixed colour. Dr Bancroft is of opinion, that the addition of a small portion of cochineal in dying madder reds upon the finer cottons, would be highly advantageous to the calico-printers. By this addition the madder reds are rendered more beautiful, and the fawn colour, or brownish yellow hue, which injures these reds, would be thus overcome *.

SECT. II. *Of Yellow.*

243. In dyeing yellow, it is necessary to employ mordants, because the affinity of yellow colouring matters for either animal or vegetable stuffs is not sufficiently strong to produce durable colours. Yellow colours, therefore, belong to that class which Dr Bancroft has denominated *adjective colours*. As in the former section, we shall first give a short description of the nature and properties of the substances employed in dyeing yellow, and then point out the most approved modes of communicating their colours to woollen, silk, cotton, and linen stuffs.

The substances capable of giving a yellow colour to different stuffs are very numerous; they do not all produce similar quantities of colouring matter; their dye is not equally free; the colours they impart incline more or less to orange or green; they possess various degrees of brightness and permanency, and differ considerably in price; circumstances by which the choice of the dyer ought always to be regulated. But those commonly employed in dyeing yellow, are weld, fustic, anotta, and quercitron bark.

I. *Of the Substances employed in dyeing Yellow.*

Substances employed in dyeing yellow. Weld.

244. Weld (*reseda luteola*, Lin.) is a plant which grows wild in Britain, and in different European countries. Its leaves are long, narrow, and of a bright green, but the whole plant is made use of in the dyeing of yellow. There are two kinds of weld, cultivated and wild, the former of which is deemed more valuable than the latter, as it yields a much greater proportion of colouring matter. When this plant is fully ripe, it is pulled, dried, and bound up in bundles for the use of the dyer. The wild species grows higher and has a stronger stalk than that which is cultivated, by which the one may be readily distinguished from the other.

Properties.

245. A strong decoction of weld is of a brownish yellow colour, and if very much diluted with water the colour inclines to a green. An alkali gives to this decoction a deeper colour, and the precipitate it occasions is not soluble in alkalies. Most of the acids give it a paler tinge, occasioning a little precipitate which is soluble in alkalies. Alumina has so strong an affinity for the colouring matter of weld, that it can even abstract it from sulphuric acid, and the oxide of tin produces a similar effect. The greater part of metallic salts throw down similar precipitates, which vary in their shades of colour according to the metal employed. A solution of common salt renders the liquor turbid, and a solution of tin yields a copious yellow precipitate, while the liquor long continues turbid, and slightly coloured.

Fustic.

246. Fustic (*morus tinctoria*, Lin.) is procured from a tree of considerable magnitude, which grows in the West Indies. The wood is yellow, as its name imports, with orange veins. Ever since the discovery of America it has been used in dyeing, as appears from a paper in the Transactions of the Royal Society, of which Sir William Petty was the author. Its price is moderate, the colour it imparts is permanent, and it readily combines with indigo, which properties give it a claim to attention as a valuable ingredient in dyeing. Before it can be employed as a dye-stuff, it must be cut into chips and put into a bag, that it may not fix in, and tear the stuff, to which it is to impart its colouring matter.

Properties.

247. When a decoction of yellow wood or fustic is made very strong, the colour is of a reddish yellow, and when diluted it is of an orange yellow, which it readily yields to water. It becomes turbid by means of acids, its colour is of a pale yellow, and the greenish precipitate may be re-dissolved by alkalies. The sulphates of zinc, iron, and copper, as well as alum, throw down precipitates composed of the colouring matter and the different bases of the salts employed.

In examining the causes of the fixity of yellow colours, obtained from vegetables, Chaptal discovered that the durability of the pale yellow depended on the tanning principle, which is found united with the yellow colouring matter. He obtained by analyzing fustic, 1. A resinous or gummy matter, which can communicate a beautiful yellow colour. 2. An extractive matter, which is also yellow, and affords a beautiful colour. 3. A tanning principle of a pale yellow colour, which becomes black by boiling, or exposure to the air. This latter diminishes the brilliancy of the two former; but it may be separated by a simple process. Chaptal boiled with the wood some animal substance containing gelatinous matter, such as bits of skin, strong glue, &c. The tanning principle was thus precipitated with the gelatinous matter, and the bath held in solution only the colouring matters which yield a bright full yellow; and by means of this process he procured colours from several vegetables, equally bright with those which are communicated by yellow wood and quercitron bark *.

Anotta.

248. Anotta is a species of paste of a red colour, obtained from the berries of the *bixa orellana*, Lin. which is a native of America. The anotta of commerce is imported from America to Europe in cakes of two or three pound weight, where it is prepared from the seeds of the tree mentioned above; but the Americans are said to be in possession of a species of anotta superior to that which they export, both for the brilliancy and

---

* *Phil. of Perm. Col.* 317.

* *Phil. Mag.* i. 43

and permanency of the colour it imparts. They bruise the seeds with their hands moistened with oil, separating with a knife the paste as it is formed, and drying it in the sun; but the seeds are pounded with water when designed for sale, and allowed to undergo the process of fermentation.

247. Anotta yields its colouring matter more readily to alcohol than to water, on which account it is used in yellow varnishes to which an orange tinge is intended to be given. Acids form a precipitate with a decoction of anotta of an orange colour, which is soluble in alkalies; but solutions of common salt produce no sensible change. It yields an orange precipitate with a solution of alum, and the sulphates of copper and iron produce effects of nearly a similar nature. With a solution of tin, the precipitate is of a lemon colour and slowly deposited.

248. Quercitron, as it is denominated by Dr Bancroft, is the *quercus nigra* of Linnæus, and is a large tree which grows spontaneously in North America. The bark of it yields a considerable quantity of colouring matter, which was first discovered by Dr Bancroft in the year 1784, in whom the use and application of it in dyeing were exclusively vested for a certain term of years by virtue of an act of parliament. To prepare it for use, the epidermis is taken off and pounded in a mill, the result of which process is a number of filaments and a fine light powder; but as these do not contain equal quantities of colouring matter, it will be proper to employ them in their natural proportions.

249. Quercitron bark readily imparts its colouring matter to water at 100° of Fahrenheit, which is of a yellowish brown, capable of being darkened by alkalies, and brightened by acids. With muriate of tin the precipitate is copious, and of a yellow colour; with sulphate of tin it is a dark olive; and with sulphate of copper it is yellow, but inclining to an olive. Nitromuriate of tin yields a yellow extremely beautiful, probably owing to the oxide of tin combining with the colouring matter in a greater proportion than some other salts.

250. Besides the substances already mentioned as employed in the dyeing of yellow, we may add saw-wort to the number (*serratula tinctoria*, Lin.) a plant which yields a colouring matter nearly similar to that of weld, and may of consequence be used as a proper substitute. Dyers broom (*genista tinctoria*) produces a yellow of very indifferent nature, and is therefore only employed in dyeing stuffs of the coarsest kind. Turmeric (*curcuma longa*) is a native production both of the East and West Indies, and yields a more copious quantity of colouring matter than any other yellow dye-stuff; but it will probably never be of any essential service in dyeing yellow, as no mordant has yet been discovered, capable of giving permanency to its colour.

251. Chamomile (*anthemis tinctoria*) yields a faint yellow colour, the hue of which is not unpleasant, but is far from being durable, and even mordants are not capable of fixing it. Sulphate of lime, tartar and alum, bid fairest for success.

252. Fenugreek (*trigonella fœnugræcum*) yields seeds which, when ground, communicate to stuffs a pale yellow of tolerable durability; and the best mordants are found to be alum and muriate of soda, or common salt. American hiccory (*juglans alba*) is a tree, the bark of which yields a colouring matter in every respect resembling that of the *quercus nigra*, but in quantity greatly inferior. French berries (*rhamnus infectorius*) produce a tolerable yellow colour, but it is by no means permanent. When used in the process of dyeing, they are to be employed in the same manner as weld. According to Scheffer, a fine yellow colour may be imparted to silk, thread, and wool, by means of the leaves of the willow: but Bergman informs us that only the leaves of the sweet willow (*salix pentandra*) are proper for producing a permanent colour, as a few weeks exposure to the sun extracts that which is produced by the colouring matter from the leaves of the common willow.

253. In Switzerland and in England, the seeds of purple trefoil are sometimes employed in the art of dyeing, on which Vogler made a number of experiments, in order to ascertain what colours they would produce: and he found that a fine deep yellow was afforded by a bath made of a solution of these seeds with potash; that sulphuric acid yielded a light yellow, and sulphate of copper or blue vitriol, a yellow inclining to green. M. Dizé informs us, that the seeds of trefoil impart to wool a beautiful orange, and to silk a greenish yellow; and that while aluming is necessary in the process of dyeing with the seeds of trefoil, a solution of tin cannot be employed.

II. *Of the Processes for Dyeing Wool Yellow.*

With weld.

254. In dyeing woollen stuffs with weld, the mordants employed are alum and tartar, and by their means a pure, permanent yellow is obtained. The boiling is to be conducted in the usual way; and according to Hellot, four ounces of alum to one ounce of tartar are to be employed. Other dyers, however, employ half as much tartar as alum. The colour is rendered paler, but more lively, by means of the tartar.

Preparation of the bath.

255. The bath is prepared by boiling the plant inclosed in a thin linen bag, and keeping it from rising by means of a wooden cross. Some boil it till it sinks to the bottom of the vessel; while others, after it is boiled, take it out, and throw it away. From three to four lbs. of weld, and sometimes less, are allowed for every lb. of stuff; but the quantity must be regulated by the intensity of the shade desired. Some dyers add a small quantity of quicklime and ashes, which are found to promote the extraction of the colouring matter. These substances at the same time heighten the colour, but render it less susceptible of resisting the action of acids.

For different shades.

256. With other additions, and different management, different shades may be obtained. Thus, lighter shades are produced by dyeing after deeper ones, adding water at each dipping, and keeping the bath at the boiling temperature. These shades, however, are less lively than when fresh baths are employed, with a suitable proportion of weld. The addition of common salt or sulphate of lime to the weld bath communicates a richer and deeper colour. With alum it is paler and more lively, with tartar still paler, and with sulphate of iron the shade inclines to brown. According to Scheffer, by boiling the stuff two hours, with one-fourth of its weight of a solution of tin, and the same proportion of tartar, and then washing and boiling it with an equal weight of weld, a fine yellow is produced; but if the stuff

stuff be in the state of cloth, its internal texture is not penetrated. Poerner recommends a similar preparation as for dyeing scarlet, and by these means the colour is brighter, more permanent, and lighter.

With quercitron bark.

257. Dr Bancroft recommends the quercitron bark as one of the cheapest and best substances for dyeing wool yellow. The following is the simple process which he has proposed for its application. The bark is to be boiled up with about its weight, or one-third more, of alum, in a suitable proportion of water, for about 10 minutes. The stuff previously scoured is then to be immersed in the bath, taking care to give the higher colours first, and afterwards the paler straw colours. By this cheap and expeditious process, colours which are not wanted to be of a full or bright yellow, may be obtained. The colour may be considerably heightened by passing the unrinsed stuff a few times through hot water, to which a little clean powdered chalk, in the proportion of about 1½ lb. for each 100 lb. of stuff has been previously added. The bark, when used in dyeing, being first reduced to powder, should be tied up in a thin linen bag, and suspended in the liquor, so that it may be occasionally moved through it, to diffuse the colouring matter more equally.

Cheap process.

Process for permanent colours.

258. But although the above method possesses the advantages of cheapness and expedition, and is fully sufficient for communicating pale yellows; to obtain fuller and more permanent colours, the common mode of preparation, by previously applying the aluminous mordant, ought to be preferred. The stuff, therefore, should be boiled for about one hour or one hour and a quarter, with one-sixth, or one-eighth of its weight of alum, dissolved in a proper proportion of water. The stuff is then to be immersed, without being rinsed, into the dyeing bath, with clean hot water, and about the same quantity of powdered bark tied up in a bag, as that of the alum employed in the preparation. The stuff is then to be turned as usual through the boiling liquor, until the colour appears to have acquired sufficient intensity. One pound of clean powdered chalk for every 100 lb. of stuff is then to be mixed with the dyeing bath, and the operation continued for eight or ten minutes longer. This addition of the chalk raises and brightens the colour.

259. *Orange Yellow.*——To communicate a beautiful orange yellow to woollen stuffs, 10 lbs. of quercitron bark, tied up in a bag, for every 100 lb. of stuff, are to be put into the bath with hot water. At the end of six or eight minutes, an equal weight of murio-sulphate of tin is to be added, and the mixture well stirred for two or three minutes. The cloth, previously scoured, and completely wetted, is then immersed in the dyeing liquor, and briskly turned for a few minutes. By this process the colouring matter fixes on the cloth so quickly and equally, that after the liquor begins to boil, the highest yellow may be produced in less than 15 minutes.

For different shades.

260. High shades of yellow, somewhat similar to those obtained from quercitron bark by the above process, are frequently given with young fustic (*rhus cotinus*, Lin.) and dyers spirit, or nitro-muriate of tin; but this colour is much less beautiful and permanent, while it is more expensive than what is obtained from the bark.

261. *Bright golden Yellow.*——This colour is produced by employing 10 pounds of bark for every 100 lbs. of cloth, the bark being first boiled a few minutes, and then adding seven or eight lbs. of murio-sulphate of tin, with about five pounds of alum. The cloth is to be dyed in the same manner as in the process for the orange yellow.

262. Bright yellows of less body are produced by employing a smaller proportion of bark, as well as by diminishing the quantity of murio-sulphate of tin and alum. And indeed every variety of shade of pure bright yellow may be given by varying the proportions of the ingredients.

For gr- ish ye

263. To produce the lively delicate green shade, which, for certain purposes, is greatly admired, the addition of tartar, with the other ingredients, only is necessary, and the tartar must be added in different proportions, according to the shade which is wanted. For a full bright yellow, delicately inclining to the greenish tinge, it will be proper to employ eight pounds of bark, six of murio-sulphate of tin, with six of alum, and four of tartar. An additional proportion of alum and tartar renders the yellow more delicate, and inclines it more to the green shade; but when this lively green shade is wanted in the greatest perfection, the ingredients must be used in equal proportions. The delicate green lemon yellows are seldom required to have much fulness or body. Ten pounds of bark, therefore, with an equal quantity of the other ingredients, are sufficient to dye three or four hundred pounds of stuffs *.

For p green low.

264. To produce the exquisitely delicate and beautiful pale green shades, the surest method, Dr Bancroft observes, is to boil the bark with a small proportion of water, in a separate tin vessel for six or eight minutes, and then to add the murio-sulphate of tin, alum, and tartar, and to boil them together for about fifteen minutes. A small quantity of this yellow liquor is then to be put into a dyeing vessel, which has been previously supplied with water sufficiently heated. The mixture being properly stirred, the dyeing process is to be conducted in the usual way, and the yellow liquor, as it is wanted, gradually added from the first vessel. In this way, the most delicate shades of lively green lemon yellows are dyed with ease and certainty. Weld is the only dye-stuff from which similar shades of colour can be obtained; but it is four times more expensive. The yellows dyed from quercitron bark, Dr Bancroft adds, with murio-sulphate of tin and alum as mordants, do not exceed the expence of one penny for each pound of stuff; besides a considerable saving of time, labour, and fuel †.

Verdi used fo tartar.

265. A greenish shade may also be produced without tartar, by substituting verdigrise dissolved in vinegar, along with the bark; but it is neither so permanent, nor so bright and delicate, as that produced by means of tartar. Sulphate of indigo also, in very small proportion, communicates a similar shade, when it is employed with the bark, murio-sulphate of tin, and alum; but it is apt to take unequally on the stuff, and besides, in the language of the dyers, the colour has a tendency to *cast* or *fly* in the finishing.

Cochin and ma employ

266. Small proportions of cochineal, employed along with the bark and other ingredients, raise the colour to a beautiful orange, and even to an aurora. Madder may be also employed with the same view, for it heightens the yellow obtained from quercitron bark, although

---

* Banc 330.

† Ibid.

mple ours.

although the colour thus obtained is inferior in beauty to that from cochineal. The madder may also be employed with weld for the same purpose †.

rs quer- bark dur-

267. The colours obtained from quercitron bark, by the processes which we have now described, are very durable. They resist the action of the air, of soap, and of acids. It is by the effects of alum, but especially of tartar, that these colours become so fixed as to remain permanent by exposure to the air. It is observed of the highest yellows, even when they approach to the orange, and which are best dyed, either with muriate or murio-sulphate of tin and bark, that although they resist the action of soap and acids, they are apt to lose their lustre and become brown by the effect of the sun and air; but this also happens to yellows dyed with nitro-muriate of tin, both with the bark and with weld, but in a still greater degree with other yellow vegetable colouring matters. In some of these this defect is less easily obviated by alum and tartar, than it is in the yellow obtained from weld and quercitron bark *.

III. *Of the Processes for Dyeing Silk Yellow.*

ith weld.

268. To dye silk a plain yellow colour, the only ingredient which was formerly employed is weld. The following is the process. The silk being previously scoured in the proportion of 20 lbs. of soap to the 100 of stuff, and then alumed and washed after the aluming, or, as it is called, *refreshed*, the bath is prepared with two pounds of weld for every pound of silk; and, having boiled for 15 minutes, it is to be passed into a vat through a sieve or cloth. When the temperature is such as the hand can bear, the silk is introduced, and turned, until it has acquired a uniform colour. While this operation is going on, the weld is to be boiled a second time in fresh water; one half of the first bath is taken out, and its place supplied with a fresh decoction. The temperature of the fresh bath may be a little higher than the former, but it is necessary to guard against too great a degree of heat, that the colouring matter already fixed may not be dissolved. The stuff is to be turned as before, and afterwards taken out of the bath. A quantity of soda is to be dissolved in a part of the second decoction, and a larger or smaller proportion of this solution is to be added to the bath, according to the intensity of the shade required. When the silk has been turned a few times, a skain is wrung out, that it may be examined whether the colour be sufficiently full, and have the proper golden shade. To render the colour deeper, and to give it the gold cast, an addition of the alkaline solution is to be made to the bath, and to be repeated till the shade has acquired sufficient intensity. The alkaline solution may also be added along with the second decoction of the weld, observing the precaution, that the temperature of the bath be never too great.

a ep- colo

oth des

269. To produce other shades of yellow, having more of a gold or jonquille colour, a quantity of anotta, proportioned to the shade required, is to be added to the bath, along with the alkali. Lighter shades of yellow, such as pale lemon, or Canary-bird colour, are obtained, by previously whitening the silk, and regulating the proportion of ingredients in the bath by the shade required. To communicate a yellow having a tinge of green, a little indigo is added to the bath, if the silk has not been previously azured. To prevent the intensity of the shade from being too great, the silk may be more slightly alumed than usual.

Of Simple Colours.

A cheaper process.

270. But, according to Dr Bancroft, the different shades of yellow obtained from weld, may be given to silk with equal facility and beauty, and at a cheaper rate, by employing quercitron bark as a substitute. A quantity of bark powdered and enclosed in a bag, in proportion to the shade of colour wanted, as from one to two pounds for every twelve pounds of silk, is put into the dyeing vat while the water is cold. Heat is then applied; and when it has become rather more than blood warm, or of the temperature of 100°, the silk having previously undergone the aluming process, is to be immersed and dyed in the usual way. If a deep shade is wanted, a small quantity of chalk or pearl-ashes may be added towards the end of the operation. To produce a more lively yellow, a small proportion of murio-sulphate of tin may be employed; but it should be cautiously used, as it is apt to diminish the lustre of the silk. To produce such a shade, the proportions of the ingredients may be four pounds of bark, three of alum, and two of murio-sulphate of tin. These are to be boiled with a proper quantity of water for ten or fifteen minutes; and the temperature of the liquid being so much reduced as the hand can bear it, the silk is immersed and dyed as usual, till it has acquired the proper colour. Care should be taken to keep the liquor constantly agitated, that the colouring matter may be equally diffused *.

For an orange colour.

271. To dye silk of an aurora or orange colour, after being properly scoured, it may be immersed in an alkaline solution of anotta, the strength of which is to be regulated by the shade required; and the temperature of the bath should be between tepid and boiling water. When the desired shade has been obtained, the silks are to be washed and twice beetled, to free them from the superfluous colouring matter, which would injure the beauty of the colour. When raw silk is to be dyed, that which is naturally white should be selected, and the bath should be nearly cold; for otherwise the alkali, by dissolving the gum of the silk, destroys its elasticity. Silk is dyed of an orange shade with anotta, but the stuffs must be reddened with vinegar, alum, or lemon juice. The acid, by saturating the alkali employed to dissolve the anotta, destroys the yellow shade produced by the alkali, and restores its natural colour, which inclines to a red. But although beautiful colours are obtained by this process, they do not possess any great degree of permanency.

Yellow dye from mushrooms.

272. Several kinds of mushrooms afford lively and durable yellow dyes. A bright shining dye of this description has been extracted from the *boletus hirsutus*, which commonly grows on walnut and apple trees. The colouring matter is contained both in the tubular part, and also in the parenchyma of the body of the mushroom. To extract the colouring matter, it is pounded in a mortar, and the liquor which is thus obtained, is boiled for a quarter of an hour in water. An ounce of liquor is sufficient to communicate colouring matter to six pounds of water. After the liquor has been strained, the stuff to be dyed is immersed in it, and boiled for fifteen minutes. When silk is subjected to this process, after being dyed, it is made to pass through a bath of soft soap, by which it acquires a shin-

---

† croft, 35

* I 334.

* Ibid. 345.

ing golden yellow colour, which has a near resemblance to the yellow of the silk employed to imitate embroidery in gold. This has been hitherto brought from China, and bears a very high price, the method of dyeing it being unknown in Europe. All kinds of stuff receive this colour, but it is less bright on linen and cotton, and seems to have the strongest affinity for silk. The use of mordants, it is supposed, would modify and improve it greatly *.

IV. *Of the Processes for Dyeing Cotton and Linen Yellow.*

Processes with weld.

273. The process which has been usually followed in dyeing cotton and linen yellow, is by scouring it in a bath prepared in a ley with the ashes of green wood. It is afterwards washed, dried, and alumed, with one-fourth of its weight of alum. After 24 hours, it is taken out of the aluming, and dryed, but without being washed. The cotton is then dyed in a weld bath, in the proportion of one pound and a quarter of weld for each pound of cotton, and turned in the bath till it has acquired the proper colour. After being taken out of the bath, it is soaked for an hour and a half in a solution of blue vitriol (sulphate of copper), in the proportion of one-fourth of the weight of the cotton, and then immersed, without washing, for nearly an hour, in a boiling solution of white soap, after which it is well washed and dried.

For a deeper yellow

274. A deeper yellow is communicated to cotton, by omitting the process of aluming, and employing two pounds and a half of weld for each pound of cotton. To this is added a dram of verdigrise, mixed with part of the bath. The cotton is then to be dipped and worked till the colour become uniform. It is then taken out of the bath, that a little solution of soda may be added, after which it is returned, and kept for fifteen minutes. It is then wrung out and dried.

and other shades.

275. Other shades of yellow may be obtained, by varying the proportion of ingredients. Thus, a lemon colour is dyed by using only one pound of weld for every pound of cotton, and by diminishing the proportion of verdigrise, or using alum as a substitute †.

Cheaper and more permanent colours.

276. But a better method, as it affords more permanent and more beautiful colours, and at a smaller expence, is recommended by Dr Bancroft. This is by the use of quercitron bark, and the calico printers aluminous mordant, or the sugar of lead. The following is the process which he proposes to employ, for producing bright and durable yellow colours. One pound of sugar of lead, and three pounds of alum, are to be dissolved in a sufficient quantity of warm water. The cotton or linen, after being properly rinsed, is to be soaked in this mixture, heated to the temperature of 100°, for two hours. It is then taken out, moderately pressed over a vessel, to prevent the waste of the aluminous liquor. It is then dried in a stove heat, and after being again soaked in the aluminous solution, it is wrung out and dried a second time. Without being rinsed, it is to be barely wetted with lime water, and afterwards dried, and if a full, bright, and durable yellow is wanted, it may be necessary to soak the stuff in the diluted aluminous mordant, and after drying, to wet it a second time with lime water. After it has been soaked for the last time, it should be well rinsed in clean water, to separate the loose particles of the mordant, which might injure the application of the colouring matter. By the use of the lime-water, a greater proportion of alumina combines with the stuff, besides the addition of a certain proportion of lime.

Dyein bath.

277. In the preparation of the dyeing bath, from 12 to 18 lbs. of powdered quercitron bark are inclosed in a bag for every 100 lbs. of the stuff, varying the proportion according to the intensity of the shade desired. The bark is put into the water while it is cold; and immediately after, the stuff is immersed and agitated or turned for an hour, or an hour and a half, during which the water should be gradually heated, and the temperature raised to about 120°. At the end of this time the heat is increased, and the dyeing liquor brought to a boiling temperature; but at this temperature the stuff must remain in it only for a few minutes, because otherwise the yellow assumes a brownish shade. The stuff having thus acquired a sufficient colour, is taken out, rinsed and dried.

Advan of a dil mordan

278. Dr Bancroft observes, that when the aluminous mordant is employed, without the addition of water, one soaking only, and an immersion in lime water, may be sufficient; but he thinks that greater advantage is derived from the application of a more diluted mordant at two different times, or even by the immersion of the stuff a greater number of times, alternately in the diluted aluminous mordant, and lime water, and drying it after each immersion. By this treatment he found, that the colour always acquired more body and durability.

Nanke yellow.

279. Chaptal has proposed a process, for communicating to cotton a nankeen yellow, which at the same time that it affords a durable colour, has the advantage of being cheap and simple. When cotton is immersed in a solution of any salt of iron, it has so strong an affinity for the oxide, that it decomposes the salt, combines with the iron, and assumes a yellow colour. The process recommended by Chaptal is the following. The cotton to be dyed is put into a cold solution of copperas (sulphate of iron) of the specific gravity 1.02. It is afterwards wrung out, and immediately immersed in a ley of potash of the specific gravity 1.01. This ley must have been previously saturated with a solution of alum. When the stuff has been kept for four or five hours in this bath, it may be taken out, washed and dried. By varying the proportion of sulphate of iron, every variety of shade of nankeen yellow may be obtained.

By ano process.

280. We shall lay before our readers another process for dyeing nankeen colour, which is proposed and followed by Mr Brewer, a practical dyer. It is as follows.

"Mix as much sheep's dung in clear water as will make it appear of the colour of grass; and dissolve in clear water one pound of best white soap for every ten pounds of cotton yarn, or in that proportion for a greater or lesser quantity.

"Observe:—The tubs, boards, and poles, that are used in the following preparations must be made of deal; the boiling pan of either iron or copper.

First Operation.—"Pour the soap liquor prepared as above into the boiling pan; strain the dung liquor through a sieve; add as much thereof to the soap liquor in the pan as will be sufficient to boil the yarn, intended to be dyed, for five hours. When the liquors are

---

* *Phil. Mag.* v. 100.

† *Berthollet*, ii. 267.

are well mixed in the pan, enter the yarn, light the fire under the pan, and bring the liquor to boil in about two hours, observing to increase the heat regularly during that period. Continue it boiling for three hours; then take the yarn out of the pan, wash it, wring it, and hang it in a shed on poles to dry. When dry, take it into a stove or other room where there is a fire; let it hang there until it be thoroughly dry.

N. B. "The cotton yarn, when in the shed, should not be exposed either to the rain or sun: if it is, it will be unequally coloured when dyed.

Second Operation.—" In this operation use only one half of the soap that was used in the last, and as much dung liquor (strained as before directed) as will be sufficient to cover the cotton yarn, when in the pan, about two inches. When these liquors are well mixed in the pan, enter the yarn, light the fire, and bring the liquor to boil in about one hour; then take the yarn out, wring it out without washing, and hang it to dry as in the former operation.

Third Operation.—" This operation the same as the second in every respect.

Fourth Operation.—" For every ten pounds of yarn make a clear ley from half a pound of pot or pearl-ashes. Pour the ley into the boiling-pan, and add as much clear water as will be sufficient to boil the yarn for two hours; then enter the yarn, light the fire, and bring it to boil in about an hour. Continue it boiling about an hour, then take the yarn out, wash it very well in clear water, wring it, and hang it to dry as in former operations.

N. B. " This operation is to cleanse the yarn from any oleaginous matter that may remain in it after boiling in the soap and dung liquors.

Fifth Operation.—" To every gallon of iron liquor (K) add half a pound of ruddle or red chalk (the last the best) well pulverized.

" Mix them well together, and let the liquor stand four hours, in order that the heavy particles may subside; then pour the clear liquor into the boiling-pan, and bring it to such a degree of heat as a person can well bear his hand in it; divide the yarn into small parcels, about five hanks in each; soak each parcel or handful very well in the above liquor, wring it, and lay it down on a clean deal board. When all the yarn is handed through the liquor, the last handful must be taken up and soaked in the liquor a second time, and every other handful in succession till the whole is gone through; then lay the yarn down in a tub, wherein there must be put a sufficient quantity of ley made from pot or pearl-ashes, as will cover it about six inches. Let it lie in this state about two hours, then hand it over in the ley, wring it, and lay it down on a clean board. If it does not appear sufficiently deep in colour, this operation must be repeated till it has acquired a sufficient degree of darkness of colour: this done, it must be hung to dry as in former operations.

N. B. " Any degree of red or yellow hue may be given to the yarn by increasing or diminishing the quantity of ruddle or red chalk.

Sixth Operation.—" For every ten pounds of yarn make a ley from half a pound of pot or pearl-ashes; pour the clear ley into the boiling pan: add a sufficient quantity of water thereto that will cover the yarn about four inches; light the fire, and enter the yarn when the liquor is a little warm; observe to keep it constantly under the liquor for two hours; increase the heat regularly till it come to a scald; then take the yarn out, wash it, and hang it to dry as in former operations.

Seventh Operation.—" Make a sour liquor of oil of vitriol and water: the degree of acidity may be a little less than the juice of lemons; lay the yarn in it for about an hour, then take it out, wash it very well and wring it; give it a second washing and wringing, and lay it upon a board.

N. B. " This operation is to dissolve the metallic particles, and remove the ferruginous matter that remains on the surface of the thread after the fifth operation.

Eighth Operation.—" For every ten pounds of yarn dissolve one pound of best white soap in clear water, and add as much water to this liquor in your boiling-pan as will be sufficient to boil the yarn for two hours. When these liquors are well mixed, light the fire, enter the yarn, and bring the liquor to boil in about an hour. Continue it boiling slowly an hour; take it out, wash it in clear water very well, and hang it to dry as in former operations: when dry, it is ready for the weaver.

N. B. " It appears to me, from experiments that I have made, that less than four operations in the preparation of the yarn will not be sufficient to cleanse the pores of the fibres of the cotton, and render the colour permanent *."

Process followed in the east.

281. A method of dyeing cotton and linen a durable yellow colour is practised in the east. The object of this process, which is tedious, is to increase the affinity between the alumina and the stuff, so that it may adhere with sufficient force to produce a permanent colour. For this purpose three mordants are employed: these are oil, tan, and alum. The cotton is soaked in a bath of oil, mixed with a weak solution of soda. Animal oil, as it is found to answer best, is preferred. Glue has also been tried, and is found to answer very well. The soda must be in the caustic state, for in that state it combines with the oil, and produces on the cloth an equal absorption. The stuff is then to be washed, and afterwards put into an infusion of nut-galls of the white kind, and the infusion should be used hot. The tan combines with the oil, while the gallic acid carries off any portion of alkali which may adhere to the cloth. When the stuff is removed from the bath, it should be quickly dried; and too great an excess of galls beyond a proper proportion with the oil should be avoided, as it is apt to darken the shade of colour. After this preparation the stuff is to be immersed in a solution of alum; and in consequence of the affinity which exists between tan and alumina, the alum is decomposed, and its earth combines with the tan. After these preliminary steps, the cotton is to be dyed with quercitron bark, according to the process which has been already described.

SECT.

(K) Iron liquor is what the linen-printers use.

* Edin. Mag. xxii.

SECT. III. *Of Blue.*

282. The next of the simple colours is blue. We shall first treat of the substances which are employed in dyeing blue, and then describe the processes which are followed in fixing this colour.

I. *Of the Substances which are employed in Dyeing Blue.*

The only substances which are used in dyeing blue, are indigo and woad.

Indigo.

283. Indigo was not used for the purpose of dyeing in Europe till near the middle of the 16th century. A substance is mentioned by Pliny *, which was brought from India, and termed *indicum*, which seems to have been the same as the indigo of the moderns; but it does not appear that either the Greeks or the Romans knew how to dissolve indigo, or its use in dyeing, although it was applied as a paint. It was, however, long before known as a dye in India. The first indigo which was employed for the purpose of dyeing by Europeans, was brought by the Dutch from India. One of the species of the plant from which it is obtained, was discovered by the Portuguese in Brazil, where it grows spontaneously, as well as in other parts of America. Being afterwards successfully cultivated in Mexico, and some islands of the West Indies, the whole of the indigo employed in Europe was supplied from these countries. The indigo from the East Indies has, however, of late recovered its character, and is imported into Britain in considerable quantities.

introduced into Europe.

Three species.

284. There are three species of the indigo plant, which are usually cultivated in America. The first is the *indigofera tinctoria*, Linn. which besides being a smaller and less hardy plant, is inferior to the others on account of its pulp; but as it yields a greater proportion, it is generally preferred. The second is the *indigofera disperma*, Linn. or *Guatimala indigo plant*. This is a taller and hardier plant, and affords a pulp of a superior quality to the former. The third is the *indigofera argentea*, Linn. which is the hardiest of the three species; yields a pulp of the finest quality, though in smallest proportion.

Method of preparing indigo.

285. When the indigo plant has arrived at maturity, it is cut a few inches above the ground, disposed in strata in a large vessel or steeper, and being kept down with boards, is covered with water; and in this state it is left to ferment till the pulp is extracted. The process commences by the evolution of heat, and the emission of a great quantity of carbonic acid gas. When the fermentation has continued for a sufficient length of time, which is known by the tops becoming tender and pale, the liquor, which is now of a green colour, is drawn off into large flat vessels, called *beaters*, where it is agitated with buckets, or other convenient apparatus, till blue flocculæ begin to appear. To promote the granulation or separation of the flocculæ, it is usual to add clear lime water till the liquor in which they are suspended become quite colourless. The liquor being sufficiently impregnated with the lime water, is left at rest, to allow the particles of the colouring matter to precipitate; after which the supernatant liquor is drawn off, and the sediment collected into linen bags, which are suspended for some time to let the water drain off. It is then put into square boxes, or formed into lumps and dried in the shade. The indigo thus prepared is in a state fit for the market.

Varies in its qualities.

286. The indigo which is produced in this operation differs greatly, not only according to the quality of the plant from which it is obtained, but according to the mode of preparation. But the difference of quantity seems to depend entirely on the heterogeneous substances with which it is mixed, and on the degree of consistence which it has acquired in drying. The lightest kind, which is brought from Guatimala, is called *light indigo*; it is of a fine blue colour, and is the most valuable, because it is of the finest quality. Indigo exhibits various shades of colour, which is also owing to the mixture of foreign substances. The most common shades are blue, violet, and copper colour.

Is obtained from other plants.

287. Other plants have also been discovered, which by a process somewhat similar, afford indigo, and in particular the *nerium tinctorium*, or rose bay, an account of which, with the method of manufacturing indigo from its leaves, has been given by Dr Roxburgh. This tree grows in great abundance in different parts of the East Indies; and plantations of it, raised from seeds, have succeeded well in Bengal. The leaves of the nerium afford indigo, not only when they are fresh gathered, but also when they are nearly dried; but they yield the best indigo after being kept a day or two. The leaves collected the preceding day are put into a copper, so as nearly to fill it without pressing. The copper is filled with water till within three inches of the top; and hard spring water, which increases the quantity of indigo, and improves its quality, is preferred. The fire is then applied, and kept up, till the liquid becomes of a green colour in the vessel. The leaves then become of a yellowish colonr, and the heat of the liquor about 150°, or 160°. The leaves should be constantly agitated, that they may be equally heated, as well as to promote the operation, by the expulsion of the carbonic acid gas. When the process exhibits the above appearances, the liquor is to be drawn off, passed through a hair-cloth, and agitated while hot in the usual way, till granulation takes place, or the appearance of blue flakes is observed. About $\frac{1}{15}$th part of strong lime water is then added, to promote the precipitation of the indigo, and the remaining part of the process is similar to that described above, for the manufacture of indigo from *indigofera* †.

Nature of the substances extracted.

288. The object of the processes which are followed in the manufacture of indigo, is to extract from the plants which yield it, a green substance, which is soluble in water. This substance, which has a strong affinity for oxygen, gradually attracts it from the air, becomes of a blue colour, and is then insoluble in water. This absorption is greatly promoted by agitation, for then a greater surface is exposed to the action of the air; and the lime water, by combining with carbonic acid, which exists in the green matter, also promotes the separation of the indigo.

Properties of indigo.

289. Indigo is insoluble in water, alcohol, ether, and oils, and the only acids which produce any effect upon it, are the sulphuric and nitric. By the latter it is soon changed to a dirty white colour, and is at last entirely decomposed. When the acid is concentrated, the indigo is inflamed; but when it is diluted, the indigo becomes brown, and crystals like those of oxalic and

---

* *Lib.* xxxv.

† *Bancroft* 427.

and tartarous acids make their appearance: and when the acids and crystals are washed off, there remains behind a kind of resinous matter. Sulphuric acid in the concentrated state dissolves indigo, with the evolution of a great deal of heat. The solution is opaque and black, but when diluted with water, it changes to a deep blue colour. Dr Bancroft has denominated this solution *sulphate of indigo*, which has been long known by the name of *liquid blue*. The fixed alkalies in the state of carbonate precipitate slowly from sulphate of indigo, a blue coloured powder, which has the properties of indigo, but is found to be soluble in most of the acids and alkalies. Pure alkalies destroy the colour of sulphate of indigo, as well as that which is precipitated.

s employ- ed dye- in two tes.

290. Indigo is employed in dyeing, both in the state of liquid blue, or sulphate of indigo, from which is obtained the beautiful colour called *Saxon blue*; and also in the state of simple indigo, or the indigo of commerce. In dyeing with indigo, it must be reduced to the state of the green matter as it exists in the plants, or when it is first extracted from them. It must be deprived of the oxygen, to the combination of which the blue colour is owing. In this state it becomes soluble in water by means of the alkalies. To effect this separation of the oxygen, the indigo must be mixed with a solution of some substance which has a stronger affinity for oxygen than the green matter of indigo. Such substances are green oxide of iron and metallic sulphurets. Lime, green sulphate of iron, and indigo, are mixed together in water, and during this mixture the indigo is deprived of its blue colour, becomes green, and is dissolved, while the green oxide of iron, is converted into the red oxide. In this process, part of the lime decomposes the sulphate of iron, and as the green oxide is set at liberty, it attracts oxygen from the indigo, and reduces it to the state of green matter, which is immediately dissolved by the action of the rest of the lime. Indigo is also deprived of its oxygen, and prepared for dyeing, by another process. Some vegetable matter is added to the indigo mixed with water, with the view of exciting fermentation; and quicklime or an alkali is added to the solution, that the indigo, as it is converted into the green matter, may be dissolved.

Wo

291. Another plant, known under the name of *pastel* or *woad* (*isatis tinctoria*), is employed for dyeing blue. Another species (*isatis lusitanica*), which is a smaller plant, is also employed in dyeing. The *isatis tinctoria* is cultivated in France and in England. When the plant has reached maturity, it is cut down, washed in a river, and speedily dried in the sun. It is then ground in a mill, and reduced into a paste, which is formed into heaps, covered up to protect them from the rain, and at the end of a fortnight, the heap is opened to mix the whole well together. It is afterwards formed into round balls, which are exposed to the wind and sun, that the moisture may be separated, The balls are heaped upon one another, become gradually hot, and exhale the smell of ammonia. To promote the fermentation, which is stronger in proportion to the quantity heaped up, and the temperature of the season, the heap is to be sprinkled with water till it falls down in the state of coarse powder, in which state it appears in commerce. The blue colour obtained from woad is very permanent, but has little lustre. But its colour is not only inferior in beauty to that obtained from indigo; it affords also a smaller proportion of colouring matter, so that since the discovery of indigo, the use of woad has diminished.

II. *Of the Processes for Dyeing Wool Blue.*

Preparation of the vat.

292. The preparation for dyeing blue is made in a large wooden vessel or vat, which should be so constructed as to retain the heat, which is a matter of considerable importance in the process. The vat is therefore set up in a separate place from the coppers, and is sunk so far in the ground as to be only breast high above it. Before the introduction of indigo, blue was dyed with woad, which furnished a permanent, but not a deep colour; but a very rich blue is obtained by mixing indigo with the woad, and these are almost the only substances which are now employed for dyeing woollen stuffs. The proportions of these substances are varied by different dyers, and according to the shade which is required. The following is the account of the preparation of a vat, as it is given by Quatremere. Into a vat of about seven and a half feet deep, and five and a half in diameter, are thrown two balls of pastel or woad, which are previously broken, and together amount to about 400 pounds weight; 30 pounds of weld are boiled in a copper for three hours, in a sufficient quantity of water, to fill the vat. To this decoction are added 20 pounds of madder and a basket full of bran. The boiling is then continued half an hour longer. This bath is cooled with 20 buckets of water, and after it is settled, and the weld taken out, it is poured into the vat, which must be stirred with a rake all the time that it is running in, and for 15 minutes longer. The vat is then covered up very hot, and allowed to stand for six hours, when it is uncovered, and raked again for 30 minutes. The same operation must be repeated every three hours. When the appearance of blue streaks is perceived on the surface of the vat, eight or nine pounds of quicklime are added; the colour then becomes of a deeper blue, and the vat exhales more pungent vapours. Immediately after the lime, or along with it, the indigo, which has been previously ground in a mill, with the smallest possible quantity of water, is put into the vat. The quantity is to be regulated by the intensity of the shade required. From ten to thirty pounds may be put into a vat such as we have now described. If on striking the vat with a rake, a fine blue scum arises, no other previous preparation is required than to stir it with the rake twice in the space of six hours, to mix the ingredients completely. Great care should be taken not to expose the vat to the air, except during the time of stirring it. When that operation is finished, it is covered with a wooden lid, on which are spread thick cloths, to retain the heat as much as possible; but after all these precautions, at the end of eight or ten days it is greatly diminished, and is at last entirely dissipated, so that the liquor must be again heated, by pouring the greater part of the liquor of the vat into a copper under which a large fire is made. When the liquor has acquired a sufficient temperature, it is returned into the vat, and carefully covered up.

Accidents to which the vat is liable.

293. Vats of this description are sometimes liable to accidents. A vat is said to be repelled, when having previously afforded fine shades of blue, it appears black,

black, without any blue streaks; and if it be stirred, the black colour becomes deeper; the vat at the same time exhales, instead of a sweetish smell, a pungent odour; and the stuff dyed in a vat in this state, comes out of a dirty gray colour. These effects are ascribed to an excess of lime.

Means of obviating them,

294. Different means are employed to recover a repelled vat. Some are satisfied with merely reheating it; while others add tartar, bran, urine, or madder. Hellot recommends bran and madder as the best remedy. If the excess of lime be not very great, it is sufficient to leave it at rest five or six hours, putting in a quantity of bran and three or four pounds of madder, which are to be sprinkled on the surface, and then it is to be covered up, and after a certain interval, to be tried again. But if the vat has been so far repelled as to afford a blue only when it is cold, it must be left at rest to recover, and sometimes must remain whole days without being stirred with the rake. When it begins to afford a tolerable pattern, the bath must be reheated. In general, this revives the fermentation. The addition of bran or madder, or a basket or two of fresh woad, produces the same effect.

and remedying putrefaction.

295. This vat sometimes runs into the putrefactive process. When this happens, the colour of the vat becomes reddish, the paste rises from the bottom, and a fetid smell is exhaled. This accident is owing to a deficiency of lime, and it must be corrected by adding a fresh quantity. The vat is then to be raked; after two hours more lime is added, and the process of raking again performed. These operations are to be repeated till the vat is recovered.

Precautions in the use of lime.

296. Nothing requires more attention in treating a vat of this kind, than the distribution of the lime, the principal use of which is to moderate the tendency to putrefaction, and to limit the fermentation to that degree which is necessary to deprive the indigo of its oxygen. If too much lime be added, the necessary fermentation is retarded, and if there be too little, the putrefactive process commences.

Dyeing process.

297. Two hours previous to the dyeing operation, the vat should be raked; and to prevent the stuff coming in contact with the sediment, which would produce inequalities in the colour, a cross of wood is introduced. The stuff is then to be completely wetted with pure water a little heated; and being wrung out, it is dipped into the vat, where it is moved about for a longer or a shorter time, according to the depth of shade required. During this operation it is taken out occasionally, to be exposed to the air, the action of which is necessary to change the green colour of the bath into a blue. Stuffs dyed blue in this manner must be carefully washed, to carry off the loose particles of colouring matter; and when the shade of blue is deep, they ought even to be cleansed, by fulling with soap. This operation does not alter the colour.

Indigo vat.

298. When a vat is prepared entirely of indigo, without pastel or woad, it is called an *indigo vat.* The vessel employed for this purpose is of copper, into which water is poured according to its capacity, to the amount of 40 buckets, in which have been boiled six pounds of potash, twelve ounces of madder, and six pounds of bran. Six pounds of indigo ground in water are then put in, and after it has been carefully raked, the vat is to be covered. A slow fire is to be kept up, and twelve hours after it is filled, it is to be raked a second time. This operation is to be repeated every twelve hours, till it come to a blue colour, which will generally be the case in about 48 hours. If the bath is properly managed, it will be of a fine green, exhibiting on the surface coppery scales, and a blue scum or flower. In this vat the indigo is rendered soluble in water, by means of the alkali instead of lime. The dyeing operation is to be conducted in the same manner as the preceding.

Hellot's vats.

299. Two vats have been described by Hellot, in which the indigo is dissolved by means of urine. Madder is added to it, and in the one vinegar, in the other alum and tartar, of each a quantity equal in weight to that of the indigo. The proportion of urine must be considerable. In considering the theory of this process, it seems probable that the indigo, deprived of its oxygen by the urine and madder during the fermentation, is dissolved by the ammonia which is formed in the urine. When the solution of alum and tartar is added, an effervescence, which Hellot observed, is produced. This, it is probable, has a tendency to retard or stop the putrefaction. But in vats of this description, operations on a large scale cannot be carried on; they seem only adapted for small dye-houses.

III. *Of the Processes for Dyeing Silk Blue.*

With indigo.

300. Silk is dyed blue with indigo alone, without any proportion of woad. The proportion of indigo mentioned in the preparation of the indigo vat, and sometimes a larger proportion, is employed, with six pounds of bran, and about twelve ounces of madder. According to Macquer, half a pound of madder for each pound of potash, renders the vat greener, and produces a more fixed colour in the silk. When the vat is come to, it should be refreshed with two pounds of potash, and three or four ounces of madder; and after being raked, in the course of four hours it is fit for dyeing. The temperature should be so moderated, that the hand may be held in it without uneasiness.

Preparation of th silk.

301. The silk, after being boiled with soap, in the proportion of 30 pounds of soap to 100 of silk, and well cleaned by repeated beetlings in a stream of water, must be dyed in small portions, because it is apt to take on an uneven colour. When it has been turned once or oftener in the bath, it is wrung out, and exposed to the air, that the green colour may change to a blue. When the change is complete, it is thrown into clear water, and afterwards wrung out. Silk dyed blue should be speedily dried. In damp weather and in winter, it is necessary to conduct the drying in a chamber heated by a stove. The silk should be hung on a frame kept constantly in motion. To dye light shades, some dyers employ vats that are somewhat exhausted: but it ought to be observed, that the colour thus obtained is less beautiful and less permanent than when fresh vats, containing a smaller quantity of indigo, are employed.

For Turke blue.

302. Some addition is required to be made to the indigo, to give silk a deep blue. A previous preparation is necessary, by giving it another colour or ground. For the Turkey blue, which is the deepest, a strong bath of archil is first prepared. Cochineal is also sometimes used, instead of archil, for the ground, to render the colour more permanent. A blue is given to silk

O mple C urs.

silk by means of verdigrise and logwood, but possesses little durability. It might be rendered more permanent, by giving it a lighter shade in this bath, then dipping it in a bath of archil, and finally in the indigo vat.

D g ra ilk.

303. When raw silk is to be dyed blue, such as is naturally white should be selected. Being previously soaked in water, it is put into the bath in separate hanks, as already directed for scoured silks; and as raw silk is found to combine more readily with the colouring matter, the scoured silk, when it can be conveniently done, should be first put into the bath. If archil, or any of the other ingredients which have been already mentioned, are required to give more intensity to the colour, the mode of application is the same as that directed for scoured silk.

IV. *Of the Processes for Dyeing Cotton and Linen Blue.*

re ation t vat.

304. For dyeing cotton and linen blue, Pileur d'Apligny recommends a vat containing about 120 gallons. From six to eight pounds of indigo, reduced to powder, are boiled in a ley drawn off from a quantity of lime, equal in weight to the indigo, and a quantity of potash double its weight. During the boiling, which is to be continued till the indigo is completely penetrated with the ley, the solution must be constantly stirred, to prevent the indigo from being injured, by adhering to the bottom of the vessel.

305. During this process, another quantity of quicklime, equal in weight to the indigo, is to be slaked. Twenty quarts of warm water are added, in which is to be dissolved a quantity of copperas (sulphate of iron) equal to twice the weight of the lime. The solution being completed, it is poured into the vat, which is previously half filled with water. To this the solution of indigo is added, with that part of the ley which was not employed in the boiling. The vat must now be filled up to within two or three inches of the top. It must be raked twice or thrice a day till it is completely prepared, which is generally the case in 48 hours, and sometimes sooner, as it depends on the temperature of the atmosphere. A small proportion of bran, madder, and woad, is recommended by some, to be added to such a vat as we have now described.

imer ce

306. The process which is followed at Rouen, and described by Quatremere, is simpler. The vats, which are constructed of a kind of flint, are coated within and without with fine cement, and are arranged in one or more parallel lines. Each vat contains four hogsheads of water. The indigo, to the amount of 18 or 20 pounds, being macerated for a week in a caustic ley, strong enough to bear an egg, is ground in a mill; three hogsheads and a half of water are put into the vat, and afterwards 20 pounds of lime. The lime being thoroughly slaked, the vat is raked, and 36 pounds of copperas are added; and when the solution is complete, the ground indigo is poured in through a sieve. It is raked seven or eight times the same day, and after being left at rest for 36 hours, it is in a state fit for dyeing.

ces n rge t.

307. In extensive manufactories, it is necessary to have vats set at different times. In conducting the process of dyeing, the stuffs are first dipped in the most exhausted vat, and then regularly proceeding from the weakest to the strongest, if they have not previously attained the desired shade. The stuffs should remain in the bath only about five or six minutes, for in that time they combine with all the colouring matter they can take up. After the stuffs have been dipped in a vat, it should not be used again, till it has been raked, and stood at least 24 hours, unless it has been lately set, when a shorter period is sufficient.

Of Simple Colours.

308. After the stuffs have been dipped three or four times in a vat, it begins to change. It becomes black, and no blue or copper-coloured streaks are seen on the surface after raking it. It must then be renewed, by adding four libs. of copperas, with two of quicklime, after which it must be raked twice. In this way a vat may be renewed three or four times; but the additional quantity of ingredients must be diminished, as the strength of the vat is exhausted *.

Process of Bergman.

309. A vat which is still more simple and more easily prepared, has been recommended by Bergman. The proportion of the ingredients which he has directed to be employed, is the following. To three drachms of indigo reduced to powder, three drachms of copperas, and three of lime, add two pints of water. Let it be well raked, and in the course of a few hours it will be in a proper state for dyeing.

Haussmann's

310. Haussmann employs a still smaller proportion of indigo. For 3000 libs. of water, he takes 36 lbs. of quicklime slaked in 200 libs. of water, with which the indigo in the proportion of from 10 to 20 libs. well ground, is to be mixed. He then dissolves 30 libs. of copperas in 120 libs. of hot water. The whole being left at rest for fifteen minutes, the vat is filled, and gently and constantly stirred. When a deeper shade is wanted, and particularly when linen is to be dyed, the proportion of indigo should be greater; but the shade depends very much on the time the stuffs remain in the vat, and the times it has been used. When the vat becomes turbid, the process of dyeing must be interrupted, till it has been again raked, and the supernatant liquor become transparent. If the effects of the lime fail, a new quantity, fresh slaked, must be added; and if the iron cease to produce the effect on the indigo, a new portion must be also added, observing the precaution to have a greater quantity of lime than what is necessary to saturate the sulphuric acid. When the indigo seems to be exhausted, fresh portions ground in water are also to be added; the vat is to be raked several times, and allowed to settle, after which it is again fit for use. In this way Mr Haussmann informs us he preserved a vat for the space of two years; and had it not been for the accumulation of sediment, which prevented the stuffs from being immersed to a sufficient depth, it might have been continued in use for a much longer time. It is worth while to add, that Mr Haussmann found, that a pattern of cloth dipped in water acidulated with sulphuric acid, immediately after it was taken out of the bath, became of a much deeper blue than a similar pattern exposed to the air, or another dipped in river water.

311. Another convenient and expeditious vat is mentioned by Bergman, and described by Scheffer. Indigo reduced to fine powder, in the proportion of three drachms to a quart, is added to the strong ley of the soap boiler. After a few minutes, when the colouring matter is well penetrated by the ley, six drachms of powdered orpiment are to be added. In a few minutes after the bath has been well raked, it becomes green,

---

* *Berthollet*, ii. 90.

Of Simple Colours.

and the blue streaks appear on the surface. Heat is to be applied; when the operation of dyeing may commence.

312. The preparation employed for printing cottons is similar to the above bath, excepting in the proportions of orpiment and indigo, which are greater in the former; but these proportions are very different in different manufactories.

Discovery of Saxon blue.

313. *Saxon Blue.*—The colour which is obtained by dyeing with a solution of indigo in sulphuric acid is known under the name of *Saxon blue*, because the process was first carried on at Grossenhayn in Saxony, by Counsellor Barth, who made the discovery about the year 1740. This discovery was for some time kept secret, and the method seems to have been originally very complicated. Alumina, antimony, and some other substances, were previously added to the sulphuric acid. These, however, are now omitted, and the indigo alone is dissolved in the acid.

Preparation of the dye.

314. From a great number of experiments which were made on this process by Bergman, he concluded, that in those cases where the sulphate of indigo afforded only a fading colour, the acid employed had been too weak. Quatremere observes that, among several processes for dyeing with sulphate of indigo, he discovered only two, in which the stuffs were completely penetrated with colouring matter. To effect this, he employed an alkali, in the proportion of one ounce to an ounce of indigo, and six ounces of sulphuric acid. With these proportions of the ingredients he obtained a deep vivid blue, equally intense through every part of the stuff. Poerner, who has paid great attention to this preparation, also employs an alkali, by means of which a more pleasing colour, which penetrates deeper, is produced. The proportions which he recommends are four parts of sulphuric acid to one of indigo. The indigo is first reduced to a fine powder, and the sulphuric acid, in the concentrated state, is poured upon it. The mixture is stirred for some time, and having stood twenty-four hours, one part of dry potash in fine powder, is added; and after the whole is again stirred, it remains for twenty-four hours longer. It is then to be diluted with eight times its weight of water, which must be gradually added, or a greater or less proportion as may be wanted.

By Bancroft.

Dr Bancroft seems to be of opinion, that a more durable blue may be obtained by diluting the acid with an equal quantity of water, when the indigo is put in, and allowing the mixture to remain forty-eight hours; for he thinks by this slower and more moderate action, the basis of the indigo is less injured. Instead of the potash employed by Poerner, Dr Bancroft uses chalk; and even in such a quantity as to saturate the acid. In this case the indigo is precipitated along with the chalk; and, when collected into a solid mass, communicates a blue colour to wool, but more slowly than by the common method, in which the combination is very rapid and the dyeing unequal. This inconvenience he thinks might be obviated by the use of chalk *.

For woollen stuffs.

315. To produce a Saxon blue colour on woollen stuffs, they are prepared with alum and tartar. And in proportion to the shade required, the quantity of solution of indigo put into the bath must be regulated. When a deep shade of Saxon blue is wanted, the stuff must be passed different times through vessels containing such a quantity of colouring matter as is sufficient to give light colours. In this way, by repeated applications, the colours become more uniform.

For sil

316. The sulphate of indigo is also employed to dye silk. For this purpose, attempts have been made to unite the advantages of the indigo vat and its solution in sulphuric acid. A process of this kind is greatly recommended by Guhliche, which produces beautiful colours, and is at the same time cheap and convenient. The bath is composed of one pound of indigo, three pounds of quicklime, three of copperas, and one and a half of orpiment. The indigo is first to be carefully ground and mixed with water, put into a wooden vat, and diluted with water, according to the shade of colour wanted. The lime is then to be added, and the mixture being well stirred, it is covered up, and allowed to remain at rest for some hours. After this the copperas in the state of powder is added, the whole well stirred, and the vat covered up. And lastly, at the end of some hours, the orpiment reduced to powder is thrown in, and the whole left at rest for several hours. The mixture is afterwards to be stirred, and then left to settle, till the liquor becomes clear; when the blue streaks or flower which covers it is removed, and the silk previously dipped in warm water, is to be dyed hank by hank. When it is removed from the bath, it is to be washed in a stream of water, and dried.

317. This process is recommended as the means of obviating a greenish cast, which is sometimes observed in Saxon blue, and which is supposed to be owing to some change in the particles of indigo, by means of the sulphuric acid.

Engli blue.

318. The colour denominated *English blue* is produced by means of the sulphate of indigo. To give silk this colour, it is first to be dyed a light blue; and, when taken out of this bath, it is dipped in hot water, washed in a stream, and left in a bath composed of the sulphate of indigo, to which a little of the solution of tin has been added, until the proper shade is obtained, or the bath is exhausted. Previous to its being put into this bath, it may be dipped in a solution of alum, in which it should only remain a very short time. Silk, which has been dyed according to this process, is free from the reddish shade which it derives from the blue vat, as well as from the greenish cast of the Saxon blue †.

319. The sulphate of indigo has been hitherto only applied for the purpose of dyeing wool and silk. The affinity of indigo for vegetable substances is not sufficiently strong to effect the decomposition of the sulphate. It cannot, therefore, be employed with advantage in dyeing cotton and linen.

Dyein with sian b

320. Attempts have been made to dye with Prussian blue. The process which was followed by Macquer is the following. He soaked wool, silk, cotton, and thread, in a solution of alum and sulphate of iron, and afterwards in an alkaline solution, which was partly saturated with prussic acid. He then immersed the stuffs in water, acidulated with sulphuric acid, for the purpose of dissolving that part of the oxide of iron which remained uncombined with the prussic acid, and which the uncombined alkali had precipitated. By successive repetitions of these immersions he obtained a fine blue, but very unequal. Berthollet justly remarks on this experiment,

---

* Phil. of Perm. Col. 132.

† Ber let, ii.

imple
ours.

experiment, that an alkali saturated with prussic acid should be employed, or lime water or magnesia, both of which have the property of combining with that acid. In a second experiment Macquer boiled the stuffs in a solution of tartar and alum, and then passed them through a bath which contained prussian blue merely diffused in it. The colour was faint, and could not be made deeper; but it was equal, and soft to the touch.

per
ess.

321. In the process proposed by Abbé Menon for thread and cotton, they are first dyed black, and soaked for a few minutes in prussiate of alkali, and afterwards boiled in a solution of alum. In this way they acquired a deep blue. When a lighter blue is wanted, the stuffs must be passed through a weak acid.

De Pla-
iere's.

322. Similar to the second experiment of Macquer is the process of Roland de la Platiere. He takes prussian blue in the proportion of a pound to a piece of stuff, powdered, and passed through a very fine sieve, and adds muriatic acid till it is reduced to the consistence of syrup. It is to be constantly stirred for about half an hour while it ferments. It is then well diluted, and stirred every hour for a day, till the fermentation ceases. The particles are thus in a state of minute division. Seven or eight buckets of water for one piece of velvet, are put into a trough; then add the mixture, which has been previously well diluted in a separate vessel, and poured into the bath through a very fine sieve. When the piece is placed on the winch, over the trough, let the bath be briskly stirred, and the piece speedily let down; and the same operation must be continued as quickly as possible for several hours. This colour requires great management, for as the particles of the prussian blue are only in a state of minute division, and heavy, they are quickly deposited on the stuff. Hence the colour appears very unequal and in patches, even with the utmost care; and nothing can be done to avoid it, but repeating the operations again and again. The stuff should be put into the baths thoroughly wet, for when it is dry, it penetrates with difficulty, and is always unequal. Between the dryings the stuff is always to be washed and beetled, excepting the last time, when it is not washed, but dried in the open air, either in the sun or in the shade; observing, however, that it be well stretched. This beautiful colour is not changed by the air; it resists the action of acids, and is little altered by boiling with alum; but it is soon tarnished by friction, or particles of dust that adhere to it. It is scarcely necessary to add, that it is instantly decomposed by alkaline liquors. Guhliche employs a solution of tin in nitro-muriatic acid, as a substitute for muriatic acid, in the process of dyeing with prussian blue *.

Bethol-
t, ii. o.
andt's.

323. Dr Bancroft made a number of experiments in dyeing both vegetable and mineral matters, with prussian blue, and particularly with the view of obviating the difficulties which had occurred to others in the use of it. He boiled up copperas with quercitron bark, fustic, and logwood, separately, in what he thought the best proportions; and in each of these mixtures he dyed a piece of woollen cloth by boiling it for 10 or 15 minutes. The stuffs were afterwards separately immersed in warm diluted prussiate of potash neutralized by sulphuric acid. They acquired an equal and beautiful blue. This, however, was not the uniform result; for when too much copperas was employed in dyeing with quercitron bark, there was an excess of oxide of iron, which combining with the fibres of the wood, gave the prussian blue a greenish tinge; but this he found could be remedied, by passing the cloth through warm water, slightly acidulated with muriatic acid. The prussian colouring matter, Dr Bancroft observes, must always be applied in a moderate heat, otherwise it will be precipitated by the sulphuric acid, and rendered unfit for this purpose, till it is again dissolved by potash, lime, or some other substance.

Of Simple
Colours.

324. He then tried to fix prussian blue by means of the aluminous mordant; but at the end of 15 minutes, after being immersed in a solution of prussiate of potash, it had acquired no colour. The addition of a small proportion of a solution of iron in muriatic acid, communicated a blue colour. All parts of the cloth, as well as those to which the mordant had been applied, received the colour. The cloth being washed with soap, the whole of the colour was discharged, excepting where it had been impregnated with alumina, and even there it had become fainter. A piece of the same cotton was immersed in a solution of ammonia (volatile alkali); the pale blue was greatly heightened. Another piece was put into water slightly tinctured with a solution of copper in ammonia. The blue colour became suddenly of an intensely deep garter-blue or violet, and it resisted the action of soap. Into water mixed with a little of a solution of muriate of copper, he put another piece of the same cotton, and it soon became of a deeper blue, without any of the purple or violet shade. This resisted the action of soap, and after long exposure to the weather, the colour was little diminished; and when the colour remained in any degree weakened, immersion in water slightly acidulated with sulphuric acid, completely restored it. From these facts it would appear to be advantageous to prepare woollens by the usual boiling with alum, or alum and tartar, before they are dyed with copperas and quercitron bark, fustic or logwood, for a prussian blue; but a greater proportion of sulphuric acid, in the prussiate of potash or lime, that the excess of acid may discharge the vegetable colouring matters, becomes necessary *.

For silk and
cotton.

325. Dr Brancroft afterwards tried pieces of silk and cotton in the diluted prussiates of potash, soda, lime, &c. with solutions of most of the metals in different acids and alkalies; and from the different metallic solutions he obtained a very full, lively colour, which he calls the *red copper colour*, from the different solutions of copper in sulphuric, nitric, muriatic, and acetic acids; the same effect succeeded well from a solution in ammonia. He obtained also the same colour from the nitrates of silver and of cobalt. The prussian colouring matter fixed by these metallic mordants resisted the action of acids, washings with soap, and exposure to the weather for the greatest length of time; but in all these cases there must be a double application. The prussian colouring matter must first be applied to the linen, cotton or silk, which must be afterwards allowed to dry. It must then be immersed in the metallic solution, or the metallic solution must be applied first, and then the solution of prussiate of potash, soda, lime, &c.

SECT. IV. *Of Dyeing Black.*

The next of the simple colours is black, of which we shall treat as in the former sections; first describing the substances which are employed, and then giving an account

---

* *Phil. of Perm. Col.* 217.

account of the processes which are followed in dyeing different stuffs of a black colour.

I. *Of the Substances employed in Dyeing Black.*

Juices of plants.

326. There are few substances which have the property of producing a permanent black colour, without any addition. The juice of some plants produces this effect on cotton and linen. A black colour is obtained from the juice of the *cashew nut*, which will not wash out, and even resists the process of boiling with soap or alkalies. The cashew nut of India is employed for marking linen. That of the West Indies (*anacardium occidentale*, Lin.) also yields a permanent dye, but the colour has a brownish shade. The juice of some other plants, as that of the toxicodendron, or sloes, affords a durable blueish black colour; but these substances cannot be obtained in sufficient quantity, even if they afforded colours equal to those produced by the common processes.

Tan, &c.

327. The principal substances which are employed to give a black colour are gall-nuts which contain the astringent principle, or tan, and the red oxide of iron (L). For a particular account of the nature and properties of tan, see CHEMISTRY *Index*. The black colour is produced by the combination of the astringent principle with the oxide of iron, held in solution by an acid, and fixed on the stuff. When the particles are precipitated from the mixture of tan and a solution of iron, they have only a blue colour; but after they are exposed for some time to the air, and moistened with water, the colour becomes deeper, although the blue shade is still perceptible. After the particles are fixed on the stuff, the shade becomes much deeper.

328. Logwood is not to be considered as affording a black dye, but is much employed to give a lustre to black colours. We have (180.) already described its nature and properties, among the substances from which red colouring matters are obtained.

Mordants necessary for black.

329. Black colours are rarely produced by a simple combination between the colouring matter and the stuff; but are usually fixed by means of mordants, as in the case of the black particles which are the result of a combination of the astringent principle and the oxide of iron, held in solution by an acid. But when the particles are precipitated from the mixture of an astringent and a solution of iron, they have only a blue colour. By being exposed to the air, and moistened with water, the colour becomes deeper, although the blue shade is still perceptible. No fine black colour is ever obtained, unless the stuffs are freely exposed to the air. In dyeing black, therefore, the operations must be conducted at different intervals. Berthollet has observed, that black stuffs, when brought in contact with oxygen gas, diminish its volume, so that some portion of it is absorbed.

II. *Of the Processes for Dyeing Woollen Black.*

Must be first dyed blue.

330. In dyeing woollen stuffs black, if a full and fine deep colour is wanted, it is necessary that they are previously dyed of a deep blue colour. To remove all the particles of colouring matter which happen to be loosely attached to the stuff, it should be washed in a river as soon as it is taken out of the vat, and afterwards cleansed at the fulling mill. After these preliminary processes, the stuffs are ready to receive the black colouring matter. The process of Hellot is the following.

Hellot's process.

For every hundred pounds of stuff, ten pounds of logwood, and ten pounds of galls reduced to powder, are put into a bag, and boiled in a middle-sized copper, with a sufficient quantity of water, for 12 hours. A third of this bath is put into another copper, along with two pounds of verdigrise. The stuff is immersed in this bath, and continually stirred for two hours. The bath should be kept hot, but it ought not to boil. At the end of two hours the stuff is taken out, and a similar portion of the bath is put into the copper, with eight pounds of copperas (sulphate of iron). During the solution of the copperas, the fire is diminished, and the bath is allowed to cool for half an hour, stirring it well the whole time. The remainder of the bath is then to be added, and after making this addition, the bag containing the astringent matters should be strongly pressed, to separate the whole. A quantity of sumach from 15 to 20 pounds, is now to be added, and the bath is just raised to the boiling temperature; and when it has given one boil, it is to be immediately stopped with a little cold water. A fresh quantity of sulphate of iron, to the amount of two pounds, is then added, and the stuff is kept in it for another hour, after which it is taken out, washed and aired; it is again put into the copper, and constantly stirred for an hour. It is then carried to the river, well washed, and fulled. To soften the black colour, and make it more firm, another bath is prepared with weld. This is made to boil for a moment, and when it has cooled, the stuff is passed through it. By this process, which is indeed somewhat complicated, a beautiful black colour is produced.

Common process.

331. But the processes usually followed for dyeing black, are more simple. Cloth which has been previously dyed blue, is merely boiled in a vat of galls for two hours. It is then kept two hours, but without boiling, in the bath of logwood and sulphate of iron, and afterwards washed and fulled. According to Hellot's process, a bath is to be prepared of a pound and a half of yellow wood, five pounds of logwood, and ten pounds of sumach, which is the proportion of the ingredients

---

(L) Oak bark has been recommended as a substitute for gall-nuts in dyeing black, and particularly in dyeing hats; and it is said that the colour thus obtained is fuller, more beautiful and durable, while the operation is easier and less liable to accident. It was first proposed in the year 1782 by Stephanopoli, a Corsican, and a surgeon in the French army. The examination of the process was referred by the French government to Macquer, who gave a favourable report of it; and afterwards to Berthollet, who gave a different opinion. The process has since been examined, and promises to be more economical and advantageous, especially for dyeing hats *.

* Phil. Mag. vi. 176.

gredients for every 15 yards of deep blue cloth; and the cloth having boiled in this bath for three hours, ten pounds of sulphate of iron are added; the cloth is allowed to remain for two hours longer, when it is taken out to be aired, after which it is again returned to the bath for an hour, and then washed and fulled.

heaper ess.

332. When stuffs are to be dyed at a less expence, instead of the blue ground, a brown or root-coloured ground may be substituted. This brown or fawn colour is communicated by means of the root of the walnut tree, or green walnut peels. The stuffs are then to be dyed black, according to some of the processes already described.

ess of th Eng- li dyers.

333. The proportions of the ingredients employed by the English dyers are, for every hundred pounds of cloth previously dyed a deep blue, about five pounds of sulphate of iron, five pounds of galls, and 30 of logwood. The first step in the process is to gall the cloth, after which it is passed through the decoction of logwood, to which the sulphate of iron has been added.

A tus us for ga

334. The leaves of the *arbutus uva ursi* have been recommended, and employed as a substitute for galls. The leaves must be carefully dried, so that the green colour may be preserved. A hundred pounds of wool are boiled with 16 pounds of sulphate of iron, and eight of tartar, for two hours. The day following the cloth is to be rinsed as after aluming. A hundred and fifty pounds of the leaves of *uva ursi* are then to be boiled for two hours in water, and after being taken out, a small quantity of madder is to be added to the liquor, putting in the cloth at the same time, which is to remain about an hour and a half. It is then taken out and rinsed in water †. By this process, it is said, blue cloth receives a pretty good black, but white cloth becomes only of a deep brown. It is said, too, that the madder and tartar are useless ingredients.

pe- ati

335. After the different operations for dyeing the cloth have been finished, it is washed in a river, and fulled, till the water comes off clear and colourless. Soap suds are recommended by some in fulling fine cloths, but it is found difficult to free the cloth entirely from the soap. After the cloth has come from the fulling mill, some propose to give it a dip in a bath of weld, by which it is said to be softened, and the colour better fixed; but according to Lewis, this operation, which in other cases is of some advantage, is useless after the cloth has been treated with the soap suds.

III. *Of the Processes for Dyeing Silk Black.*

336. In communicating a black colour to silk, different operations are necessary, such as boiling, galling, repairing the bath, dyeing, and softening.

337. To give a deeper shade to silk, it is necessary to deprive it of the gummy substance to which its stiffness and elasticity are owing. This is done by boiling the silk four or five hours with one-fifth its weight of white soap, and afterwards beetling and carefully washing it.

alli.

338. In conducting the process of galling silk, three-fourths of its weight of galls are to be boiled for three or four hours, but the proportion of galls must depend on their quality. After the boiling, the liquor is allowed to remain at rest for two hours; the silk is then put into the bath, and left there from 12 to 36 hours, when it is to be taken out, and washed in the river. But as silk is capable of combining with a great proportion of the astringent principle, or tan, from which it receives a considerable increase of weight, it is allowed to remain for a longer or shorter time, as the silk is required to have more or less additional weight. To communicate, therefore, to silk, what is called a *heavy* black, it is allowed to remain longer in the gall liquor: the process is repeated oftener, and the silk is also dipped in the dye a greater number of times.

Dyeing.

339. While silk is preparing for the process of dyeing, the bath is to be heated, and should be occasionally stirred, that the grounds which fall to the bottom may not acquire too much heat. It should always be kept under the boiling temperature. Gum and solution of iron are added in different proportions, according to the different processes. When the gum is dissolved, and the bath near the boiling temperature, it is left to settle for about an hour. The silk, which in general is previously divided into three parts, that each may be successively put into the bath, is immersed in it. Each part is then to be three times wrung, and after each wringing hung up to air. The silk being thus exposed to the action of the air, acquires a deeper shade. This operation being finished, the bath is again heated, with the addition of gum and sulphate of iron; and this is repeated two or three times, according as the black required is light or heavy. When the process of dyeing is finished, the silk is rinsed in a vessel with some cold water, by turning or shaking it over.

Softening.

340. Silk, after it has been taken out of the dye, is extremely harsh, to remove which it is subjected to the operation of softening. A solution of four or five pounds of soap for every hundred pounds of silk, is poured through a cloth into a vessel of water. The solution being completed, the silk is immersed, and allowed to remain in it for about 15 minutes; it is then to be wrung out and dried.

Dyeing raw silk.

341. When raw silk is to be dyed, that which has a natural yellow colour is preferred. The galling operation must be performed in the cold, if it be proposed to preserve the whole of the gum, and the elasticity which it gives to the silk; but if part only of the gum is wished to be preserved, the galling is to be performed in the warm bath.

342. The dyeing operation is also performed in the cold. All that is necessary is to add the sulphate of iron to the water in which the stuff is rinsed. By this simple process, the black dye is communicated. It is then washed, once or twice beetled, and dried without wringing, that its elasticity may not be destroyed. Raw silk may be dyed by a more speedy process. After galling, it may be turned or shaken over in the cold bath; and thus by alternately dipping and airing the stuff, the operation may be completed. It is then to be washed and dried as in the former processes.

A speedier process.

Improved process for velvet.

343. The method of dyeing velvet at Genoa, which has been simplified and improved in France, is thus described by Macquer. For every 100 pounds of silk, 20 pounds of Aleppo galls, reduced to powder, are boiled in a sufficient quantity of water for an hour. The bath is allowed to settle till the galls have fallen to the bottom; they are then taken out, and two pounds and a half of sulphuric acid, twelve pounds of iron filings, and 20 pounds of gum, are put into a cop-

per

---

† Stockholm Tr. 75

per vessel, or cullender, furnished with two handles. This vessel is immersed in the bath, and supported that it may not touch the bottom. The gum, which is allowed to dissolve for an hour, is to be occasionally stirred; and if it appear that the whole of the gum is dissolved, three or four pounds more are to be added. Excepting during the operation of dyeing, the cullender is to remain in the copper, which must be kept hot the whole time, but at a temperature below the boiling point. In galling the silk, one-third of Aleppo galls is employed, and the stuff should remain six hours in the liquor the first time, and twelve hours the second. By frequent additions of sulphate of iron, and repeated immersions of the stuff, a fine black, according to Lewis, has been obtained. In the above process, the proportion of sulphate of iron is too small, and the gum, according to some, being carried off in the washing, may be considered as useless. Berthollet thinks that, although the quantity be excessive, it has some effect in keeping up the bath; and he adds, if it is to be diminished, it would be useful to add the sulphate of iron in separate portions during each interval.

Substitute for galls.

344. To diminish the quantity of galls, which are an expensive ingredient in dyeing silk black, other substances have been proposed as substitutes. With this view the following process is recommended.

The silk being boiled and washed, is immersed in a strong decoction of green walnut peels, and allowed to remain till the colouring matter of both is exhausted. It is then to be slightly wrung out, dried and washed (M). To give the silk a blue ground, logwood and verdigrise are employed, in the proportion of one ounce of the latter for every pound of silk. The verdigrise is dissolved in cold water, and the silk is allowed to remain two hours in this solution. It is then immersed in a strong decoction of logwood, slightly wrung out, dried, and afterwards washed at the river. The bath is prepared by macerating two pounds of galls and three of sumach in 25 gallons of water, over a slow fire, for twelve hours. The liquid being strained, three pounds of sulphate of iron, and the same quantity of gum arabic, are to be dissolved in it. The silk is dipped in this solution at two different times; it is to remain in the bath two hours each time, and it must be aired and dried between each dip. After being twice beetled at the river, it is dipped a third time, and left in the bath four or five hours, after which it is to be dried, washed and beetled as before. The temperature of the bath should not exceed 120°. After the first dipping, it may be necessary to add half a pound of sulphate of iron, and an equal quantity of gum arabic.

345. Silk which has been previously dyed blue with indigo, it is said, takes only a mealy black; but when it has been prepared with logwood and verdigrise, it acquires a velvety lustre. A fine black may be obtained from green walnut peel; but the addition of logwood and verdigrise renders a smaller quantity of sulphate of iron necessary, and this is of importance, because it is apt to weaken the silk. The only use of galls, according to some, is to increase the weight of the silk; for the purposes of dyeing, sumach is considered sufficient*.

IV. *Of the Processes for Dyeing Cotton and Linen Black.*

Must be previously dyed blue.

346. It is more difficult to communicate a fine black to linen or cotton than to silk or woollen stuffs. To succeed in producing a black colour of that degree of intensity which will resist soap, it is necessary to adopt particular processes. In dyeing animal matters black, as silk and wool, the best colours are obtained on those which have been previously dyed blue. This also is an essential preliminary process in dyeing linen and cotton black; for it is found that the process which succeeds best, is first to give a deep blue grain to the cotton or linen.

Galling.

347. The first part of the process is the operation of galling. The stuffs which have been previously dyed blue, wrung out and dried, are kept 24 hours in the gall-liquor, composed of four ounces of galls to every pound of thread. A bath is then prepared of a solution of iron in acetic acid. This solution is obtained by saturating the acid with oxide of iron. In France, vinegar, small beer, or small wine, is employed for this purpose. To promote the acid fermentation, rye meal, or some other substance, is added, and pieces of old iron are thrown into the liquid, which are allowed to remain for six weeks or two months, that the acid may be saturated with the iron. This solution, called *iron liquor* in this country, is prepared from fermented worts, to which old iron is added, as is described above.

Dyeing.

Five quarts of the iron-liquor for every pound of stuffs, are put into a vessel. In this the stuffs are wrought with the hand, pound by pound, for 15 minutes: they are then wrung out and aired. This operation is to be again repeated, taking care to add a fresh quantity of the iron-liquor, which should be carefully scummed, after which the stuffs are to be wrung out, aired, and washed at the river. In the next operation, a pound of alder bark for every pound of stuff is boiled in a sufficient quantity of water for an hour. One half of the bath which was employed in the galling, and about one half the quantity of sumach as of alder bark, are then added. The whole is boiled together for two hours, and strained through a sieve. When this liquid is cold, the stuffs are immersed, wrought pound by pound, and occasionally aired. They are afterwards put into the bath, and after remaining for 24 hours, are wrung out and dried. The above is the process which, according to D'Apligny, is followed at Rouen, for dyeing cotton and linen.

Another process.

348. The process followed at Manchester, which is described by Mr Wilson, is the following. For the operation of galling, galls or sumach are employed. The stuff is afterwards dyed in a bath consisting of a solution of iron in acetic acid. This bath is also frequently composed of alder bark and iron. After having passed through this bath, the stuff is dipped in a decoction of logwood, to which a small quantity of verdigrise has been added. This process is to be repeated

* Berthollet, ii. 20.

(M) The decoction of walnut peels is prepared by boiling for 15 minutes, after which it is taken from the fire. After it has subsided, the silk, which has been previously immersed in warm water, is dipped in it.

peated till a black of sufficient intensity is obtained, observing to wash and dry after each operation.

aration olution on.

349. According to Guhliche, a solution of iron may be prepared by the following process. A pound of rice is to be boiled in 12 or 15 quarts of water, till the whole is dissolved. A sufficient quantity of old iron made red hot, to reach half way to the surface of the liquor, is thrown into the solution. The vessel in which the solution is kept must be under cover, but exposed to the air and light, at least for a week. In another vessel, containing a quantity of warm vinegar equal to the solution of rice, an equal quantity of red-hot iron is to be put. This vessel must also be exposed in the same way to the air and light. After several days, the contents of both vessels are mixed together, and the mixture is to be exposed for a week to the open air, after which it is to be decanted and kept for use in a close vessel. To give a sufficient black to linen and cotton, it is only necessary, it is said, to steep them 29 hours in this solution: and if it should appear that the liquor is exhausted of colouring matter, a fresh portion is to be employed. In this way a fine permanent black is obtained. According to the same author, this solution may be advantageously employed as a substitute for sulphate of iron, in dyeing silk and wool. But to give them a fine black, silk and woollen stuffs must be dipped in a decoction of logwood after they are taken from the bath.

plica- tio

Sect. V. *Of Brown.*

350. The last of the simple colours is brown. This is also known under the name of *fawn* colour, (*fauve*, Fr.). It is that brown colour which has a shade of yellow, and might perhaps be considered as a compound colour, although it is communicated to stuffs by one process.

I. *Of the Substances employed in Dyeing Brown.*

351. The vegetable substances which are capable of inducing a fawn or brown colour on different stuffs, are very numerous, but those chiefly employed for this purpose are walnut peels and sumach. The peels constitute the green covering of the nut; they are internally of a white colour, which is converted into brown or black by exposure to the air. The skin, when impregnated with the juice of walnut peels, becomes of a brown or almost black colour. When the inner part of the peel, taken fresh, is put into weak oxymuriatic acid, it assumes a brown colour. If the decoction of walnut peels be filtered and exposed to the air, its colour becomes of a deep brown; the pellicles on evaporation are almost black, the liquor detached from these yields a brown extract completely soluble in water. The colouring particles are precipitated from a decoction of walnut peels, by means of alcohol, and they are soluble in water. No apparent change is at first produced by a solution of potash; but it gradually becomes turbid, and the colour is deepened. A copious precipitate of a fawn colour, approaching to an ash colour, is produced in a decoction of walnut peels by means of a solution of tin, and the remaining liquor has a slightly yellow tinge.

Wa t eel

opies.

352. A decoction of walnut peels yields a small quantity of fawn-coloured precipitate by means of a solution of alum, and the liquor remains of the same colour. Sulphate of copper renders it slowly turbid, and throws down a small quantity of precipitate of a brownish green colour, leaving the supernatant liquor of the same colour. Sulphate of iron deepens the colour; when diluted, the colour becomes brownish green, without the deposition of any sediment. Sulphate of zinc also deepens the colour, and produces no precipitate. The same properties are exhibited by a decoction of the walnut-tree wood, but the colouring matter is not obtained from it in such abundance as from the peels; and the bark may also be used with advantage in dyeing.

Advantages

353. The affinity of the colouring matter of walnut peels for wool is very strong; and it readily imparts to it a durable colour, which even mordants do not seem capable of increasing, but they are generally understood to give it additional brightness. A lively and very rich colour is obtained with the assistance of alum. Walnut peels afford a great variety of pleasing shades; and as they require not the intervention of mordants, the softness of the wool is preserved, and the process of dyeing becomes both cheap and simple.

Preparation

354. Walnut peels are not gathered till the nuts are completely ripe, when they are put into large casks, along with as much water as is sufficient to cover them. When used in dyeing at the Gobelins in Paris, Berthollet informs us, they are kept for upwards of a year, and very extensively used; but if not made use of till the end of two years, they yield a greater quantity of colouring matter, at which time their odour has become peculiarly disagreeable and fetid. The peels separated from the nuts before they arrive at maturity, may likewise be used in dyeing, but in this state they do not keep so long.

Sumach.

355. Sumach (*rhus coriaria*, Linn.) is a shrub produced naturally in Palestine, Syria, Portugal, and Spain, being carefully cultivated in the two last of these countries. Its shoots are annually cut down, dried, and reduced to powder in a mill, by which process they are prepared for the purposes of dyeing.

Properties.

356. The infusion of sumach, which is of a fawn colour with a greenish tinge, is changed into a brown by exposure to the air. A solution of potash has little action on the recent infusion of sumach; its colour is changed to yellow by the action of acids; the liquor becomes turbid by means of alum, a small quantity of precipitate being at the same time formed, and the supernatant liquor remaining yellow. A copious precipitate of a yellowish green colour is thrown down by sulphate of copper, and the liquor remains clear. No change is speedily produced by muriate of soda (common salt), but it becomes rather turbid at the end of some hours, and its colour is rather clearer. Sulphate of copper produces a copious precipitate of a yellowish green, which after standing some hours, changes to a brownish green; the supernatant liquor, which is slightly yellow, remains clear. Sulphate of zinc renders the liquor turbid, darkens its colour, and produces a deep blue precipitate; but when the sulphate of zinc is pure, the precipitate, which is of a brownish fawn colour, is in very small quantity. Acetate of lead gives a copious precipitate, of a yellowish colour; the supernatant liquor is of a clear yellow colour. No astringent has so strong a resemblance to galls as sumach; but the precipitate

precipitate thrown down from an infusion of it by a solution of iron, is not so copious as that which is yielded by an equal quantity of galls, on which account sumach may be generally employed as a substitute for galls, only its quantity will require to be increased.

Bark of birch.

357. The bark of the birch tree (*betula alba*, Lin.) yields a decoction of a clear fawn-colour, but it soon becomes turbid and brown. The addition of a solution of alum in the open air, produces a copious yellow precipitate; a solution of tin gives also a copious precipitate of a clear yellow colour. With solutions of iron the decoction of the birch-tree strikes a black colour, and it dissolves in considerable quantity the oxide of iron, but in smaller proportion than the decoction of walnut peels. On account of this property, it is employed in the preparation of black vats for dyeing thread.

Sandal wood.

358. Sanders or sandal wood, is also employed for the purpose of giving a fawn colour. There are three kinds of sandal wood, the white, the yellow, and the red. The last only, which is a compact heavy wood, brought from the Coromandel coast, is used in dyeing. By exposure to the air it becomes of a brown colour; when employed in dyeing, it is reduced to fine powder, and it yields a fawn colour with a brownish shade, inclining to red. But the colouring matter which it yields of itself is in small quantity, and it is said that it gives harshness to woollen stuffs. When it is mixed with other substances, as sumach, walnut peels, or galls, the quantity of colouring matter is increased; it gives a more durable colour, and produces considerable modifications in the colouring matter with which it is mixed. Sandal wood yields its colouring matter to brandy, or diluted alcohol, more readily than to water.

Soot.

359. Soot communicates to woollen-stuffs a fawn or brown colour, of a lighter or deeper shade, in proportion to the quantity employed; but the colour is fading, and its affinity for wool is not great; and besides leaving a disagreeable smell, it renders the fibres harsh. In some manufactories, it is employed for browning certain colours, and it produces shades which could not otherwise be easily obtained.

II. *Of the Processes for Dyeing Woollen, &c. a Fawn or Brown Colour.*

With walnut peels.

360. In dyeing with walnut peels, a quantity proportioned to the quantity of stuff, and the intensity of shade wanted, is boiled for fifteen minutes in a copper. All that is necessary in dyeing with this substance is, to moisten the cloth or yarn with warm water, previous to their immersion in the copper, in which they are to be carefully stirred till they have acquired the proper shade. This is the process, if the aluminous mordant is not employed. In dyeing cloth, it is usual to give the deepest shades first, and the lighter ones afterwards; but in dyeing woollen yarn, the light shades are given first, and the deeper ones afterwards. An additional quantity of peels is joined to each parcel.

Berthollet's experiments.

361. Berthollet made a number of experiments to ascertain the difference of colour obtained from the simple decoction of walnut peels, and the addition of metallic oxides as mordants. The oxide of tin, he found, yielded a clearer and brighter fawn colour than that of the simple decoction. The oxide of zinc produced a still clearer colour, inclining to ash or gray. The colour from oxide of lead had an orange cast, while that from oxide of iron was of a greenish brown *.

Dyeing with sumach.

362. A fawn colour, which has a shade of green, is obtained from sumach alone; but to cotton stuffs which have been impregnated with printers mordant, or acetate of alumina, sumach communicates a good and durable yellow. Here, however, some precaution is necessary in the use of this substance for this purpose; for as the colouring matter is of so fixed a nature, the ground of the stuff cannot be bleached by exposure on the grass. This inconvenience is avoided by impregnating the whole of the stuff with different mordants, producing in this way a variety of colours, and leaving no part white.

With sandal wood.

363. Vogler employed the tincture of sanders wood for dyeing patterns of wool, silk, cotton and linen, having previously impregnated them with a solution of tin, and afterwards washing and drying them. Sometimes he used the solution unmixed, and at other times added six or ten parts of water, and in whatever way he employed it, he obtained a poppy colour. When the mordant employed was solution of alum, the colour was a rich scarlet; with sulphate of copper it was a clear crimson, and with sulphate of iron a beautiful deep violet †.

CHAP. II. *Of Compound Colours.*

Nature of compound colours.

364. A MIXTURE of two colouring substances, it is well known, produces a very different shade from that of either of the uncombined colouring matters; hence compound colours are obtained, which are merely mixtures of simple colours. It would undoubtedly be a desirable thing to ascertain with acuracy the peculiar shade produced by the combination of two colouring matters; but these results can only be certainly known by experiment, because by the action of different substances in the bath, they are subject to great variations in their effects, according to the affinities which are brought into action, and the new combinations which are formed. What is natural to colouring particles is not to be considered as a constituent part of compound colours, but only the difference of shade which they ought to assume, with a particular mordant, or in a particular bath. The effects, therefore, of the chemical agents employed in these processes, and the result of different combinations, ought to be particularly attended to. It is in dyeing compound colours that skill and ingenuity are most conspicuous, and their application of greatest utility, to enable the dyer to vary his processes according to the shade desired, and at the same time to accomplish his operations by the shortest and cheapest means.

Great variety of shade.

365. As compound colours are obtained by the mixture of simple colours, very different shades will be obtained from different-proportions of the simple colours; hence compound colours exhibit an indefinite variety of shade, and the processes by which they are produced are very numerous. It would extend this treatise to an unusual length, were we to attempt to describe every variety of shade which is obtained from the mixture of simple colours. We shall therefore limit our observations to some of the principal compound colours, and an

---

* Elements of Dyeing, ii. 296.

† Crell Ann. 1790.

pound ours.

an account of the processes by which they are obtained, leaving it to our readers, who have made themselves familiar with the principles already detailed, to vary these colours, by employing different proportions and different combinations of simple colouring matters.

366. Compound colours have been usually divided into four classes, namely, green, purple, orange, and gray or drab colour. These are obtained from mixtures of the following simple colours.

1. Blue and yellow produce a green.
2. Red and blue, a purple, &c.
3. Red and yellow, orange.
4. Black and other colours, gray, &c.

The following sections will be occupied in a short detail of the methods which are usually employed in producing these different compound colours.

Sect. I. *Of the Mixture of Blue and Yellow, or Green.*

367. Green colours, from the great variety of shades which they exhibit, have been long known by different names, by which the intensity of shade is characterised, such as sea-green, apple-green, meadow or grass-green, pea-green, parrot-green, &c. Many plants afford a green colour, such as brome grass (*bromus secalinus*, Lin.) green berries of *rhamnus frangula*, wild chervil (*chærophyllum sylvestre*, Lin.), purple clover (*trifolium pratense*), common reed (*arundo phragmites*). These colours, however, do not possess sufficient permanency. According to D'Ambourney, indeed, a permanent green may be obtained from the fermented juice of the berries of the berry-bearing alder (*rhamnus frangula*). Having previously prepared the cloth with tartar, solution of nitrate of bismuth, and common salt, he added to the fermented juice of the berries, after it was warmed, a small proportion of acetate of lead; and in this bath he communicated to the cloth an intermediate shade between parrot and grass green. But it is usually from the mixture of blue and yellow that green is obtained; and it may be observed, that it requires much skill and experience, especially in giving light shades, to produce a colour which is uniform, and entirely without spots.

I. *Of the Processes for Dyeing Woollen Stuffs Green.*

368. To dye woollen green, either the yellow or the blue dye may be given to it first. But when the stuff is first dyed yellow, and in this state is introduced into the blue vat, part of the yellow colouring matter being dissolved in the vat, communicates to it a green colour, which renders it unfit for dyeing any other colour than green. To avoid this inconvenience, therefore, the blue colour is first given, and afterwards the yellow. It would be quite unnecessary to resume the account of any part of the processes for dyeing blue, which have been already detailed. It is proper, however, to add, that the intensity of the blue shade must be proportioned to the green, or to the depth of the green colour which is wished to be obtained. Thus, for instance, to produce a parrot green, a ground of sky blue is given, and for the green like that of a drake's neck, a deep blue is required. When the blue dye has been communicated, the yellow is afterwards given, according to some of the processes which have been already described for dyeing yellow. The proper ground being communicated to the cloths, they are washed in the fulling mill, and boiled as for the common process of welding; but when the shade is light, the proportion of salts should be less. Cloths which are to receive light shades are first boiled, and when these are taken out, tartar and alum are added in fresh portions, till the cloths which are intended for the darkest shades are boiled. The process of welding is conducted in the same way as for dyeing yellow, with this difference, that a larger proportion of weld is employed, excepting for lighter shades, when the proportion must be smaller. In dyeing green, it is usual to have a succession of shades at the same time; the process is begun with the deepest, and ends with the lightest. Between each dip there should be an interval of one-half or three quarters of an hour, and at each interval water is added to the bath. It is the practice of some dyers to give each parcel two dips, beginning the first time with the deep shades, and the second with the lighter ones; but when this practice is followed, the time of immersion should be shortened. In dyeing very light shades, the bath should never be permitted to reach the boiling temperature. For deep greens, a browning is given with logwood, and a small proportion of sulphate of iron.

Compound Colours.

Saxon green.

369. For some kinds of green, sulphate of indigo is employed; and in this case either the blue and yellow are dyed separately, or the whole of the ingredients are mixed together in the bath, and the whole process is finished at a single operation. The colour thus obtained has been distinguished by the name of *Saxon green*. The following is the process recommended by Dr Bancroft.

370. "The most beautiful Saxon green (says he) may be produced very cheaply and expeditiously, by combining the lively yellow which results from quercitron bark, murio-sulphate of tin, and alum, with the blue afforded by indigo when dissolved in sulphuric acid, as for dyeing the Saxon blue.

"To produce this combination most advantageously, the dyer, for a full-bodied green, should put into the dyeing vessel after the rate of six or eight pounds of powdered bark, in a bag, for every 100 lb. weight of cloth, with only a small proportion of water as soon as it begins to grow warm; and when it begins to boil, he should add about six pounds of murio sulphate of tin (with the usual precautions), and a few minutes after, about four pounds of alum; these having boiled together five or six minutes, cold water should be added, and the fire diminished so as to bring the heat of the liquor nearly down to what the hand is able to bear; and immediately after this, as much sulphate of indigo is to be added as will suffice to produce the shade of green intended to be dyed, taking care to mix it thoroughly with the first solution by stirring, &c.; and this being done, the cloth previously scoured and moistened, should be expeditiously put into the liquor, and turned very briskly through it for a quarter of an hour, in order that the colour may apply itself equally to every part, which it will certainly do in this way with proper care. By these means, very full, even, and beautiful greens may generally be dyed in half an hour; and during this space, it is best to keep the liquor at rather less than a boiling heat. Murio-sulphate of tin is infinitely preferable, for this use, to the dyer's spirit; because the latter consists chiefly of nitric acid, which, by its highly injurious action upon indigo, would render that part of the green colour very fugitive, as I have found by repeated trials. But no such effect can result from the murio-sulphate of tin, since the muriatic acid has no action upon indigo; and the sulphuric is that very acid which alone is proper to dissolve it for this use.

"Respecting the beauty of the colour thus produced, those who are acquainted with the unequalled lustre and brightness of the quercitron yellows, dyed with the tin basis, must necessarily conclude, that the greens composed therewith will prove infinitely superior to any which can result from the dull muddy yellow of old fustic; and in point of expence, it is certain that the bark, murio-sulphate of tin, and alum, necessary to dye a given quantity of cloth in this way, will cost less than the much greater quantity (six or eight times more) of fustic, with the alum necessary for dyeing it in the common way, the sulphate of indigo being the same in both cases. But in dyeing with the bark, the vessel is only to be filled and heated once; and the cloth, without any previous preparation, may be completely dyed in half an hour; whilst in the common way of producing Saxon greens, the copper is to be twice filled: and to this must be joined the fuel and labour of an hour and a half's boiling and turning the cloth, in the course of preparation, besides nearly as much boiling in another vessel to extract the colour of the fustic; and after all the dyeing process remains to be performed, which will be equal in time and trouble to the whole of the process for producing a Saxon green with the bark; so that this colour obtained from bark will not only prove superior in beauty, but in cheapness, to that dyed as usual with old fustic *."

II. *Of the Processes for Dyeing Silk Green.*

Preparation.

371. In giving silk a green colour, greater precaution is necessary, to preserve uniformity of colour, and to prevent spots and stripes. Silk which is intended to receive a green colour, is scoured in the same way as for other colours; but for light shades, the scouring must be as complete as for blue. Silk which is to be dyed green, is first dyed yellow, and being well alumed, it is slightly washed at the river, and divided into small parcels, that it may receive the colouring matter uniformly, and then carefully turned in the weld bath. When the ground is supposed to have acquired a sufficient degree of intensity, a pattern is put into the blue vat, to ascertain the proper shade. When this is the case, the silk is taken out of the bath, washed, and immersed in the blue vat. To produce a deeper colour, and at the same time to give variety of shade, a decoction of logwood, fustic, or anotta, is added to the yellow bath, after the weld has been taken out. For very light shades, such as apple and sea green, it is scarcely necessary to add, that a weaker ground is to be given. For all light shades, except sea green, the process is found to succeed better when the yellow is communicated by baths which have been already used; but these baths should not contain any logwood or fustic.

Saxon green.

372. Saxon green is produced by means of sulphate of indigo. This is a brighter, but less durable colour than the former. This process is conducted by boiling as for welding, after which the cloth is washed. Fustic in chips is enclosed in a bag, put into the same bath, and boiled for an hour and a half, when it is taken out, and the bath allowed to cool till the hand can bear it. A pound and a quarter of sulphate of indigo for each piece of cloth of eighteen yards, is added. The cloth is at first to be turned quickly, and afterwards more slowly, and it should be taken out before the bath boils. Some dyers put in only two-thirds of the solution at first; and after two or three turns, take out the cloth, and add the other one-third. By this means the colour is more uniform.

By one operation.

373. To produce Saxon green at one operation, the following process is recommended by Dr Bancroft. A bath is prepared of four pounds of quercitron bark, three pounds of alum, and two pounds of murio-sulphate of tin, with a sufficient quantity of water. The bath is boiled ten or fifteen minutes, and when the liquor is so far reduced in temperature as the hand can bear it, it is fit for dyeing. By adding different proportions of sulphate of indigo, various and beautiful shades of green may be obtained, and the colour thus produced is both cheap and uniform. Care should be taken to keep the bath constantly stirred, to prevent the colouring matter from subsiding. Those shades which are intended to incline most to the yellow, should be dyed first; and by adding sulphate of indigo, the green, having a shade of blue, may be obtained. This process, Dr Bancroft observes, is the most commodious and certain for dyeing most beautiful Saxon greens upon silk †.

English green.

374. To produce English green, which is more beautiful than common green, and is said to be more durable than the Saxon green, Guhliche gives the following process. He first dyes the silk of a light blue in the cold vat already described (316.), then soaks it in warm water, washes it in a stream, and dips it in a weak solution of alum. He then prepares a bath of sulphate of indigo, one ounce of solution of tin, with the tincture of French berries made with aceto-citric acid. The silk is kept in this bath till it has obtained the desired colour. It is then washed and dried in a shady place. Lighter shades may be dyed afterwards ‡.

III. *Of the Processes for Dyeing Cotton and Linen Green.*

Blue first given.

375. Cotton and linen, after being scoured in the usual way, are first dyed blue; and after being cleansed, they are dipped in the weld bath, to produce a green colour. The strength of the blue and yellow is proportioned to the shade of green which is wanted. But as it is difficult to give to cotton velvet an uniform colour in the blue vat, it is first dyed yellow with turmeric, and the process is completed by giving it a green with sulphate of indigo. The same result, however, will be obtained by commencing the process either with the yellow or the blue.

Process fo cotton velvet.

376. The process which D'Apligny describes for dyeing cotton velvet, or cotton thread, a sea or apple green, in one bath, is the following. A quantity of verdigrise is dissolved in vinegar, and the mixture is kept excluded from the air in the heat of a stove for fifteen days. A quantity of potash equal in weight to the verdigrise employed is dissolved in water, and four hours

---

* Phil. of Perm. Col. 336.

† Phil. of Perm. Col. 346.

‡ Berthollet, ii. 319

ompound olours.

hours before dyeing it is added to the solution of verdigrise. The mixture is to be kept hot. One ounce of alum in five quarts of water for each pound of stuff being prepared, the cotton thread or velvet is soaked in this solution. It is then taken out, and the verdigrise mixture being added to the solution of alum, it is again introduced to be dyed.

ive een.

377. The different shades of olive green, and drake's neck green, are given to thread after it has received a blue ground, by galling it, and dipping it in a weaker or stronger bath of iron liquor, then in the weld bath, to which verdigrise has been added, and afterwards in the bath with sulphate of copper. The colour is lastly to be brightened with soap.

een from ussian e.

378. Cotton dyed with Prussian blue may be dyed green by previously aluming while it is still wet with the blue, and then dipping in a weld bath, the strength of which is proportioned to the shade required. The colour from weld is more lively than that obtained from fustic. But fustic which gives a deeper shade than weld, and diminishes the brightness of the blue, is to be preferred when a green with an olive shade is wanted.

neral arks.

379. The shade of green given to any stuff, it is obvious, must vary according to the intensity of the blue shade, the strength of the yellow bath, and the nature of the yellow colouring matter employed. Yellow colours are rendered more intense by means of alkalies, sulphate of lime and ammoniacal salts; but become fainter by means of acids, alum, and solutions of tin. In dyeing Saxon green the result will be different according to the process which is followed. The effects will be different by adding a yellow to a Saxon blue, from the process in which the sulphate of indigo is mixed with the yellow ingredients; because in the latter case the sulphuric acid has a considerable action on the colouring matter, and thus diminishes the intensity of the yellow. As the particles of indigo have a stronger affinity for the stuff than the yellow colouring matter, in dyeing a succession of shades in a bath in which both are mixed, the bath being first exhausted of the indigo, the last shades incline more to the yellow on account of the predominance of the yellow colouring matter.

SECT. II. *Of the Mixture of Red and Blue, or Purple, &c.*

380. By the mixture of red and blue, violet, purple, dove-colour, lilac, and a great variety of other shades, according to the proportion of the substances employed, or the predominance of the blue or the red, are produced. In stuffs which are to be dyed violet, a deeper blue must be given, but for purple colours, the ground requires to be of a lighter blue; but in lilac and similar light colours, it is necessary that both the blue and the red have a light shade.

I. *Of Dyeing Wool Violet, Purple, &c.*

B first gi.

381. In the attempts which have been made to communicate a violet or purple colour to a scarlet ground, according to the observations of Hellot, the colour is very unequal. It becomes therefore necessary to give the blue colour first; and for violets or purples, the shade of blue ought not to be deeper than that of sky blue. The stuff being dyed blue, is boiled with alum, and two-fifths of tartar, and is afterwards dipped in a bath composed of nearly two-thirds the quantity of cochineal required for scarlet, with the addition of tartar. The same process, indeed, as for dyeing scarlet, is followed. It is a common practice to dye these colours after the reddening for scarlet, making such additions of cochineal and tartar as the intensity of the shade may require.

Compound Colours.

Lilac, &c.

382. For lighter shades, as lilacs, dove-colours, &c. the stuff may be dipped in the bath which has served for violet and purple, and is now somewhat exhausted, taking care to add a quantity of alum and tartar. For reddish shades, such as peach blossom, a small proportion of solution of tin is added. It may be observed, in general, that although the proportion of cochineal is less in dyeing lighter shades, the quantity of tartar must not be diminished.

Cheaper and shorter process.

383. To obtain the same colours, a shorter and less expensive process is recommended by Poerner. In this process he employs sulphate of indigo. He boils the stuff in a solution of alum, in the proportion of three ounces of the latter to one pound of the former, for an hour and a half, and afterwards allows it to remain in the liquid for a night after it has cooled. The dyeing bath is prepared with an ounce and a half of cochineal, and two ounces of tartar, which are boiled for three quarters of an hour: two ounces and a half of sulphate of indigo are then added, the whole is stirred, and boiled gently for 15 minutes. The dyeing operation is conducted in the usual way, and a beautiful violet is thus obtained. To have all the variety of shades which are produced by the mixture of red and blue, the proportion of the sulphate of indigo is increased or diminished. It is sometimes increased to five ounces, and diminished to five drachms, for each pound of stuff. The quantity of cochineal is also varied, but when it is less than an ounce, the colour is dull. Different proportions of tartar are also employed. To produce variety of shades, the stuff is also prepared with different proportions of solution of tin.

Purple from logwood.

384. To communicate a purple colour to wool, as well as some other shades, logwood, with the addition of galls, has been employed. The stuff is previously dyed blue, and to give a brown shade, sulphate of iron is used; but the colours thus obtained are not permanent. By the following process, described by Decroizille, a durable dye is produced, by means of this wood. He dissolved tin in sulphuric acid, to which were added common salt, red acidulous tartrite of potash, and sulphate of copper; or it may be more conveniently done by making a solution of tin in a mixture of sulphuric acid, common salt, and water, to which are to be added the tartrite and sulphate in the state of powder. Of this mordant not less than 1500 quarts were made in twenty-four hours, in a leaden vessel to which a moderate heat was applied. A very lucrative trade was carried on for three years by Decroizille, who sold it at the rate of 1s. 3d. sterling per pound.

Process.

385. If wool in the fleece is to be dyed, it will require a third of its weight of this mordant, while a fifth is a proportion sufficient for stuffs. A bath is prepared of such a degree of temperature as the hand can bear, with which the mordant is properly mixed, and the wool or stuff dipped in it and stirred, the same degree of

of temperature being kept up for two hours, and increased a little towards the end: after which it is taken out, aired, and well washed. A fresh bath of pure water is prepared at the same temperature, to which is added a sufficient quantity of the decoction of logwood; the stuff is then immersed, stirred, and the heat increased to the boiling temperature, which is to be continued for 15 minutes, after which the stuff being taken out, aired, and carefully rinsed, the process of dyeing is completed. If for every three pounds of wool, one pound of decoction of logwood has been used, and a proportionate quantity for stuffs which require less, a fine violet colour is produced, to which a sufficient quantity of Brazil wood imparts the shade known in France by the name of *prune de Monsieur*.

Different shades from other substances.

386. Logwood and Brazil, fustic and yellow wood, are colouring substances which may be fixed with advantage upon wool by means of this mordant. The colour communicated by the two first of these is liable to be changed in the fulling by the action of the soap or urine employed for that purpose; but this change, which is always produced by alkaline substances, is remedied by a slightly acid bath a little hot, called *brightening*, for which the sulphuric acid has the preference. The colour becomes as deep, and frequently much brighter than before the change. Wools which have been dyed by means of this mordant, are said to admit of being spun into a finer and more beautiful thread than by the use of alum. If the use of sulphate of copper is omitted, more beautiful colours are produced by fustic and yellow wood, as well as by weld. An orange red colour is communicated by madder, but not so deep as with a similar quantity of alum. When sulphate of copper is omitted, the wool is said to become much harsher, and the mordant thus prepared yields but indifferent colours with logwood, and in particular with Brazil wood. The use and carriage of this mordant are inconvenient, on account of the heavy sediment by which the vessel is half filled under a corrosive liquor, capable only of being kept in stone ware. These inconveniences may be remedied by the omission of the water in the receipt, which leaves only a paste more conveniently used, and the carriage of it two-fifths cheaper.

Nature of the process.

387. The above process is thus explained by Berthollet. The decomposition of the muriate of soda is effected by the action of the sulphuric acid; and the muriatic acid being thus disengaged, dissolves the tin, part of which is precipitated by means of the tartaric acid, producing the sediment already mentioned. The oxide of copper produces the blue with the colouring particles of the logwood; the violet is formed by the oxide of tin with the same wood, and the red, with the colouring matter of the Brazil wood. The same ingenious chemist farther observes, that as an excess of acid is retained in the liquor, it might probably be of advantage to employ acetate as a substitute for sulphate of copper, in which case the action of the free acid would be moderated. He thinks it would still be more adviseable to make use of verdigrise; because the uncombined part of the oxide of copper would, in that case, unite with the excess of acid, on which account a smaller quantity of acid would remain in the liquor; and probably the quantity of tartar might be diminished, as a smaller quantity of tin would thus be precipitated *.

II. *Of Dyeing Silk Violet or Purple.*

Two ki of violet.

388. Silk is capable of receiving two kinds of violet colours, denominated the fine and the false, the latter of which is produced by means of archil or Brazil wood. When the fine violet colour is required, the silk must first be passed through cochineal, and dipped afterwards in the vat. The preparation and dyeing of the silk with cochineal are the same as for crimson, with the omission of tartar and solution of tin, by means of which the colour is heightened. The quantity of cochineal made use of is always proportioned to the required shade, whether it is more or less intense; but the usual proportion for a fine violet colour is two ounces of cochineal for each pound of silk. When the silk is dyed, it is washed at the river, twice beetled, dipped in a vat more or less strong, in proportion to the depth of the violet shade, and then washed and dried with precautions similar to those which all colours require that are dyed in the vat. If the violet is to have greater strength and beauty, it is usual to pass it through the archil bath, a practice which, though frequently abused, is not to be dispensed with for light shades, which would otherwise be too dull.

Purple.

389. When silk has been dyed with cochineal according to the above directions, only a very light shade is requisite for purple; the shades which are deepest are dipped in a weak vat, while dipping them in cold water is sufficient for such as are lighter, the water having been incorporated with a small quantity of the liquor of the vat, because in the vat itself, however weak it might be, they would acquire too deep a tinge of blue. In this manner are the light shades of this colour, such as gilly-flower, peach blossom, &c. produced by diminishing the quantity of cochineal.

False vio lets.

390. There are various ways of imparting to silk what are denominated the false violets; but those which are most frequently used, and possessed of greatest beauty, are prepared with archil, the bath of which is, in point of strength, to be suited to the colour required. Having been beetled at the river after scouring, the silk is turned in the bath on the skein sticks; and when the colour is deemed sufficiently deep, a pattern is tried in the vat, to ascertain whether it takes the violet colour intended to be produced. If the shade is found to have acquired the proper depth, the silk is beetled at the river and dipped in the vat, in the same way as for the fine violet colours; and less either of the blue or of the archil colour is given, according as it is meant that the red or blue shade of the violet colour should predominate.

Process o Gubliche

391. The process recommended by Gubliche for communicating a violet colour to silk is the following. A pound of silk is to be soaked in a bath of two ounces of alum, and a like quantity of solution of tin, after having carefully poured off the sediment formed in the mixture. The dye-bath is prepared with two ounces of cochineal reduced to powder with a dram of tartar, and the remaining part of the bath which has answered the purpose of a mordant, with the addition of a sufficient quantity of water. When slightly boiled, such a quantity of solution of indigo is added as may communicate

---

* Berthol let, ii. 340.

cate to the bath a proper shade of violet; after which the silk is immersed, and boiled till it has acquired the intended shade. It is then wrung, washed in a stream, and like every other delicate colour, must be dried in the shade. The light shades exhaust the bath. But it ought to be observed, that this colour, which is said to be a beautiful violet, possesses but little durability, and is apt to assume a reddish tinge, owing to the colour of the indigo fading first.

A ther. 392. A violet colour may be imparted to silks, by immersing them in water impregnated with verdigrise, as a substitute for aluming, and next giving them a bath of logwood, in which they assume a blue colour, which is converted to a violet, either by the addition of alum to the bath, or by dipping them in a weaker or stronger solution of that substance, which communicates a red colour to the particles of logwood. This violet possesses but a small degree of beauty, and little durability, But if alumed silk be immersed in a bath of brazil-wood, and next in a bath of archil, after washing it at the river, a colour is obtained possessing a much higher degree of beauty and intensity. The process described above (385.), for dyeing wool, succeeds equally well, according to M. Decroizille, in communicating to silk a violet colour.

III. *Of Dyeing Cotton and Linen Violet.*

Co hon ess. 393. The most ordinary mode by which a violet colour is communicated to cotton and linen stuffs is first to give them a blue ground in the vat, proportioned to the required shade, and to dry them. They are afterwards galled, in the proportion of three ounces of galls to a pound of stuff, and being left in this bath for 12 or 15 hours, are wrung out and dried again. They are next passed through a decoction of logwood, and when thoroughly soaked and taken out, the bath receives an addition of two drams of alum, and one of dissolved verdigrise for each pound of cotton or thread. The skeins are then dipped again on the skein sticks, and turned for about 15 minutes, when they are taken out and aired. They are next immersed in the bath for 15 minutes, taken out and wrung. To complete the process, the vat employed is emptied; half of the decoction of logwood not formerly made use of is now poured in, with the addition of two drams of alum, and the thread is again dipped in it till it has acquired the shade proposed, which must always regulate the strength or weakness of the decoction of logwood. This colour resists in a considerable degree the action of the air, but in point of permanency is much inferior to that which is obtained from the use of madder.

Sect. III. *Of the Mixtures of Yellow and Red, or Orange.*

394. Orange is the usual result of a composition of yellow and red colours; but an almost endless variety of shades may be produced, according as we vary the proportion of the ingredients, and the particular nature of the yellow made use of. It is sometimes the practice of dyers to combine blue with yellow and red, the result of which is the colour denominated *olive.* Many varieties may be obtained from the use of weld, saw-wort, dyers-weed, and other yellows, and by employing tartar, alum, sulphate of zinc, or sulphate of copper in the bath, or in the preparation of the cloth.

I. *Of Dyeing Wool Orange.*

Orange by the scarlet process. 395. By a process exactly the same as that which is followed in communicating to stuffs a scarlet colour, an orange may be given to wool; but the quantity of red must be diminished, and that of the yellow increased. If wool is dyed a red colour by means of madder, and afterwards yellow with weld, the resulting compound is a cinnamon colour, and the most proper mordant in this case is a mixture of alum and tartar. The shades may be varied at pleasure by substituting other yellow dye stuffs instead of weld, and by varying the proportions as circumstances may require. Wool may receive a reddish yellow colour by passing it through a madder bath, after it has undergone the usual process for yellow, which has already been described. The strength of the madder bath is always to be proportioned to the shade required. Brasil-wood is sometimes employed with yellow substances, or mixed with cochineal and madder. Snuff, chesnut, musk, and other shades are produced, by substituting walnut-tree root, walnut peels or sumach, for weld.

II. *Of Dyeing Silk, Orange, &c.*

Marone, &c. 396. Logwood, brasil-wood, and fustic, communicate to silk a marone and cinnamon colour, together with all the intermediate shades. The silk is scoured in the usual manner, alumed, and a bath is prepared, by mixing together decoctions of the three different woods mentioned above, made separately, varying the quantity of each according to the shade intended to be given; but the proportion of fustic should be greatest. The silk is turned in the bath on the skein sticks, and when it is taken out, if the colour be uniform, it is wrung and again dipped in a second bath of these three ingredients, according to the effect produced by the first in order to obtain the shade required.

Olive. 397. The blue vat is not made use of, when an olive colour is to be communicated to silk. After being alumed, it is dipped in a bath of weld, which is made very strong. To this is afterwards added the juice of logwood, with a small quantity of solution of alkali when the silk is dipped. This converts it into green, and gives the olive colour. It is dipped again in this bath till it has acquired the shade wanted.

398. To communicate to it the colour known by the name of *rotten olive*, fustic and logwood are added to the bath after welding, without any alkali. If the colour wanted is to incline more to a red, the addition of logwood alone is sufficient. A sort of reddish olive may likewise be obtained, by dyeing the silk in a fustic bath, to which a greater or lesser quantity has been added of sulphate of iron and logwood.

III. *Of Dyeing Cotton and Linen Orange, &c.*

Cinnamon colour. 399. A cinnamon colour is communicated to thread and cotton, by commencing the process for dyeing them with verdigrise and weld; they are afterwards to be dipped in a solution of sulphate of iron, denominated by the French *bain d'assurage*, and then wrung out and dried. As soon as they are dried, they are galled in the

Compound Colours.

the proportion of three ounces to the pound of stuff; then dried again, alumed as for red colours, and maddered. After being washed and dried, they are put into hot soap suds, and turned till they have acquired a sufficient degree of brightness. It is the practice of some dyers to add to the aluming a decoction of fustic.

Olive.

400. By boiling four parts of weld and one of potash in a sufficient quantity of water, M. d'Apligny informs us, a fine olive colour is communicated to cotton and thread. Brasil wood, which has been steeped for a night, is boiled separately with a small quantity of verdigrise, and these solutions are mixed together in various proportions, according to the particular shade required. The thread or cotton is dipped in the compound solution in the usual way.

SECT. IV. *Of the mixture of Black with other Colours.*

Brown.

The compound colours which are obtained from the mixture of black and other colours, are brown, gray, drab, &c. according to the nature and proportions of the simple colours employed.

I. *Of Dyeing Woollen Stuffs Brown, Gray,* &c.

401. To give a browning to cloth, as soon as it has been dyed, it is dipped in a solution of sulphate of iron, with the addition of an astringent, which makes a *black bath*. It is more common to mix a small quantity of solution of iron with a bath of water, adding more till the dyed stuff dipped in it has received the intended shade. Sulphate of iron is sometimes added to the dye bath; but by dipping the dyed stuff in a solution of this salt, the end is more easily attained. It is the usual practice of M. Poerner to soak the stuff in a solution of sulphate of iron, to which other ingredients are sometimes added, and after having taken it out of the mordant, it is dipped in the dye bath.

Coffee colour.

402. In order to obtain coffee and damascene colours, with other shades of browns of the common dye, the first method is adopted; a colour more or less deep is communicated to them, according to the shade intended to be obtained by the browning; and a bath is made of galls, sumach, and alder bark, with the addition of sulphate of iron. Those stuffs are first dipped to which the lightest shades are to be communicated, and when these are finished, the browner ones are dipped; a quantity of sulphate of iron being added for each operation, proportioned to the effect intended to be produced.

Gray.

403. Blueish grays are communicated to stuffs, according to Poerner, by the solution of indigo in sulphuric acid, combined with a mixture of decoction of galls and sulphate of iron, varying the shades according to the different quantities of these ingredients made use of. If to a bath composed of cochineal, fustic and galls, sulphate of iron be added, other shades are obtained.

404. For marone, and such other colours as bear a strong resemblance to it, sanders and galls are employed, and sometimes a browning with the addition of logwood. If dyed in the remains of a cochineal bath, these colours may be made to incline to a crimson or purple, and the same effect is produced by adding a small quantity of madder or cochineal to the bath. A little tartar gives a greater degree of brightness to the colour. With a mixture of galls, fustic, and logwood, and a greater or smaller quantity of madder, with the addition of a little alum, those colours may be communicated to stuffs which are known by the name of *hazel*.

Hazel.

Puce colour.

405. M. Guhliche produces what is called a *puce* colour, by boiling for fifteen minutes a pound of woollen stuff with two ounces of alum, a certain proportion of vinegar and solution of iron, after which he leaves it in the mordant for twelve hours. He then makes a bath with the decoction of two ounces of white galls carefully poured off from the sediment, and mixed with four ounces of madder, in which, when it grows hot, the stuff is immersed, after being taken out of the mordant, allowing it to remain there, while the temperature is gradually increased, till the colour intended has been imparted to it; after which it is boiled for two minutes, washed, and dried in the sun. The colour thus obtained possesses a great degree of durability. It is of a deeper brown by the omission of the alum and vinegar in the mordant; and after these colours the lighter shades are dyed. Sumach may be employed as a substitute for half of the madder. Different brown colours possessing considerable permanency, may likewise be produced by the use of brasil and logwood, if more or less of a solution of iron be mixed with a decoction of these substances. The wool being previously alumed and galled, is dyed in it.

II. *Of Dyeing Silk with Mixtures of Black,* &c.

Purple violet.

406. M. Guhliche imparts to silk a purple violet without a blue ground, with a mixture of one part of galls dissolved in white wine, with three parts of water, in which a pound of silk is macerated for twelve hours, soaked in a mordant made up of two ounces of alum, one ounce of solution of tin, and half an ounce of muriatic acid. After wringing the stuff, it is dyed in a bath composed of two ounces of cochineal and a small quantity of solution of iron, till the intended shade has been communicated; and for shades which are lighter, the residua of these baths are sufficient, either separately or mixed together. Madder may be used in the same way, macerating a pound of silk in a solution of alum, mixed with an ounce of muriatic acid, and a quantity of solution of iron. When the stuff is wrung out, it is dyed in a bath made of eight ounces of madder. When deeper colours are wanted, some of the solution of galls in white wine is mixed with the madder and cochineal baths.

407. Silk may be dyed in a bath made of equal parts of brasil and logwood juice, adding a certain quantity of solution of iron, after the stuff has been soaked in a solution of two ounces of alum, and an ounce of muriatic acid. If solution of galls be added, the colour becomes deeper.

Brick colour.

Colours resembling that of brick, may be produced, by immersing silk in an anotta bath, after preparing it with a solution of galls mixed with a certain quantity of solution of iron. By the mixture of brasil, logwood, archil, and galls, and by a browning with sulphate of iron, a number of different shades are produced; but the whole of them have more or less

a

a tendency to fade, although their brightness is very pleasing to the eye.

III. *Of Dyeing Silk with Mixtures of Black*, &c.

408. A permanent violet colour may be given to thread and cotton, when scoured in the ordinary way, by preparing a mordant with two quarts of the bath of what is called the *black cask*, and four quarts of water for each pound of stuff, which is made to boil, and the scum is removed which forms on the surface, till it wholly disappears. The liquor is poured into a vat, and, when warm, four ounces of sulphate of copper and one ounce of nitre are dissolved in it. The skeins are left to soak in it for ten or twelve hours, wrung out, and dried. If it is required to produce a deep violet colour, two ounces of verdigrise must be added to the bath; and if the nitre be omitted, the colour becomes still deeper by galling the thread more or less, prior to its being put into the mordant. If the nitre be increased, and the sulphate of copper be diminished, the violet colour becomes more inclined to lilac. A number of various shades may be produced, by different modifications of the mordants employed.

409. Cotton is galled, dipped, and wrought in the common way, when different shades of marone colour are wanted. To the bath employed must be added more or less of the liquor of the black cask. The cotton is then washed in a bath mixed with verdigrise, next welded, and dyed to a fustic bath, to which a solution of soda and alum is sometimes added. When the cotton prepared in this manner has been thoroughly washed, it is next well maddered, dipped in a weak solution of sulphate of copper, and last of all in soap suds.

410. For some hazel and snuff colours, a browning is communicated to stuffs by means of soot, after the welding and madder bath, to which galls and fustic have been added; sometimes soot is mixed with this bath, and a browning is likewise imparted by means of a solution of sulphate of iron; and for browning colours, walnut peels are sometimes employed as a substitute for solutions of iron. For such wools as are designed for the manufacture of tapestry, they are very advantageous, because the colour is not changed into yellow by exposure to the air, as is the case in browning which is imparted by means of iron; but remains a considerable time without any sensible change. The hue is indeed rather dull; but its goodness and very moderate price are sufficient to recommend a more extensive use of it for grave colours, which in common stuffs are sometimes fashionable.

CHAP. III. *Of Calico-printing.*

411. THIS may be defined to be the art of communicating different colours to particular spots on the surface of cotton or linen cloth, while the rest of the stuff retains its original white colour.

The wonderful and truly ingenious art of calico-printing seems to have been first known in India, and for more than two centuries before the commencement of the Christian era. Although the Egyptians were well acquainted with this art in the days of Pliny, as he himself informs us, it can scarcely be doubted that they derived the knowledge of it from India, as that country rather than Egypt, produced the colouring and other materials for carrying it on. If we consider its present improved state, the elegance of different patterns, the beauty and durability of the colours which can now be imparted to cotton or linen stuffs, and the dispatch with which the various operations of this art are conducted, we must be astonished at the rapidity of its improvements, when we recollect that it has been known in Europe for little more than a century. Perhaps no other art has risen to such perfection in so short a period.

412. Our readers will not expect that our account of this subject should be tedious or elaborate, since the artist is presumed to be already acquainted with the different processes which are employed in calico-printing; and to such as wish only for a general knowledge of the art, in a theoretical point of view, prolixity would be disagreeable.

Nature of this art.

413. The art of calico-printing consists in impregnating with a mordant, such parts of cotton or linen stuffs as are to have particular colours communicated to them, and then dyeing them in the usual manner with some colouring substance. Those parts of the cloth only which receive the mordant are intimately united with the colouring matter, although the whole surface must be more or less tinged; but the parts which have not received the mordant are restored to their original brightness by means of washing, and afterwards bleaching it upon the grass for some days, taking care to turn the wrong side towards the sun. If red stripes are to be communicated to a piece of white cotton cloth, those parts of its surface upon which stripes are intended to appear, are marked out by a pencil dipped in acetate of alumina; after which it is dyed with madder in the usual way. When it is first taken out of the dyeing vessel, its whole surface is red; but when it is washed and bleached, it resumes its original whiteness, the stripes only excepted, which, being impregnated with the acetate of alumina, remain red. By a similar process may yellow or any other stripes be fixed upon cotton or linen, by the substitution of quercitron bark, weld, &c. in the room of madder.

To communicate different colours.

414. When different parts of the cloth are to receive different coloured stripes at the same time, different mordants must be employed. If stripes are delineated on its surface with the acetates of alumina and iron, and if it be then dyed with madder in the ordinary way, it will, after being washed and bleached as formerly directed, exhibit stripes of a red and brown colour. If the same mordants are employed, but quercitron bark used instead of madder, the stripes will then be *yellow*, and *olive* or *drab*.

Usual mordants.

415. The mordants known by the names of acetate of alumina and acetate of iron, which are made use of in calico-printing, may either be applied to stuffs with a pencil, as already mentioned, or still more expeditiously by means of blocks, on which the intended patterns are cut. Being designed only for particular parts of the surface of the cloth, great caution is necessary to prevent them from spreading to any part of it which is to remain white, and to prevent their interference when the application of more than one is required. Such a degree of consistence must of consequence be given to the mordants employed, as will prevent this disagreeable effect, which cannot fail to destroy the beauty and

and elegance of the print. If blocks are to be made use of, the mordants may be brought to a proper consistence by means of starch; but gum arabic must be mixed with them, when the pencil is to be employed. The thickness should not exceed what is absolutely necessary to prevent the mordants from spreading; because, if carried too far, the cotton is frequently not saturated with the mordant, in consequence of which the dye is but imperfectly communicated.

Application of the mordant.

416. To distinguish those parts of the cloth which are impregnated with mordants, it is a common practice to give the mordants some particular tinge by which they may be known; and for this purpose printers commonly make use of the decoction of brasil wood. Dr Bancroft objects to this practice, because he is of opinion that the process of dyeing is impeded by the colouring matter of brasil wood. The affinity of the dye stuff for the mordant displaces the colouring matter of the brasil wood; and without such affinity it would be impossible to strike the colour. Some of the dye stuff to be employed afterwards is recommended by Dr Bancroft for colouring the mordant, who prohibits the use of a larger quantity than what is sufficient to render it distinguishable when an application of it is made to the cloth. Should too large a quantity be united with the mordant, a considerable proportion of the latter would be combined with colouring matter, by which means its affinity for the cloth would be diminished, and therefore a permanent colour could not be expected to result from such a partial combination.

Cloth must be dried,

417. It is necessary to dry the cloth completely after the application of the mordants, for which purpose artificial heat may be employed, which has a tendency to promote the separation of the acetous acid from its base, and assist its evaporation, and thus the combination of the mordant with the cloth will be facilitated.

and then washed.

418. When the cloth is thoroughly dried, it is customary to wash it with warm water and cow-dung, till every particle of the starch or gum arabic which had been employed to give a proper consistence to the mordants, and those parts of them which do not combine with the cloth, are entirely removed. The loose particles of the mordant are entangled by means of the cow-dung, and prevented from being attached to those parts of the cloth which are to remain white. After this, it must be completely rinsed in pure water.

Colouring matters employed.

419. Indigo, madder, quercitron bark, and weld, are the chief dyeing ingredients made use of by calico-printers; but the last of these is seldom used by the printers of this country, except for the purpose of communicating yellows of a delicate greenish shade. Quercitron bark, on account of its inferior price, and capacity of imparting colours equally good, as well as requiring a less degree of heat, is employed as a substitute. It is usual to apply indigo at once, either by means of the block or pencil, because it requires not the intervention of a mordant to fix it. This preparation is made by boiling together indigo, potash reduced to the caustic state by means of quicklime, and orpiment; afterwards thickening the solution with gum. Dr Bancroft recommends the use of coarse brown sugar as a substitute for orpiment, which operates as powerfully in the decomposition of the indigo, and in promoting its solubility, answering at the same time all the purposes of gum.

Dyeing process.

420. When the cloth is thoroughly cleansed after it has been impregnated with the mordant, the dyeing process is conducted in the usual manner. As the whole of it receives a tinge of the dye, it must be completely washed and bleached for some days on the grass, as formerly mentioned, by which means the colour is entirely removed from those parts of the cotton not impregnated with the mordant, while all the other parts of it retain the colouring matter as powerfully as at first.

Nanke yellow,

421. One of the most common colours imparted to cotton prints is a species of nankeen yellow of different shades, and for the most part in stripes or spots. It is produced by means of a block on which is cut the intended pattern, rubbed over with acetate of iron brought to a proper consistence with gum or starch, and applied to the cotton; which, being dried and cleansed in the ordinary way, is immersed in a ley of potash. It is proper to observe, that the quantity of acetate of iron must be proportioned to the particular shade required.

Yellow.

422. In order to produce a yellow colour, the block is rubbed over with acetate of alumina; and the cloth, after being impregnated with this mordant, is dyed with quercitron bark in the common manner, and then bleached.

Red.

423. If madder be substituted for the quercitron bark, a red colour is given to cotton by the same process.

Blue.

424. To communicate to stuffs the fine light blue colours which we frequently behold upon cotton, the block is rubbed over with a composition consisting partly of wax, by means of which all those parts of its surface are to remain white. It is next dyed in a cold vat of indigo, and when it is dried, the wax composition may be removed by the use of hot water.

Lilac,

425. Lilac and blackish brown colours are communicated by acetate of iron, proportioning the quantity to the particular shade required, and adding a little sumach for such shades as are to be very deep. The cotton is then dyed with madder, and bleached in the usual manner. Dove colour and drab are produced by means of acetate of iron and quercitron bark.

How t ply diff ent col

426. When a variety of different colours are to be made on the same print, a greater number of operations are unavoidably necessary. Upon each of the blocks to be employed is cut that particular part of the pattern which is to have one appropriate colour; and when these blocks are rubbed over with their respective mordants and thus applied to the cloth, the dyeing process is afterwards conducted in the ordinary manner. If, for example, three different blocks are to be made use of, the first rubbed over with acetate of alumina brought to a proper consistence, the second with acetate of iron, and the third with a composition of these two, the colours resulting, after the dyeing and bleaching processes are finished, will be the following.

Acetate of alumina	yellow,
iron	olive, drab, dove,
From the compound	olive green, olive.

It is proper to observe, that these are the results when quercitron bark is employed; but by the substitution of madder the following colours will be obtained.

Acetate

Acetate of alumina	red,
iron	brown, black,
From the compound	purple.

When it is required to produce at the same time both those colours which are imparted by madder, and likewise by the use of quercitron bark, mordants are first applied for one part of the pattern, after which the cotton is dyed in a bath of madder, and then bleached. The rest of the mordants are then applied in a similar manner, after which the cotton is dyed with the quercitron bark, and bleached as before. The colours which the madder communicates are very little affected by the second dyeing, because the mordants by which their permanency is secured, are previously saturated. A new mordant may be applied to some of the colours resulting from the use of madder, by which means they receive a new durable colour from the bark. And by means of the indigo liquor other new colours may still be communicated after the last bleaching.

Va ty of co rs by di ent pr sses.

427. The following colours may be communicated to cotton, by means of the different processes which have been described.

Madder Dye.

Acetate of alumina	red,
iron	brown, black,
Ditto diluted	lilac,
Mixture of the two	purple.

Dark Dye.

Acetate of alumina	yellow,
iron	dove-drab,
Lilac and acetate of alumina	olive,
Red and acetate of alumina	orange.

Indigo Dye.

Indigo	blue,
Indigo and yellow	green.

Thus may twelve different colours be communicated to the same print by these different processes.

Co s or cil- ng.

428. If durable colours could be directly applied to cotton by means of the block or pencil, without the help of mordants, nothing could be conceived more simple than the art of calico-printing; but with the single exception of indigo, the communicating of permanent colours requires the process of dyeing. Yellow, indeed, which is a compound colour, and some others, may be communicated to cotton at once, by mixing together an infusion of quercitron bark and acetate of alumina, while the same mordant with a decoction of madder, imparts to it a red colour; but those which are produced in this way are far from being durable, since they are destroyed by washing, and sometimes even by exposure to the air.

Com si- ion r ell co. ou

429. But as it is not always practicable for calico-printers to avoid the application of colours in this manner, every endeavour to give them a greater degree of permanency becomes an object of importance. The following composition has been recommended for a yellow printing colour. Three pounds of alum, and three ounces of pure chalk are to be dissolved in a gallon of hot water, to which are to be added two pounds of acetate of lead. This mixture is to be occasionally stirred for 24 or 36 hours, after which it is to remain at rest during 12 hours. The clear liquor is then to be poured off, and as much more hot water added to the residuum, as will, after being stirred and allowed to settle, amount to three quarts when added to the first quantity. Into a tinned copper vessel put six pounds, or at most a quantity not exceeding eight pounds, of quercitron bark sufficiently ground, and boil it for an hour in four or five gallons of clean soft water, adding afterwards a little more water if the bark is not properly covered. When the liquor is thoroughly boiled, let it be removed from the fire, and left to settle for half an hour, when the clear decoction is to be poured off through a fine sieve. Six quarts more of pure water are then to be put upon the same bark, and boiled for a quarter of an hour, being previously well stirred. When it has stood a sufficient time to settle, the clear liquor is to be strained off, and being mixed with the former, both are put into a shallow wide vessel to be evaporated by boiling, till the whole, in addition to the mordant already mentioned, and the gum or paste for bringing it to a proper consistence, does not exceed three gallons. It will be proper not to add the three quarts of aluminous mordant till the decoction has been cooled down almost to the natural heat of blood. Let gum arabic or gum senegal be taken for thickening, if the pencil is to be used, and starch or flour when blocks are to be employed.

For bright yellow.

430. If a pound of murio-sulphate of tin be used as a substitute for the aluminous mordant in the composition described above, a mixture will be produced which is capable of imparting to cotton a very bright yellow, and considerably permanent.

Cinnamon colour.

431. A cinnamon colour possessed also of a sufficient degree of permanency may be given to cotton, by means of a mixture of sulphate of tin and a decoction of the quercitron bark.

Green.

432. If the decoctions of this bark and of logwood are boiled together, and proper quantities of sulphate of copper and verdigrise added to them, together with a small proportion of carbonate of potash, there results a compound which communicates to cotton a green colour. Although the expectations of Dr Bancroft were not fully answered by the trials which he made of this substance, he deemed his success sufficient to encourage him to a farther investigation of it.

Drab and olive.

433. A permanent drab colour may be given to cotton by means of acetate of iron mixed with a decoction of quercitron bark, and reduced to a proper consistence. This mixture will also produce an olive, if added to the olive colouring liquor already mentioned; and the colours may be made still more permanent, if a solution of iron in diluted nitric or muriatic acid be used as a substitute for iron liquor. They ought, however, to be used sparingly and with caution, that the texture of the cotton or linen to which they are applied may not be injured.

Colours from different mordants and the quercitron bark.

434. Dr Bancroft made a number of experiments with the decoction of quercitron bark, to ascertain its effects when combined with different metallic salts as mordants. The sulphate, nitrate, and muriate of zinc, with this decoction, yielded brownish yellow colours of different shades; but none of them were found sufficiently permanent when they were applied topically to linen or cotton. Mercury in the different acids pro-

Indian Method of Dyeing Red.

duced with the decoction of bark different shades of brown or yellowish brown colours; but they did not prove more durable than the former. The nitro-muriate of platina with a proper proportion of decoction of quercitron bark, afforded, when topically applied to linen or cotton, strong full-bodied snuff colours, which were found sufficiently permanent, and capable of resisting the action of acids, and of the sun and air. Nitrate of silver with a decoction of the bark, when applied topically to linen or cotton, produced strong dark brown and cinnamon colours of considerable durability. Nitrate of lead with the same decoction gave, by topical application, a drab colour which was not less durable than the former. Nitrate of bismuth produced with the decoction of bark a very full and strong brownish yellow. This colour, however, is attended with the inconvenience of becoming almost black when exposed to the action of the alkaline sulphurets, sulphurated hydrogen gas, or even by the action of common soap. Muriate of bismuth with the decoction gives a drab colour: sulphate of the same metal affords a yellow; but these colours when applied to cotton or linen are not durable. Nitro-muriate of antimony produced with the decoction of bark something of a snuff colour, which applied to linen and cotton possess some degree of durability. Nitrate and muriate of cobalt with the quercitron bark gave different shades of brown; but these colours were extremely fugitive; they soon faded by exposure to the sun and air.

Indian M thod o D yein Red.

435. The art of calico-printing has been hitherto almost solely limited to linens and cottons. Many colouring matters have such an affinity for these stuffs that they readily enter into combination with them at the ordinary temperature of the atmosphere. This is also the case with silk, so that colouring matters might be applied topically to the latter by means of similar operations as to linen and cotton. Attempts, however, have been made to extend the process of topical dyeing or printing to woollen stuffs, and particularly those kinds known by the name of kerseymeres, which are employed after being prepared in this way for waistcoat patterns. When it is recollected that woollen stuffs when they are to be dyed generally must be exposed to a considerable degree of heat, it is easy to conceive that it will be difficult to communicate spots or figures by printing to woollen stuffs. The means by which this difficulty is obviated in those manufactories where this operation is conducted have been hitherto kept secret. The preparation of colouring matter, whether such as may be employed simply or require the use of mordants to fix them, will be easily understood from what we have already fully detailed in the course of this treatise. The application of the colours is made in the usual way; and it is said that, after the woollen stuffs are printed, they are wrapped up in two or three folds of thick paper, to prevent the access of moisture which might cause the colours to run, and exposed to the steam of boiling water for such a length of time as may be supposed necessary for the colouring matter to combine with the stuffs†.

Woolle stuffs pri ted.

APPENDIX.

After that part of the preceding treatise to which it properly belongs, was printed off, the following account of the Indian method of dyeing cotton cloth and cotton thread a red colour came under our notice. It was communicated to the Society for the Encouragement of Arts, &c. by Mr Maclachlan of Calcutta. The insertion of it may perhaps excite the curiosity of some of our countrymen into farther inquiries into the state of this as well as of other arts in India, where, from being long known and practised, many of them have arrived at a high degree of simplicity and perfection.

Directions for dyeing a bright Red, four yards of three-fourths broad Cotton Cloth.

1st. The cloth is to be well washed and dried, for the purpose of clearing it of lime and congee, or starch, generally used in India for bleaching and dressing cloths; then put into an earthen vessel, containing twelve ounces of chaya or red root, with a gallon of water, and allow it to boil a short time over the fire.

2d. The cloth being taken out, washed in clean water, and dried in the sun, is again put into a pot with one ounce of myrobalans, or galls coarsely powdered, and a gallon of clear water, and allowed to boil to one half: when cool, add to the mixture a quarter of a pint of buffalo's milk. The cloth being fully soaked in this, take it out, and dry it in the sun.

3d. Wash the cloth again in clear cold water, and dry it in the sun; then immerse it into a gallon of water, a quarter of a pint of buffalo's milk, and a quarter of an ounce of the powdered galls. Soak well in this mixture, and dry in the sun. The cloth, at this stage of the process, feeling rough and hard, is to be rolled up and beetled till it becomes soft.

4th. Infuse into six quarts of cold water, six ounces of red wood shavings, and allow it to remain so two days. On the third day boil it down to two-thirds the quantity, when the liquor will appear of a good bright red colour. To every quart of this, before it cools, add a quarter of an ounce of powdered alum; soak in it your cloth twice over, drying it between each time in the shade.

5th. After three days wash in clean water, and half dry in the sun; then immerse the cloth into five gallons of water, at about the temperature of 120° of Fahrenheit, adding 50 ounces of powdered chaya, and allowing the whole to boil for three hours; take the pot off the fire, but let the cloth remain in it until the liquor is perfectly cool; then wring it gently, and hang it up in the sun to dry.

6th. Mix intimately together, by hand, about a pint measure of fresh sheep's dung, with a gallon of cold water, in which soak the cloth thoroughly, and immediately take it out, and dry it in the sun.

7th. Wash the cloth well in clean water, and spread it out in the sun on a sand-bank (which in India is universally preferred to a grass-plat) for six hours, sprinkling

---

† Bancr 189.

ling it from time to time, as it dries, with clean water, for the purpose of finishing and perfecting the colour, which will be of a very fine bright red.

Directions for dyeing of a beautiful red, eight ounces of Cotton Thread.

1st. Put one gallon and a half, by measure, of sap-wood ashes, into an earthen pot, with three gallons of water, and allow the mixture to remain twenty-four hours to perfect it for use.

2d. Put the following articles into an earthen pot, viz. three quarters of a pint of Gingelly oil; one pint, by measure, of sheep's dung, intimately mixed by hand in water; two pints of the above ley.—After mixing these ingredients well, pour the mixture gradually upon the thread into another vessel, wetting it only as the thread, by being squeezed and rolled about by the hand, imbibes it, continuing to do so until the whole is completely soaked up, and allow the thread to remain in this state until next day.

3d. Take it up, and put it in the sun to dry; then take a pint and a half of ash-ley, in which squeeze and roll the thread well, and allow it to remain till next day.

4th. Squeeze and roll it in a like quantity of ash-ley, and put it in the sun to dry; when dry, squeeze and roll it again in the ley, and allow it to remain till next day.

5th. Let the same process be repeated three or four times, and intermit till next day.

6th. Ley the thread once, as the day before, and, when well dried in the sun, prepare the following liquor: One gill of Gingelly oil; one pint and a half of ash-ley.—In this squeeze and roll the thread well, and leave it so till next day.

7th. Repeat the process of yesterday, and dry the thread in the sun.

8th. The same process to be repeated.

9th. First repeat the ash-ley process three or four times, as under the operations 3, 4, and 5, and then prepare the following mixture: One pint of sheep-dung water; one gill of Gingelly oil; one pint and a half of ash-ley.—In this squeeze and roll the thread well, and dry it in the sun.

Indian Method of Dyeing Red.

10th. Repeat the same process.
11th. Do. Do.
12th. Do. Do.
13th. Do. Do.
14th. Do. Do.

15th. Wash the thread in clean water, and squeeze and roll it in a cloth until almost dry; then put it into a vessel containing a gill of powdered chaya root, one pint by measure of cashan leaves, and ten pints of clear water; in this liquor squeeze and roll it about well, and allow it to remain so till next day.

16th. Wring the thread, and dry it in the sun, and repeat again the whole of the 15th process, leaving the thread to steep.

17th. Wring it well, dry it in the sun, and repeat the same process as the day before.

18th. Do. Do.
19th. Do. Do.

20th. Wring and dry it in the sun, and with the like quantity of chaya root in ten pints of water; boil the thread for three hours, and allow it to remain in the infusion until cold.

21st. Wash the thread well in clear water, dry it in the sun, and the whole process is completed.

INDEX.

DYNAMICS.

DYNAMICS.

Introduction.

Definition.

1. DYNAMICS is that branch of physico-mathematical science which includes the abstract doctrine of *moving forces;* that is, the necessary results of the relations of our thoughts concerning motion, the immediate causes of motion, and its changes.

Idea of motion.

2. Motion and its general properties are the first and principal object of mechanical philosophy. This science indeed presupposes the existence of motion; and we may consider it as universally admitted and recognised. With regard to the nature of motion, however, philosophers are greatly divided in opinion. The most obvious and simplest conception of motion is the successive application of the moving body to the different parts of indefinite space, which are considered as the place of the body. This idea of motion supposes a space whose parts are penetrable and immoveable; a doctrine directly contrary to that of the followers of Des Cartes, who regarded extension and matter as one and the same thing. To have a distinct idea of motion, it seems requisite to conceive two kinds of extension; the one, which is considered as impenetrable, and which constitutes what we properly call *matter* or *body;* the other, which being simply considered as extended, without taking any other property into account, is the measure of the distance of one body from another; and whose parts being supposed fixed and immoveable, enable us to judge of the rest or motion of bodies. We may therefore conceive bodies to be placed in indefinite space, whether real or supposed; and motion as a change in the state or condition of a body from one part of space to another. We must indeed consider motion as a state or condition of existence of a body, which would remain till it is changed by some cause; otherwise we could not have any idea of motion in the abstract. From the changes which we observe, we infer agency in nature; and in these changes we are to discover what we know of their causes.

Idea of space.

3. In mechanical disquisitions, the simplest, and at the same time the most usual conception of space, is mere extension. We think only of the distance between two places. The path along which any body moves in passing from one place or point in space to another, is said figuratively to be the path described by that body. Space is considered by the geometer not only as having length but also breadth. In this case it is called a *surface.* But to have a more complete notion of the capaciousness of any portion of space, thickness, as well as length and breadth, is taken into consideration. This is called a solid space. By this, however, is meant only the susceptibility of measure in three ways, or extension of three dimensions. The adjacent parts or portions of space are distinguished from each other by their mutual boundaries. Contiguous portions of a line are separated by points; contiguous portions of a surface are separated by lines; and contiguous portions of a solid are separated by surfaces. The boundaries of any portions of space are not to be considered as parts of the contiguous portions. They must be conceived as common to both; as the places where one portion ends and another begins. Space cannot be said to have any bounds or limits; it is therefore said to be infinite or unbounded.

Introduction.

Relative and absolute space.

4. Any portion of space may be considered in relation to its place or situation among other portions of space. This portion of space which is occupied by any body has been called the *relative place* of that body. But this portion of space may be considered as a determinate portion of infinite space; and this portion of infinite space occupied by any body has been called the *absolute place* of that body. Space, it is obvious, taken in this meaning, is immoveable; for it cannot be conceived that this identical portion of space can be removed from one place to another. The body which occupies that space may be removed, but the space remains. We have no perception of the absolute space of any object. This may be illustrated by the motion of the earth or that of a ship. A person in the cabin of a ship does not consider the table as changing its place while it remains fixed to the same spot on the deck. While a mountain is observed to retain the same situation among other objects, few persons think that it changes its place.

Idea of time.

5. The idea of time is acquired by means of the power of memory in observing the succession of events. We conceive time as unbounded, continuous, homogeneous, unchangeable in the order of its parts, and infinitely divisible. It is conceived as a proper quantity made up of its own parts, and measured by them. But as the relation of the parts of time is unknown, the only means which we can employ to discover this relation, is to find out some other relation which is more obvious and better known, to which it may be compared. We shall then have discovered the simplest measure of time, if we compare in the simplest manner possible the relation of the parts of time with those relations which are most familiar. Hence it follows, that uniform motion is the simplest measure of time. For, on the one hand, the relation of the parts of a right line is that which is most easily conceived; and, on the other hand, there are no relations more susceptible of comparison with each other than equal relations. Now, in uniform motion, the relation of the parts of time is equal to that of the corresponding parts of the line described. Uniform motion then gives us at once, both the means of comparing the relation of the parts of time with that which is most obvious to our senses, and also of making this comparison in the simplest manner. In uniform motion, then, we find the simplest measure of time. It may be added, that the measure of time by uniform motion, is, independent of its simplicity, that which is the most natural to think of employing. Indeed as there is no relation with which we are acquainted more accurate than that of the parts of space; and, as in general, a motion, the law of which is given, would lead us to discover the relation of the parts of time, by the known analogy with that of the parts of space passed over, it is evident that such a motion would be the most accurate measure of time, and

and that which ought to be employed in preference to every other. In the actual measurement of time, some event which is imagined always to require an equal time for its accomplishment is selected; and this time is employed as a unit of time or duration, in the same way as a foot rule is employed as a measure of extension. During any observed operation, as often as this event is accomplished, so often is it supposed that the time of the operation contains this unit. While a heavy body falls 16 feet, a pendulum, $39\frac{1}{8}$ inches long, makes one vibration; but it makes three vibrations, while the same body falls 144 feet. It is therefore said that the time of a body falling 144 feet, is thrice as great as the time of falling 16 feet.

Analogy between the affections of time and space.

6. Between the affections of time and space, there is an obvious analogy; and hence in most languages the same words are employed to express the affections of both. Thus it is that time may be represented by lines and measured by motion; since uniform motion is the simplest succession of events that can be conceived. In the order of situation all things are placed in space. In the order of succession all events happen in time.

Having made these preliminary observations, we propose to divide the following treatise into two parts. In the first, we shall consider motion in general. In the second, we shall treat of *moving forces*, or of *dynamics*.

PART I. OF MOTION.

BEFORE we enter on the consideration of the different kinds of motion, it may be necessary to notice some general circumstances regarding it.

7. It is impossible to conceive that any motion can be instantaneous. A moving body, in passing from the beginning to the end of its path, must pass through all the intermediate points. Now to suppose the motion along even the most minute portions of the space passed through instantaneous, is to suppose that the moving body is in every intervening point at the same instant; which is impossible.

8. Relative motion is the change of situation with regard to other objects. Absolute motion is the change of absolute place. These two motions, it may be observed, may not only be different, but even contrary to each other. From the relative motions of things which are the differences of their absolute motions, we cannot find out what are the absolute motions. It is often a subject of elaborate and intricate investigation to discover and determine the absolute motions, by means of observing the relative motions.

9. The affections or circumstances of motion are various with regard to its quantity and direction. That affection of motion by which the quantity is determined, is called *velocity*. The length of the line, which is uniformly described or passed over during some given portion or unit of time, is the proper measure of this velocity. When a ship sails six miles per hour, she describes a length of line equal to six miles in the space of a given portion or unit of time, namely the hour; and thus the velocity of the ship is said to be ascertained.

10. Another affection or circumstance of motion is its *direction*. This is the position of the straight line along which the motion is performed. The straight line which a body describes or tends to describe is called its direction. The motion is said to be in the direction AB, fig. 1. when the body moved passes along the line AB from A to B. In common language, it is not unusual to express the direction of motion in a manner quite the reverse of this. We have an instance of this kind in speaking of the direction of the winds. A current of air or wind which moves eastward is said to be a westerly wind, deriving its name from the point or quarter from which it proceeds, not as in other cases, and in strict expression, from the point to which it is directed.

Rectilineal motion.

11. Motions are of different kinds. They are either rectilineal, deflected, or curvilineal. In a rectilineal motion the direction remains unchanged during the whole time that the motion is continued, as when a body moves from A to B, fig. 1. In a deflected motion it is performed along two contiguous straight lines in succession. Thus if a body moves from A to B, fig. 2. and at the point B its direction is changed from that of AD to BC; this change has been called *deflection*, the quantity of which may be measured either by the angle DBC, or by a line DC drawn from the point D to which the body would have arrived in the same time, if its motion had remained unchanged, in which it has actually reached the point C. When a body in moving along describes the sides of a polygon, the deflections are repeated, with the intervention of undeflected motions. In curvilineal motion the deviation and deflection are supposed to be continual. Continual deflection therefore constitutes curvilineal motion. Let the motion be performed along a curve line ABCDE (fig. 3.), the direction is continually changing. When the body is in the point C the direction is that of the tangent CF; because this direction alone lies between any pair of polygonal directions, such as CE and C *a*, or CB and CD, however near the points A and E, or B and D, are taken to the point C.

Fig. 1. Deflected. Fig. 2. Curvilineal. Fig. 3.

Division of motions.

12. Motions have been divided into *uniform* motions, *variable*, *compound*, and *curvilineal*. These we shall consider separately in the following sections.

SECT. I. *Of Uniform Motion.*

Importance of fixed characters of uniform motions.

13. It is of great importance in mechanical disquisitions, to have the characters of uniform or unchanged motion fixed. For in our conceptions of motion in general, in which we do not turn the attention to its alterations, the motion is supposed to be equable and rectilineal. By the deviations from such motion only can we determine the marks and measures of all changes; and hence also we are to obtain the measures of all changing causes, or in other words of the mechanical powers of nature.

PROPOSITION I.

14. *In uniform motions, the velocities are in the proportions of the spaces described in the same or in equal times;*

times; or as it is sometimes expressed, *The velocities are proportional to the spaces described in equal times.*

The spaces described are the measures of the velocities, and things are proportional to their measures. Let the spaces described in the time T, be represented by S and s, and let the velocities be represented by V and v. We have the analogy $V : v = S : s$. Or, as it may be expressed by the proportional equation, $v \doteq s$.

Prop. II.

15. *In uniform motions with equal velocities, the times are in the proportion of the spaces described during their currency.* Or, as it is also expressed, *The times are proportional to the spaces described with equal velocities.*

For in uniform motions, equal spaces are described in equal times. The successive portions of time therefore are equal, in which equal spaces are described in succession; and the sums of the equal times must be proportional to the corresponding sums of equal spaces. In all cases, therefore, which are susceptible of being represented by numbers, this proposition is evident. And it may be extended to all other cases, in a way similar to that in which Euclid has demonstrated that triangles of equal bases are in the proportion of their bases.

16. As proportion can only take place between quantities of the same kind, all that is to be understood by the expressions in the above propositions, which are far from being accurate, is, that the proportions of the velocities and the times are the same with the proportions of the spaces. For as space and time are quantities of a different nature, it is evident that we cannot divide space by time. Thus when it is said that *the velocities are as the spaces divided by the times*, it is an abridged mode of expression, which signifies that the velocities are as the relations of the spaces to the same common measure, divided by the relations of the times to the same measure. Thus, for example, if we take a foot for the measure of the spaces, and a minute for the measure of the times, the velocities of two bodies which move uniformly, are to each other as the number of feet described, divided by the number of minutes which the bodies require to describe the portion of space passed through, and not as the feet divided by the same minutes.

Uniform motion a measure of time.

17. Hence it is that uniform motion is universally employed as a measure of time. But it is often difficult to find out whether the motion which is proposed for the measure of time be perfectly uniform. What then are the means to ascertain this? To this it may be answered that there is no motion which is not uniform, the law of which we can determine exactly; so that this difficulty only proves that we cannot ascertain the relation of the parts of time with mathematical precision; but it does not follow that uniform motion from its nature may not be the first and simplest measure. And having no strictly accurate measure of time, we endeavour to discover the measure which comes nearest in the motions which approach nearest to uniformity.

Method of ascertaining when a motion is nearly uniform.

18. There are three ways by which it may be ascertained that a motion is nearly uniform. 1. When the moving body describes equal spaces in times which we judge to be equal; and we can determine that the times are equal, after having observed from repeated experience that similar events take place in the same times. Thus we conclude that the times which the same clepsydra requires to be emptied are equal; so also the times in which the same quantity of sand runs in the sandglass; the times in which the shadow moves over the same space on the sun-dial; the times of the same number of vibrations of a pendulum of the same length; and the times of the revolution of the heavenly bodies through the same spaces—are equal. If then it is found by observation that a body during the same time passes over equal spaces, we conclude that the motion is uniform. 2. Another method of ascertaining how far any motion is uniform, is when the effect of the accelerating or retarding cause, if such operate, is imperceptible. It is by combining these two methods that we conclude the motion of the earth round its axis to be uniform; and this inference is not only not opposed by any of the celestial phenomena, but seems to be in perfect accord with them. 3. By a third method of determining the uniformity of any motion, we compare it with others; and when the same law is observed in both the one and the other, we may conclude that the motion compared is uniform. Thus if several bodies move at such a rate that the spaces described in the same time are always to each other, either precisely or very nearly so, in the same ratio, the motion of these bodies, we conclude, is either precisely, or at least very nearly uniform. For if a body A which moves uniformly passes through the space E during the time T taken at pleasure, and another body B also moving uniformly, passes through the space e during the same time T, the relation of the spaces E, e will be always the same, whether the two bodies have begun to move in the same or in different instants; and it is only to uniform motion that this property belongs. Wherefore if we divide the time into parts, whether equal or unequal, and if it be observed that the spaces passed through by two bodies during one part of the time, are always in the same relation, the greater the number the parts of the time taken, the more there is reason to conclude that the motion of each body is uniform. None of these methods, it has been observed, possssses geometrical precision; but they are sufficient, especially when they are repeated and taken together, to afford a satisfactory conclusion, if not with regard to absolute uniformity of motion, at least with regard to a near approximation to uniform motion.

Prop. III.

19. *In uniform motions, the spaces described are in the compound ratio of the velocities and the ratio of the times.* This proposition is frequently expressed otherwise thus; *The spaces described with a uniform motion are proportional to the products of the times and the velocities*: Or otherwise thus; *The spaces described with a uniform motion are proportional to the rectangles of the times and the velocities.*

For let S be the space described with the velocity V, in the time T, and let s be the space described with the velocity v, in the time t. Let another space Z be described in the time T with the velocity v.

Then by proposition 1st we have $S : Z = V : v$,
And by proposition 2d $Z : s = T : t$.

By composition of ratios therefore (or by VI. 23. Euclid), we have $=V\times T : v\times t = S\times Z : s\times Z$; that is, $=S : s$.

The above are all equivalent expressions which are demonstrated by the same composition of ratios. The products or rectangles of the times and velocities, are the products of numbers which are as the times, multiplied by numbers which are as the velocities; or the rectangles whose bases are as the times, and whose heights are as the velocities.

Corollary.

20. *If the spaces described in two uniform motions be equal, the velocities are in the reciprocal proportion of the times.*

For in this case the products VT and $v\,t$ are equal, and therefore $V : v = t : T$, or $V : v = \frac{1}{T} : \frac{1}{t}$. Or, because the rectangles AC, DF (fig. 4.) are in this case equal, we have (by VI. 14. Euclid) $AB : BF = BD : BC$, that is $V : v\ t : T$.

Prop. IV.

21. *In uniform motions, the times are as the spaces, directly, and as the velocities, inversely.*

For by Prop. III. $S : s = VT : v\,t$;
Therafore, $S\,v\,t = s VT$,
And, $T : t = S\,v : s\,V$.
Or, $T : t = \frac{S}{V} : \frac{s}{v}$,
And, $t \doteq \frac{s}{v}$.

Prop. V.

22. *In uniform motions, the velocities are as the spaces, directly, and as the times, inversely.*

For by Prop. IV. $S\,v\,t = s VT$,
Therefore $V : v = S\,t : s\,T$.
Or, $V : v = \frac{S}{T} : \frac{s}{t}$.
And, $v \doteq \frac{s}{t}$.

23. The values of the results of these propositions are not changed by the absolute magnitudes of the space and time, if both are changed in the same ratio. The value of $\frac{12\text{ feet}}{24''}$, or of $\frac{8\text{ feet}}{16''}$, is the same with half a foot per second. Therefore, if s' be the expression of an extremely minute portion of space described with this velocity in the small portion of time t', the velocity v is still accurately expressed by $\frac{s'}{t'}$. And the accurate expression of the time t' is $\frac{s'}{v}$.

Sect. II. *Of Variable Motions.*

24. In observing the phenomena of nature, it rarely happens that the motions to which our attention is directed are perfectly uniform. These motions, however, we distinctly conceive, with all their properties; and it is obviously of the utmost importance that all the deviations from uniform motions be clearly understood; because these deviations afford the only marks and measures of the variations, and therefore of the causes which produce these changes.

Variable Motions.

25. When a body continues to move uniformly in the same direction, its motion, or circumstances with respect to motion, have suffered no change. The condition of that body, therefore, must be allowed to be the same in any two portions of its path, whatever the distance of these portions may be. And because a change of place is involved in the very conception of motion, the difference of place does not imply any change. Two bodies, therefore, moving with the same velocity in this path, or in two lines parallel to it, their condition in respect of motion must be allowed to be the same. Their direction is the same, and their rate of motion is the same. The velocity, therefore, and the direction of a body, are the only circumstances which seem to enter into our conception of the state of a body, in respect of motion. Changes either in the velocity, or in the direction, or in both of these circumstances, include all the changes of which this condition is susceptible. Let us now consider the first of these changes, namely, changes of velocity.

Velocity and direction only conceived in motion.

Of Accelerated and Retarded Motions.

26. It has been ascertained by experiment and observation, that a stone in falling is carried downward with greater rapidity in every successive period of its fall. During the first second it falls 16 feet; during the next, it falls 48 feet; during the third, it falls 80 feet; during the fourth, it falls 112 feet; continuing to fall, during every successive second 32 feet more than during the preceding second. A body moving in this manner is said to have an *accelerated motion.* But if a body be projected perpendicularly upwards, the very reverse takes place in the circumstances of its motion. It is observed to rise with a motion which is continually *retarded.* These bodies therefore are conceived to be in every succeeding instant in different states of motion. The velocity of the falling body is conceived to be greater in a certain instant than in any preceding instant; as, for example, when it has fallen 144 feet, its velocity is said to be thrice as great as when it has fallen only 16 feet. But this inference, it is evident, cannot be made directly by comparing the spaces described in the following moments; for in these it falls 112 and 48 feet; or by comparing the spaces immediately preceding; for in these the body fell 80 and 16 feet. But in this expression it is supposed that the variable condition of a body, called its velocity, is in every instant susceptible of any accurate measure; and yet in no moment, however short, does the body describe uniformly a space which can be taken as the measure of its velocity at the beginning of that moment; because the space described in any moment is too great for measuring the velocity at the beginning of the moment, and too small for the measure of its velocity at the end of it. Till however such a measure is obtained, the mechanical condition of the body is not known.

27. But in a continually accelerated motion, no such measure can be obtained. No space is described

ed in an instant: for this requires time. In that instant, however, the body possesses what has been called a *potential velocity*, that is, a certain tendency or determination, which remaining unchanged, causes it to describe a certain space uniformly during some assignable portion of time. At another instant it has another determination, by which, if it be not changed, another space will be uniformly described in an equal portion of time. Now it is in the difference of those two determinations that its difference of mechanical condition consists. The marks and measures of these determinations are known from the spaces which would be uniformly described. These therefore must be carefully investigated as the measures of the velocities; and the proportions of these spaces are to be taken as the proportions of the velocities.

Prop. VI.

Fig. 5.

28. *Let the straight line* ABD (fig. 5.) *be described with a motion continually varied; it is required to determine the proportion of the velocity in the point* A, *to the velocity in any other point* C.

Let the right line *a b d*, represent the time of this motion along the path AD, so that the points *a*, *b c*, *d*, may denote the instants of the moving body being in A, B, C, D, and the proportions *a b*, *b c*, *c d*, may express the times of describing AB, BC, CD, that is, may be in the proportion of those times; and let *a e*, perpendicular to *a d*, express the velocity of the moving body at the instant *a*, or in the point A. Let *e g h* be a line, so related to the axis *a d*, that the areas *a b f e*, *b c g f*, *c d h g*, comprehended between the ordinates *a c*, *b f*, *c g*, *d h*, all perpendicular to *a d*, may be proportional to the spaces AB, BC, CD, described in the times *a b*, *b c*, *c d*, and let this relation hold in every part of the figure. Then the velocity in A is to the velocity in B, or C, or D, as *a e* to *b f*, or *c g*, or *d h*. Or it may be expressed in other words, *If the abscissa* a d, *of a curve* e g h, *be proportional to the time of any motion, and the areas interrupted by parallel ordinates be proportional to the spaces described, the velocities are proportional to those ordinates.*

Make *b c* and *c d* equal, so as to represent very small and equal moments of time, and make *p a* equal to one of them. Complete the rectangle *p a e q*. This will represent the space uniformly described in the moment *p a*, with the velocity *a e* (Propos. 3.). Let PA be that portion of space thus uniformly described in the moment *p a*. Let the lines *i m*, *k n*, parallel to *a d*, making the rectangles *b c m i*, and *c d n k*, respectively equal to the areas *b c g f*, and *c d h g*. If the motions along the spaces PA and BC had been uniform, the velocities would have been proportional to the spaces described (Propos. 1.) because the times *p a*, and *b c* are equal. That is, the velocity in A would be to the velocity in C, as the rectangle *p a e q* to the area *b c g f*, that is, as *p a e q* to *b c m i*, that is, as the base *a e* to the base *c m*, because the altitudes *p a* and *b c* are equal.

But the motion along the line BC is not represented as uniform; for the line *f g h* diverges from the axis *b d*, the ordinate *c g* being greater than *b f*. And therefore the spaces measured by these areas increase faster than the times; and thus the figure represents an accelerated motion. Therefore the velocity with which BC would be uniformly described during the moment *b c*, is less than the velocity at the end of that moment, that is, at the instant *c*, or in the point C of the path; and therefore it must be represented and measured by a line greater than *c m*.

In the same manner it is proved that *c k* represents and measures the velocity with which CD would be uniformly described during the moment *c d*. And therefore, since the motion along CD is also accelerated, the velocity at the beginning of that moment is less than the velocity with which it would be uniformly described in the same time, and must be represented by a line less than *c k*.

Therefore the velocity in A, is to that in C, in a less ratio than that of *a e* to *c m*, but in a greater ratio than that of *a e* to *c k*. But in this case, as long as the instant *b* is prior, and *d* posterior, to the instant *c*, *c m* is less, and *c k* is greater, than *c g*. Therefore the velocity in A is to that in C in a ratio that is greater than any ratio less than that of *a e* to *c g*. And, consequently the velocity in A is to that in C, as *a e* to *c g*.

It may be proved in the same way, with respect to the velocity in any other point D; and therefore the proposition may be considered as demonstrated. And had the motion along BCD, instead of being accelerated as in this case, been retarded, the same reasoning would still apply.

Corollaries.

29. Cor. 1. *The velocities in different points of the path* AD, *are in the ultimate ratio of the spaces described in equal small moments of time.* Draw *g o* parallel to *a d*. Then the velocity in the instant *a*, is to that in the instant *c*, as *a e* to *c g*, that is, as the rectangle *p e* to the rectangle *c o*, that is, as *p a e q* to *c d h g*, nearly. As the moments are diminished, the difference *g o h* between the rectangles *c g o d* and *c g h d*, diminishes nearly in the duplicate ratio of the moment. If then the moment be taken $\frac{1}{2}$, $\frac{1}{3}$, or $\frac{1}{4}$ of *c d*, the error *g o h* is diminished to $\frac{1}{4}$, $\frac{1}{9}$, or $\frac{1}{16}$: the corollary is now manifest; for the ultimate ratio of *c g o d* to *c g h d* is the ratio of equality. That is, the velocity in A is to that in C, in the ultimate ratio of PA to BC described in equal small moments.

There are many cases in which the spaces described in very small moments can be measured, and yet the ultimate ratio cannot be ascertained. These spaces must then be taken as measures of the velocity. And by taking half the sum of the spaces BC and CD, for the measure of the velocity in the point C, the error is almost reduced to nothing.

30. Cor. 2. *The momentary increments of the spaces described, are in the compound ratio of the velocities, and the ultimate ratio of the moments.*

For the increments PA, CD are as the rectangles *p e* and *c o* ultimately, (Propos. 3.); and these are in the compound ratio of the base *a e* to the base *d o*, and the ultimate ratio of the altitude *p a*, to the altitude *c d*. This may be expressed by the proportional equation $\dot{s} \doteqdot v\,\dot{t}$.

31. Consequently $v \doteqdot \frac{\dot{s}}{\dot{t}}$; and $\dot{t} \doteqdot \frac{\dot{s}}{v}$. The equation

$\dot{s}\doteqdot v\dot{t}$, $v\doteqdot\frac{\dot{s}}{\dot{t}}$, and $\dot{t}\doteqdot\frac{\dot{s}}{\dot{t}}$ seem to be the same with those in (23), but there the same space s' was described uniformly, and the equations were absolute. In 30 and 35, $\dot{s}$ does not represent a space uniformly described. But $\dot{S}:\dot{s}$ expresses the ultimate ratio of S' to s' when they are diminished continually, and vanish together. Therefore the meaning of the equation $\dot{s}\doteqdot v\dot{t}$ is, that the ultimate ratio of S' to s', is the same with that of VT' to vt'.

32. The following is the converse of this proposition.

If the abscissa a d *of the line* e f h, *represent the time of a motion along the line* ABD, *and if the ordinates* a e, b f, c g, &c. *be as the velocities in the points* A, B, C, &c. *then the areas are as the spaces described.* This is proved by an indirect demonstration, thus:

For if the spaces AB, AD, be not proportional to the areas *abfe*, *adhe*, they must be proportional to some other, *abf' e*, *adh' e*, of another line *ef' h'*, passing through *e*. Assuming this to be true, then (by Propos. 6.) the velocity in A is to that in B, as *ae* to *bf*. Therefore $ae:bf=ae:bf$, which is absurd.

33. The relation between the space described and the time which elapses is the only immediate observation to be made on these variable motions. By means of the foregoing proposition, the mechanical condition of the body, or rather the effect and measure of this condition, denominated *velocity*, is inferred. The same inference is made in another way. Sir Isaac Newton often represents the uniform lapse of time by the uniform increase of an area during the motion along the line taken for the abscissa. The velocities or determinations to motion in the different points of this line, are inversely proportional to the ordinates of the curve which bounds this area.

6. Along the straight line AD, (fig. 6.) let a point move with a motion any how continually changed, and let the curve line LIH be so related to AD, that the area LICB is to the area LHDB as the time of moving along BC to that of moving along BD. Let this be true in every point of the line AD. Let Cc, Dd, be two very small spaces described in equal times, draw the ordinate *ic*, *hd*, and draw *ik*, *hl* perpendicular to IC, HD.

The areas IC*ci*, and HD*dh* must be equal, because they represent equal moments of time. It is evident also, that as the spaces C*c* and D*d* are continually diminished, the ratio of IC*ci*, and HD*dh* to the rectangles *k*C*ci* and *l*D*dh* continually approximates to that of equality, and that the ratio of equality is the limiting or ultimate ratio. Since, therefore, the areas IC*ci* and HD*dh* are equal, the rectangles *k*C*ci* and *l*D*dh* are ultimately in the ratio of equality. Therefore their bases *ic* and *hd* are inversely as their altitudes C*c* and D*d*, that is, $ic:hd=Dd:Cc$. But as C*c* and D*d* are described in equal times, they are ultimately as the velocities in *c* and *d* (29). Therefore *ic* and *hd*, are inversely as the velocities in *c* and *d*. And as the same reasoning may be applied to every point of the abscissa, the proposition is demonstrated.

34. In all cases, then, in which the relation between the spaces described, and the times elapsed can be discovered by observation, we discover the mechanical condition of the moving body, or its velocity. But in the practical application of these conclusions, recourse must always be had to arithmetical conclusions; and the indications of these are the algebraic symbols of geometrical reasonings. Thus any ordinate *cg* (fig. 5.) is represented by v, and the portion *cd* of the abscissa by $\dot{t}$, and the area *cdhg*, or its equal, the rectangle *cdog*, by $v\dot{t}$. This rectangle then being as the corresponding portion CD of the line of motion, and CD being represented by $\dot{s}$, we have the equation $\dot{s}=v\dot{t}$. Variable Motions.

35. The mathematical consequences of these representations may now be assumed to be true; and therefore $\dot{t}=\frac{\dot{t}}{v}$, as in (23). Algebraic symbols being the representations of arithmetical operations, they represent more remotely the operations of geometry, and only because the area of a rectangle is analogous to the product of numbers which are proportional to its sides. The symbol $\int v\dot{t}$ being used to represent the sum of all these rectangles, expresses the whole area *adhe*, as well as the whole line of motion AD; and the equation may be stated $s=\int v\dot{t}$. In like manner $\int\frac{\dot{s}}{v}$ will be equivalent to $\int\dot{t}$, that is, to t, and will express the whole time *ad*. It is plain too that $\frac{\dot{s}}{v}$ represents the ordinate DH of the line LKIH (fig. 6.) because any portion D*d* of its abscissa, is properly represented by $\dot{s}$, and the ordinates are reciprocally proportional to the velocities, that is, are proportional to the quotients of some constant number divided by the velocities, and therefore to $\frac{1}{v}$. And as $\dot{t}$ is represented by the rectangle *k*C*ci*, which is also represented by $\dot{s}\times\frac{1}{v}$, we have $\dot{t}=\frac{\dot{s}}{v}$, and $t=\int\frac{\dot{s}}{v}$, as above. Fig. 6.

36. In one case of varied motion, when the line *efgh* (fig. 5.) is a straight line, the characters are very particular and useful. Let this case of motion be represented along the line AD (fig. 7.), and let *pa*, *bc*, *cd*, represent equal moments of time, in which the moving body describes PA, BC, CD; and draw *fm*, *gn*, *es*, parallel to the abscissa *ad*. Now it is evident that *mg* and *nh* are equal, or that equal increments of velocity are acquired in equal times; *eq*, *er*, *es*, are also proportional to *qf*, *rg*, *sh*, and therefore the increments *qf*, *rg*, *sh*, of velocity are proportional to the times *ab*, *ac*, *ad*, in which they are acquired. This motion may very properly be denominated *uniformly accelerated;* for here the velocity increases in the same ratio with the times, and equal increments are acquired in equal times. If the line *eh* cut the abscissa in *v*, it will represent a motion uniformly accelerated from rest during the time *vd*, and thus exhibit the relations between the spaces, velocities, and times in such motions. Fig. 5. Fig. 7.

Hence it follows from this mode of expressing these relations, that *in motions uniformly accelerated from a state of rest, the acquired velocities are proportional to the times from the beginning of the motion.* For $a\,e$, $b\,f$, $c\,g$, $d\,h$, represent the velocities gained during the times $v\,a$, $v\,b$, $v\,c$, $v\,d$, and are in the same proportion with those lines.

37.—1. Also, *the momentary increments of velocity, are as the moments in which they are acquired.*

2. Also, *the spaces described from the beginning of the motion, are as the squares of the times.*

3. Also, *the increments of the spaces are as the increments of the squares of the times; reckoning from the beginning of the motion.*

4. Also, *the spaces described from the beginning of the motion, are as the squares of the acquired velocities.*

5. Also, *the momentary increments of the spaces are as the momentary increments of the squares of the velocities.*

6. Also, *the space described during any portion of time by a motion uniformly accelerated from rest, is one half of the space uniformly described in the same time with the final velocity of the accelerated motion.*

7. *And the space described during any portion of the time of the accelerated motion, is equal to that which would be described in the same time with the mean between the velocities at the beginning and end of this portion of time.*

In the investigation of all other varied motions, the properties of uniformly accelerated motion stated above, will be found extremely useful, and especially in cases where approximation only can be easily obtained. But for the fuller illustration of these properties the reader is referred to Robison's Elements of Mechanical Philosophy, p. 38.

38. Supposing the acceleration to be always the same, we conceive of this constancy, that in equal times there are equal increments of velocity; and therefore that the augmentations of velocity are proportional to the times in which they are required. That acceleration then, according to this supposition, must be accounted double, or triple, &c. where the velocity acquired is double or triple. And, acceleration being considered as a measurable quantity, the augmentation of velocity uniformly acquired in any given time is its measure.

COROLLARY.

39. *Therefore accelerations are proportional to the spaces described in equal times, with motions uniformly accelerated from a state of rest.* For in this case the spaces are the halves of what would be uniformly described in the same time with the acquired final velocities, and are therefore proportional to these velocities, or to the accelerations, since the velocities were acquired in equal times.

40. It is then said *that accelerations are proportional to the increments of velocity uniformly acquired, directly, and to the times in which they are acquired, inversely.*

$$A : a = \frac{V}{T} : \frac{v}{t}.$$

This relation between acceleration, velocity, and time, is also true, in uniformly accelerated motion, with respect to all momentary changes of velocity, as well as to those cases of motion passing through all degrees of velocity from nothing to the final magnitude v. For the velocity increasing at the same rate with the time, we have $v : v' = t : t'$; and v' and t' express the simultaneous increments of velocity and time.

41. But if the augmentation of velocity be the measure of the acceleration, and therefore proportional to it, and if in uniformly accelerated motions, the velocity increases at the same rate with the times, the increments of velocity are as the accelerations and as the times jointly. Hence the proportional equation

$$v \doteqdot a\,t,$$
$$\text{and } v' \doteqdot a\,t'.$$

42. It appears from (39.), that when the velocity has uniformly increased from nothing, the spaces described in equal times are proper measures of acceleration. And in (37.—3.) uniformly accelerated motions, the spaces are as the squares of the times. Therefore, when the acceleration continues the same, the fraction $\frac{s}{t^2}$ must also remain of the same value, and a is proportional to $\frac{s}{t^2}$. And therefore, *accelerations are proportional to the spaces described with a motion uniformly accelerated from rest, directly, and to the squares of the times inversely.*

43. And since $a \doteqdot \frac{v}{t}$, we have $a \doteqdot \frac{vv}{v\,t}$; but $v\,t \doteqdot s$, therefore $a \doteqdot \frac{v^2}{s}$. Therefore we have another measure of acceleration, viz. Accelerations are directly as the squares of the velocities, and inversely as the spaces along which the velocities are uniformly augmented.

44. But when the spaces are equal, we have $a \doteqdot v^2$, and in uniformly accelerated motions, that is, when a remains constant, the space being increased in any proportion, v^2 increases in the same proportion; it follows that v^2 increases in the proportion both of the acceleration and of the space. And therefore, in general, we have $v^2 \doteqdot a\,s$. And, as in 41, 42, we shall have $v^2 \doteqdot a\,S$, and $V^2 - v^2 \doteqdot a\,S - a\,s$, or $\doteqdot S - s$, which may be thus expressed, $vv \doteqdot a\,s'$, that is, *in a motion uniformly accelerated, the momentary change of the square of the velocity is proportional to the acceleration and to the space jointly.* Thus it appears, that the acceleration continued during a given time t, or t', produces a certain augmentation of the simple velocity; but the acceleration continued along a given space s' or S', produces a certain augmentation of the square of the velocity.

45. But accelerations which are constant and uniform, and such as have been considered, are very rare in the phenomena of nature. They are as variable as velocities, and therefore it is not less difficult to discover their actual measure. By changes of velocity only we obtain any knowledge of the changing cause. From the continual acceleration of a falling body we learn, that the same power which makes it press on the hand, presses it downward, as it falls through the air; and whatever be the rapidity of its descent, it is from observing that it acquires equal increments of velocity in equal times, that we know the downward pressure to be the same.

In

able
ons.

In the same way that we obtain measures of a velocity which is continually varying, we may obtain accurate measures of a similarly varying acceleration. A line may be conceived to increase along with the velocity, and at the same rate; and this rate of increase of velocity is what is called *acceleration*, in the same way as the rate at which the line increases, is what is called *velocity*. If, then, we consider the areas (fig. 5.) or the line AD, as representing a velocity; the ordinates to the line *e g h*, which were demonstrated to be proportional to the rate of variation of the area, will be proportional to the variation of the velocity, that is, to the acceleration.

Prop. VII.

46. *If the abscissa* a d *of a curve line* e g h *represent the time of a motion, and if the areas* a b f e, a c g e, a d h e, &c. *are proportioned to the velocities at the instants* b, c, d, &c. *then the ordinates* a e, b f, c g, d h, &c. *are proportional ta the acceleration at the instants* a, b, c, d, &c.

By substituting the word acceleration for the word velocity, the same demonstration may be applied here as in Prop. 6. (28.). From this proposition may be deduced some corollaries of practical use in mechanical discussions.

47. *The momentary increments of velocity are as the accelerations, and as the moments jointly.*

For the increment of velocity in the moment *c d* is accurately represented by the area *c d h g*, or by the rectangle *c d n k*; and *c d* accurately represents the moment. Also, the ultimate ratio of *c k* to such another ordinate *b i*, is the ratio of *c g* to *b f*; that is, the ratio of the acceleration in the instant *o* to that in the instant *b*. And therefore the increment of velocity during the moment *p a* is to that during the moment *c d* as $pa \times ae$ to $cd \times dg$. Or it may be expressed by the proportional equation $v \doteqdot a\dot{t}$.

48. Conversely. The acceleration *a* is proportional to $\frac{\dot{v}}{\dot{t}}$, as in the case when the motion is uniformly accelerated (40.).

And as the area of this figure is analogous to the sum of all the inscribed rectangles, when the circumstances of the case admit of its being measured, it may be expressed by $\int a\dot{t}$; and thus is obtained the whole velocity acquired during the time AC, and we say $v \doteqdot \int a\dot{t}$.

The intensities (or at least their proportions) of the accelerating power of nature in the differents points of the path being frequently known, we wish to discover the velocities in those points. This may be done by the following proposition.

Prop. VIII.

g.

49. *If the abscissa* AE (fig. 8.) *of a line* a c e *be the space along which a body moves with a motion continually varied, and if the ordinates* A *a*, B *b*, C *c*, &c. *are proportional to the accelerations in the points* A, B, C, &c. *then the areas* AB *b a*, AD *d a*, AE *e a*, &c. *are proportional to the augmentations of the square of the velocity in* A *at the points* B, D, E, &c.

Compound Motions.

Take BC, CD, as two very small portions of the line AE, and draw *b f*, *c g*, parallel to AE. Then, supposing the acceleration B *b*, to continue through the space BC, the rectangle B *b f* C will express the augmentation made on the square of the velocity in B. In the same way C *c g* D will express the augmentation of the square of the velocity in C; and, in like manner, the rectangles inscribed in the remainder of the figure will express the increments of the squares of the velocity acquired, while the body moves over the corresponding portions of the abscissa. And, therefore, the whole augmentation of the square of the velocity in A (should there be any velocity in that point) during the time of moving from A to B, will constitute the aggregate of these partial increments. The same thing must be affirmed of the motion from B to E. And, when the subdivision of AE is carried on without end, it is plain that the ultimate ratio of the area AE *e a* to the aggregate of inscribed rectangles, is that of equality; that is, when the acceleration varies continually, the area AB *b a* will express the increment made on the square of the initial velocity in A, while the body moves along AB; and the same must be affirmed with respect to the motion along BE. And, therefore, the intercepted areas AB *b a*, BD *d b*, DE *e d*, are proportional to the changes made on the squares of the velocities in the points A, B, and D.

Corollaries.

50. Cor. 1. *If the body had no velocity in* A, *the areas* AB *b a*, AD *d a*, &c. *are proportional to the squares of the velocity acquired in the points* B, D, &c.

Cor. 2. *The momentary change on the square of the velocity, is as the acceleration and increment of the space jointly*; or we have $v\dot{v} = a\dot{s}$.

Cor. 3. $v\dot{v}$ *being equal to half the increment of the square of the velocity, it follows that the area* AE *e a*, *or the fluent* $\int a\dot{s}$ *is only equal to* $\frac{V^2 - v^2}{2}$, *taking* v *and* V *as the velocities in* A *and* E.

51. What has now been said of the acceleration of motion, is equally applicable to motions that are retarded, whether these motions be uniform or unequable. The momentary variations in this case are to be taken as decrements of velocity instead of increments. A moving body, subject to uniform retardation till it come to rest, will continue in motion during a time proportional to the initial velocity; and describe a space proportional to the square of this velocity; and the space which is so described, is one half what it would have been if the initial velocity had continued undiminished.

Sect. III. *Of Compound Motions.*

Characteristics in changes of direction.

52. Having obtained the marks and measures of every variation of velocity, we are to discover similar characteristics for every change of direction. In the above investigation of the general marks of any change of motion, it is plain that the change being the same in any two or more instances, the ostensible marks must also be the same, whatever may have been the previous

previous condition of the moving bodies. In every case of change, some circumstance in the difference between the former motions and the new motions must be observed, which is exactly the same both in respect of velocity and of direction. One of the bodies then may be supposed to have been at rest; and thus the change produced on it, is the motion which it has acquired, or the determination to this motion. Therefore, *a change of motion is itself a motion*, or *determination to motion.* In the above case, it is the new motion only; but it is not the new motion in every other case. For supposing the previous condition of the body to have been different from that of a body at rest, and supposing the same change produced on it, the new condition of the one body must be different from the new condition of the other. The change, therefore, being the same in both cases, the new condition cannot be that *change.* But, when the same change happens in any previous motion, the difference between the former motion and the new motion, must indicate something that is equivalent to the motion produced in a body previously at rest, or the same with that motion, this body having received the same change. And the difference between the new motions of the two bodies will be such as shall indicate the difference between the previous conditions of each body. The change of motion then is itself a motion; and this being assumed as a principle, we are now to endeavour to discover a motion which alone shall produce that difference from the former motion, which, in all cases, is observed in the new motion. This is to be considered as the proper characteristic of the change.

illustrated, 53. The following motions may serve as an illustration of these conditions. Let it be supposed that the straight line AB (fig. 9.) lies east and west, and that it is crossed by the line AC from north to south. Suppose this line AC to be a rod or wire, and to be carried along the line AB in one minute, but always in the same position, that is, lying north and south. The end of the rod or wire A having moved uniformly one-third of AB at the end of 20″, it will be in the position Dd∂; at the end of 40″ it will have the position Eeε; and at the end of the minute it will be in the position *B b*.

Fig. 9.

Let the line AB, in the mean time (supposing it also to be material) be uniformly moved from north to south, and always parallel to its first position AB. When it has passed over one-third of AC, at the end of 20″, it will be in the position m d n; at the end of 40″ it will have the position o e p, and A o is two-thirds of AC. At the end of the minute, it will have the position C ∂ ε b. It is evident that the common intersection of these two lines will be always in the diagonal A b of the parallelogram A C b B; for the parallelogram A m d D is similar to the parallelogram A C b B, because AD : AB=A m : AC; and, in like manner, A o e E is a parallelogram similar to A C b B. Therefore, these parallelograms are about a common diagonal A b.

Again, the motion of the point of intersection of these lines is uniform; for AD : AB=A d : A b, and AE : AB=A e : A b, &c. Therefore the spaces A d, A e, A b are proportional to the times.

Thus the intersection of two lines having each a uniform motion in the direction of the other, moves uniformly in the direction of the diagonal of the parallelogram, which is formed by the lines in their first or last position; and the velocity of the intersection is to the velocity of each of the motions of the lines as the diagonal is to the side in the direction of which the motions are made. This motion of the intersection is very properly said to be compounded of two motions in the direction of the sides; for when the point d of the line D ∂ moves eastward, the same point d of the line m d n is at the same instant moving southward. The point d, therefore, may be considered as a point of both lines, partaking in every instant of both motions. The motion along A b then contains both motions along AB and AC, and being identical with a motion compounded of these motions, indicates both, or the determination to both. In every situation of the point of intersection, its velocity is compounded of the velocity AB and AC. A body, therefore, whose motion continued unchanged, would have described AB in one minute; but when it reaches the point A, it turns aside, and describes A b uniformly in the same time; the change then which the body sustains in the point A is a motion AC. For suppose the body had been at rest in the point A, and it is observed to describe AC in one minute, the motion AC is the change which it has sustained. The motion A b is not the change: for if AF had been the primitive motion, the same motion A b would have been the result of compounding with it the motion AG. But since AF is different from AB, the same change cannot produce the same new conditions. But, farther, there is no other motion which, by compounding it with AB, will produce the motion A b; and the motion AC is the only circumstance of sameness between changing the motion AB into the diagonal motion A b, and giving the motion AC to a body which was previously at rest. —From these conditions it follows, *that a change of motion, is that motion, which by composition with the previous state of motion, produces the new motion.*

54. This composition of motion has been considered in a different way. While a body is supposed to move uniformly in the direction AB, the space in which this motion is performed, is supposed to be carried in the direction AC. But it cannot be conceived that any portion of space is moved from its place. A distinct notion of this composition may be obtained, by supposing a person walking along a line AB, while this is drawn on a piece of ice, and the ice is floating in the direction AC. But the motion on moving ice is not precisely a composition of two determinations to motion; for this is completed in the first instant. When the motion in the direction and with the velocity A b begins, no farther exertion is needed; the motion continues, and A b is described. It serves, however, to exhibit to the mind the mathematical composition of two motions. In the result of this combination, all the characteristics of the two determinations are to be found; for the point of intersection, in whatever way it is considered, partakes of both motions. and in other

55. Thus a general characteristic of a change of motion is obtained, and this corresponds with the mark and measure of every moving cause; for it is the very motion which it is conceived to produce. It may perhaps even be considered as the foundation of former measures; for in every acceleration, retardation, or deflection, there is a new motion compounded with the former.

Compound Motions.

former. What is taken for the beginning of motion in every observation of surrounding bodies, is nothing more than a change induced on a motion already produced.

56. The actual composition of motion being so general in the phenomena of the universe, it obtains in all motions and changes of motion produced or observed, and the characteristic which has been assumed of a change of motion being the same, whatever may have been the previous motion, and this being equally applicable to simple motions, it is evident that a knowledge of the general results of this composition of motion will be of essential service in acquiring a knowledge of mechanical nature.

57. The following is the general theorem to which all others may be reduced.

PROP. IX.

Two uniform motions, having the directions and velocities represented by the sides AB, AC, *of a parallelogram, compose a uniform motion in the diagonal.* The demonstration of this has been already given. The motion of the point of intersection of these two lines, each moving uniformly in all its points, in the direction of the other, is, in every instant, composed of the two motions. It is the same as if a point described AB uniformly, while AB is carried uniformly in the direction AC. This motion is along the diagonal A b, and it has been already shewn to be uniform. And, because AB and A b are described in the same time, the velocities of the motions along AB, AC, and A b are proportional to those lines.

COROLLARIES.

COR. 1. *The motion* A b, *which is compounded of the two simple motions* AB *and* AC, *is in the same plane with these motions. For a parallelogram lies all in the same plane.*

COR. 2. *The motion* A b *may be produced by the composition of any two uniform motions having the direction and velocities which are represented by the sides of any parallelogram,* AF b G, or AC b B, *which has* A b *for its diagonal.*

58. Cases are not unfrequent in which the directions of two simple motions composing an observed motion may be discovered; but the proportion of the velocities is unknown. This velocity may be ascertained by means of this last proposition. For the direction of the three motions, namely the two simple and the compound motions, determines not only the species of parallelogram, but also the ratio of the sides. Again, in those cases in which the direction and the velocity of one of the simple motions are known, and therefore its proportion to that of the observed compound motion, the direction and velocity of the other may be also found by means of the same proposition; because from these data the parallelogram may be determined.

59. This motion in the diagonal is called the *equivalent motion*, or the *resulting motion*; for it is equivalent to the combined motions in the sides. Thus, if the moving body first describe AB, and then B b or AC, it will be in the same point, as if it had described A b, namely, in the point b.

60. It is often highly useful in investigations of this kind to substitute such motions for an observed motion, as will produce it by composition. This has been denominated the *resolution of motions*. By this manner of proceeding, a ship's change of situation at the end of a day, having sailed in different courses, is computed. Thus the distance sailed to the eastward or the westward, as well as that to the northward or southward, on each course, is observed and marked. The whole of the eastings, and the whole of the southings, are added together; and then it is supposed that the ship has sailed for the whole day on that course, which would be produced by combining the same easting and southing.

61. It is also useful to consider how much the body has been advanced in a certain direction by means of the observed motion; let us suppose in the direction AB (fig. 10.). The motion CD is first considered as Fig. 10. composed of a motion CE parallel to the given line AB, and another motion CF perpendicular to AB. CD is the diagonal of a parallelogram CEDF, one of whose sides CE is parallel to AB, and the other CF is perpendicular to AB. It is evident, that the body has advanced in the direction of AB as much as if it had moved from G to H, instead of moving from C to D, so that the motion CF has no effect either in obstructing or promoting the progress in AB. This is called *estimating* a motion in a given direction, or *reducing* it to that direction.

62. A motion is also said to be estimated in a given plane, when it is considered as composed of a motion perpendicular to the plane, and of another parallel to it. In a given plane ABCD (fig. 11.), let EF be a Fig. 11. motion compounded of a motion GE perpendicular to the plane, and EH parallel to it. For if the lines GE, FH are drawn perpendicular to the plane, they cut it in two points e and f, and EH is parallel to e f.

63. In the same way a compound motion may be formed of any number of motions. Let AB, AC, AD, AE, &c. (fig. 12.) be any number of motions, of which Fig. 12. the motion AF is compounded. The motion which is the result of this composition is thus ascertained. The motion AG is compounded of AB and AC; and the motion AG compounded with AD, gives the motion AH; which latter being compounded with AE, produces the motion AF. And the same place, or final situation F, will be found by supposing the different motions AB, AC, AD, AE, to be performed successively. The moving body first describes AB; then BG, equal and parallel to AC; then GH, equal and parallel to AD; and lastly, HF, equal and parallel to AE. In this case it is not requisite that all the motions lie in the same plane.

64. Three motions which have the direction and proportions of the sides of a parallelopiped, compose a motion having the direction of its diagonal. Let AB, AC, AD (fig. 13.), be these motions, the compound- Fig. 13. ed motion is in the diagonal AF of the parallelopiped; because AB and AC compose the motion AE; and AE and AD compose the motion AF.

It is in this way that the mine-surveyor proceeds. He sets down a gallery of a mine, not directly by its real position, but marks the easting and westing, the northing and southing, as well as its dip and rise. All these measures are referred to three lines, of which one runs east and west, one north and south, and a third is perpendicular. These three lines are obviously analogous

gous to the angular boundaries of a rectangular box, as AC, AB, AD.

Other compound motions.

65. The composition of uniform motions only has yet been considered. But it is easy to conceive that any motions may be compounded. It is a case of this kind when a man is supposed to walk on a field of ice along a crooked path, while the ice floats down a crooked stream. Suppose a uniform motion in the direction AB (fig. 14.), to be compounded with a uniformly accelerated motion in the direction AC. A stone falling from the mast head of a ship, while she sails uniformly forward in the direction AB, affords an example of this kind of motion; for the stone will be observed to fall parallel to a plummet hung from the mast head. But the real motion of the stone is a parabolic arch A *bfg*, which AB touches in A; for while the mast head describes the equal lines AB, BF, FG, the stone has fallen to β and ϕ and γ, and the line AC is in the positions BB′, FF′, GG′, so that A ϕ is four times A β; and A γ is nine times A β. Therefore A β, A ϕ, A γ, are as the squares of $\beta\, b$, ϕf, γg, and the line A *bfg* is a *parabola*.

Fig. 14.

Condition of compound motions discovered from that of the simple motions.

66. Knowing the direction and velocities of each of the simple motions in any instant, of which two motions, however variable, are compounded, we may discover the direction and velocities of the compound motions in that instant. For it may be supposed that each motion at that instant proceeds unchanged: a parallelogram is then constructed; the sides of which have the direction and proportions of the velocities of the simple motions; and the diagonal of this parallelogram will express the direction and velocity of the compound motion. But, on the other hand, if the direction and velocity of the compound motion, with the directions of each of the simple motions, be known, we may discover their velocities.

Fig. 15.

67. In cases where a curvilineal motion, as ABC (fig. 15.), is the result of two motions compounded, of which the direction is known to be AD and AE, we discover the velocities of the three motions in any point B, by drawing the tangent BF, and the ordinate BG, parallel to one of the simple motions, and from any point H in that ordinate drawing HF parallel to the other motion, and cutting the tangent in the point F. The three velocities are in the proportion of the three lines FH, HB, and FB.

Danger of mistakes about changes of motion.

68. As the motions which are observed in nature are very different from what they are taken to be, it is not easy to avoid mistakes with respect to the changes of motion, and consequently with respect to the inference of its cause. Without considering the real motion of any body, we are apt to judge only of the changes of distance and direction in relation to ourselves. Thus it is that our inferences with regard to the planetary motions are very different from the motions themselves, if the rapid motion of our earth be considered.

PROP. X.

69. *The motion of one body in relation to another body, or as it is seen from another body, which is also in motion, is compounded of its own real motion, and the opposite of the real motion of the second body.*

Plate CLXXXV. fig. 16.

Let A (fig. 16.) be a body in motion from A to C, as seen from B, which is another body in motion from B to D the motion of A is componnded of its own real motion, and of the opposite to the real motion of B. Join AB, and draw AE equal and parallel to BD. Complete the parallelogram ACFE, and join ED and DC. Produce EA, and make AL equal to AE or BD. Complete the parallelogram LACK, and draw AK and BK. If then A had moved along AE while B moves along BD, the two bodies would have been at E and D, at the same time, and would have the same relative situation; they would have the same bearing and distance as before. And if the spectator in B is not sensible of his own motion, A will appear not to have changed its place. In the same way two ships becalmed in an unknown current, seem to the persons on board to be at rest. The real position, therefore, and distance DC, are the same with BK; and if a spectator in B imagines himself at rest, the line AK will be taken as the motion of A. And this motion, it is obvious, is composed of the motion AC its real motion, and the motion AL which is the equal and opposite motion to that of BD.

Again, if BH be drawn equal and opposite to AC, and the parallelogram BHGD be completed, and BG and AG be drawn, the diagonal BG will be the motion of B as it is seen from A. Now as KAGB is a parallelogram, the relative situation and distances of A and B at the end of the motion will appear to be the same as in the former case. For B appears to have moved along BG, which is equal and opposite to AK. Hence it follows that the apparent or relative motions of two bodies are equal and opposite, whatever their real motions may be; and therefore they do not afford any information of their real motions.

70. Suppose equal and parallel motions are compounded with all and each of the motions of any number of bodies, moving in any manner of way, then their relative motions are not consequently changed. For if it be compounded with the motion of any one of the bodies which may be called A, the real motion of this body is changed; but its apparent motion, as seen from another body B, is compounded of the real change, and of the opposite to the real change in A, which therefore destroys that change, and the relative motion of A is the same as before. Thus it is that the motions in the cabin of a ship are not affected by the ship's progressive motion; and the motion of the earth round the sun produces no perceptible effect on the relative motions on its surface. And indeed it is only by observing other bodies which are not affected by these common motions, and to which we refer as to fixed points, that we arrive at any knowledge of them.

SECT. IV. *Of Motions continually Deflected.*

Great riety curvil motio

71. CURVILINEAL motions are cases of continual deflection. They are susceptible of great varieties; and the investigation of their modifications and chief properties is attended with no small difficulty. Uniform motion in a circular arch is an example of the simplest case of curvilineal motion; for here the deflections from rectilineal motion are equal in equal times. If, however, the velocity be increased, the momentary deflection must also be augmented; for a greater arch will be described, and the end of this greater arch is at

tions nually ected.

at a greater distance from the tangent. But the proportion of this augmentation is difficult to be ascertained.

F 17.

When a uniform rectilineal motion AB (fig. 17.) is deflected into another BC, the lineal deflection is ascertained by drawing a line from the point *c*, at which point the body would have arrived, had it not been deflected to the point C at which it has arrived. The result is the same, whether the lines d D or c C be drawn in this manner; for being proportional to B *d*, B *c*, they always give the same measure of the velocities; and here the lines of deflection are all parallel, indicating the direction of the deflection in the point B. But this is not the case in any curvilineal motion. It rarely happens that dD, cC, are parallel; and it is never found that $dD : cC = Bd : Bc$. We cannot therefore discover which lines should be taken for the indication of the direction of the deflection at B, or for the measure of its magnitude. A greater velocity, then, in the same curve, produces a greater deflection; but if the path be more incurvated, an arch of the same length, described with the same velocity, causes a farther deviation from the tangent. If therefore a body have a uniform motion in a curve of variable curvature, the deflection is greatest where the curvature is greatest.

Thus it appears that the direction and measure of the deflections by which a body deviates continually into a curvilineal path cannot be ascertained, but by investigating the ultimate positions and ratios of the lines, which join the points of the curve with the simultaneous points of the tangent, as the points ∂ and C are taken nearer to B. In some cases, but rarely, the lines joining the simultaneous points are parallel. But in most cases the direction of the deflection is discovered by observing to what direction it approximates. The following proposition which was discovered by Newton is of great importance in this investigation.

Prop. XI.

Fi8.

72. *If a body describe a curve line* ABCDEF (fig. 18.) *being in the same plane, and if in this plane there be a point* S *so situated, that the lines* SA, SB, SC, &c. *drawn to the curve, cut off areas* ASB, ASC, ASD, &c. *proportional to the times of describing the arches* AB, AC, AD, &c. *then the deflections are always directed to the point* S.

Suppose first that the body describes the polygon ABCDEF, formed of the chords of this curve, and that it describes each chord uniformly, and is deflected only in the angles B, C, D, &c. Suppose also that the sides of the polygon are described in equal times, so that, according to the hypothesis, the triangles ASB, BSC, CSD, are all equal. Continue the chords AB, BC, &c. beyond the arches, making B *c* equal to AB, and C *d* equal to BC, and so on. Join *c* C, *d* D, &c. and draw *c* S, S *d*, &c.; draw C *b* parallel to *c* B or BA, cutting BS in *b*, and join *b* A, and draw CA, cutting B *b* in *o*. And lastly, make a similar construction at E.

Then, because *c* B is equal to BA, the triangles ASB and BS *c*, are equal, and therefore BS *c* is equal to BSC. And being on the same base SB, they are therefore between the same parallels; that is, *c* C is parallel to BS, and BC is the diagonal of a parallelogram B *b* C *c*. The motion BC is therefore compounded of the motions B *c* and B *b*, and B *b* is the deflection, by which the motion B *c* is changed into the motion BC; and therefore the deflection in B is directed to S. By similar reasoning it may be shown that *f* F, or E *i*, is the deflection at E, and is likewise directed to S; and the same demonstration will apply to every angle of the polygon.—This point S has been called the centre of deflection.

Motions continually deflected.

If the sides of the polygon are diminished, and their number infinitely increased, the demonstration remains the same, and continues, when the polygon coalesces with the curvilineal area, and its sides with the curvilineal arch.

But when the whole areas are proportional to the times, equal areas are described in equal times. In such motion, therefore, the deflections are always directed to S.

Prop. XII.

73. *If the deflection by which a curve line is described, be continually directed to a fixed point, the figure will be in one plane, and areas will be described round that point proportional to the times.* Let ADF (fig. 18.) be the curve line described, and let the deflections be directed to the point S, this curve line is in the same plane. For BC is the diagonal of a parallelogram, and is in the plane of SB and B *c*; and *c* C is parallel to BS, and the triangles SBC, SB *c*, and SBA, are equal. But equal areas are described in equal times; and therefore areas are described proportional to the times.

Fig. 18.

Corollaries.

74. Cor. 1. *The velocities in different points of the curve are inversely proportional to the perpendiculars* S r *and* S t (fig. 19.) *drawn from* S *on the tangents* A r, E t *in those points of the curve.* For since the elementary triangles ASB, ESF, are equal, their bases AB, EF, are inversely as their altitudes S *r*, S *t*. And these bases being described in equal times are as the velocities, and ultimately coincide with the tangents at A and E; and therefore the velocity in A is to that in E as S *t* to S *r*.

Fig. 19.

Cor. 2. *The angular velocities round* S *are inversely as the squares of the distances.* For if we describe round the centre S the small arches B a, F ∂, they may be considered as perpendiculars on SA and SE. Describe also with the distance SF the arch *g h*. It is evident that *g h* is to F ∂ as the angle ASB to the angle ESF. And since the areas ASB, ESF are equal, we have $Ba : F\partial = SE : SA$.

But $gh : Ba = SE : SA$
Therefore $gh : F\partial = SE^2 : SA^2$
And $ASB : ESF = SE^2 : SA^2$.

75. Let us now proceed to determine the magnitude of the deflection, or to compare its magnitude in any two points, as for example the magnitude in B (fig. 18.) with its magnitude in E. The deflection in B is to that in E as the line B *b* to the line E *i*; for B *b* and E *i* are the motions, which, by being compounded with the motions B *c* and E *f* make the body describe BC and EF. And therefore when the sides of the polygon

Motions continually deflected.

lygon are infinitely diminished, the ultimate ratio of Bb to Ei is the ratio of the deflection at B to the deflection at E.

To obtain a convenient expression of this ultimate ratio, let ABCXZY be a circle which passes through the points A, B, C. Draw BSZ through the point S, and draw CZ, AZ. Now the triangles BC*b* and AZC are similar, for C*b* was drawn parallel to *c*B or BA; and therefore the angle C*b*B is equal to the alternate angle *b*BA or ZBA, which is equal to the angle ZCA, because it is subtended by the same chord ZA; and because they stand on the same chord CZ, CB*b*, or CBZ, is equal to CAZ. And therefore the remaining angles *b*CB and CZA are equal, and the triangles are similar. Therefore $Bb : CA = BC : AZ$.

Now if the sides of the polygon are continually diminished, the points A and C continually approach to B, and CA continually approaches to *c*A, or to 2*c*B, or 2CB, and is ultimately equal to it; and AZ is ultimately equal to BZ.

Therefore ultimately, $Bb : 2BC = BC : BZ$, and $Bb \times BZ = 2BC^2$, and $Bb = \frac{2BC^2}{BZ}$.

Also, at the point E, we have E*i* ultimately equal to $\frac{2EF^2}{Ez}$, for E*z* is that chord of the circle through D, E, and F, which passes through *i*.

Therefore $Bb : Ei = \frac{2BC^2}{BZ} : \frac{2EF^2}{Ez}$.

The ultimate circle, when the three points A, B, C, coalesce, is called the *circle of equal curvature*, or the *equicurve circle*, which coalesces with the curve in B in the closest manner; and the chord BZ of this circle, having the direction of the deflection in B, is called its *deflective chord*. And since BC and EF are described in equal times, they are proportional to the velocities in B and E. This proposition therefore may be expressed as follows.

In curvilineal motions, the deflections in different points of the curve, are proportional to the square of the velocities in those points directly, and to the deflective chords of the equicurve circles, inversely.

It ought, however, to be remarked, that this theorem is not limited to curvilineal motions, in which the deflections tend always to the same fixed point; it may be extended to all curvilineal motions whatever. A symbolical expression of this theorem will be convenient. If therefore the deflective chord of the equicurve circle be represented by *c*, and the deflection by *d*, the theorem may be thus expressed,

$$d \doteqdot \frac{v^2}{c}, \text{ or } d = \frac{2\,\text{arch}^2}{c}.$$

76. The line B b is the linear deflection by which the uniform motion in the chord AB is changed into a uniform motion in the chord BC, or it is the deviation *c*C from the point to which the moving body would have arrived, if the deflection at B had not taken place. In the case of curvilineal motion which we are now considering, the lines B*b* and B*c* are expressions of the measures of the velocities of these motions. B*c* is to B*b* as the velocity of the progressive motion is to the velocity of the deflection, generated in the time that the arch BC is described. But the deflection in the arch has been continual, and, like acceleration, it may be measured by the velocity generated during any moment of time. It may therefore be measured by the velocity generated during the time the arch BC is described. This measure will therefore be double of the space through which the body is actually deflected from the tangent in B in that time. The space described will be BO, or only one half of B*b*. This is exactly what happens; for the tangent is ultimately parallel to OC, and it bisects *c*C; therefore the velocity gradually generated is that which constitutes the polygonal motion in the chords, although the deflection from the tangent to the curve is only half of the deflection from the produced chord to the curve.

Motion continua deflecte

77. In any point of a curvilineal motion, the velocity is that which would be generated by the deflection in that point, if continued through one fourth of the deflective chord of the equicurve circle. Take x for the space along which a body is to be accelerated that it may acquire the velocity BC.

We have Bb^2, or $4BO : BC^2 = B : x$ (37.—1.); and therefore $x = \frac{BC^2 \times BO}{4BO^2}, = \frac{BC^2}{4BO}$, and $4x = \frac{BC^2}{BO}$, or $BO : BC = BC : 4x$. But $BO : BC = BC : BZ$; therefore $x = \frac{1}{4}BZ$.

78. We have now obtained characteristic expressions or marks and measures of the principal affections of motion. These expressions may be brought into one view as follows.

The acceleration a is $\frac{\dot{v}}{\dot{t}}$ (48.), or $\frac{v\dot{v}}{\dot{s}}$ (49.), or $\frac{\dot{s}}{\dot{t}^2}$ (42.)

The momentary variation of velocity $\dot{v} = a\dot{t}$ (48.).

The momentary variation of the square of velocity

$$2v\dot{v} = 2u\dot{s} \text{ (49.)}.$$

The momentary deflection $d = \frac{\text{arc.}^2}{\text{chord}}$ (76.).

The deflective velocity $= \frac{2v^2}{c}$ (75.).

79. But for the application of these doctrines, it is necessary to select some point in any body of sensible magnitude, or in any system of bodies, by whose position or motion, a distinct and accurate notion of the position or motion of the body or system may be formed. The condition by which the propriety of this selection is ascertained, is, *that the position, distance, or motion of this point shall be the medium or average of the positions, distances, and motions of every particle of matter in the aggregate or system.*

Centre position

This will happen, if the point be so situated, that when a plane is made to pass through it in any direction whatever, and perpendiculars being drawn to this plane from every particle of matter in this aggregate or system, the sum of the perpendiculars on the one side of the plane is equal to the sum of the perpendiculars on the other side. And that such a point, which is called the *centre of position*, may be found in every body, is proved by the following demonstration.

Fig. 2

For let P (fig. 20.) be a point so situated, and let QR be the section of a plane perpendicular to the paper, and at any distance from it, the distance P*p* of the point P from this plane is the average of all the distances of each particle from it. Let the plane APB pass through P, and parallel to QR. The distance CS otions inually ected.

CS of any particle C from the plane QR is equal to DS—DC, or to Pp—DC. And the distance GT of a particle G on the other side of APB, is equal to HT+GH, or to Pp+GH. Let n be the number of particles on that side of AB which is nearest to QR, and let o be the number of particles on the other side of AB. Let m be the number of particles in the whole body; we have then $m=n+o$. It is evident that the sum of all the distances of all the particles such as CS, is $n\times Pp$—the sum of all the distances, such as CD. Also the sum of all the distances of the particles, such as G, is $o\times Pp$, + the sum of the distances GH. And therefore the sum of both sets is $n+o\times Pp$+the sum of GH—the sum of DC, or $m\times Pp$+the sum of GH—the sum of DC. But by the supposed property of the point P, the sum of GH wanting the sum of DC is nothing; and therefore $m\times Pp$ is the sum of all the distances, and Pp is the mth part of this sum, or the average distance.

g. 21.

Suppose the body to have changed both its place and its position with respect to the plane QR, and that P (fig. 21.) is still the same point of the body, and $\alpha P \beta$ a plane parallel to QR. Make $p\pi$ equal to pP of fig. 20. It is plain that Pp is still the average distance, and that $m\times Pp$ is the sum of all the present distances of the particles from QR, and that $m\times\pi p$ is the sum of all the former distances. Therefore $m\times P\pi$ is the sum of all the changes of distance, or the whole quantity of motion estimated in the direction πP. $P\pi$ is the mth part of this sum, and is therefore the average motion in this direction. The point P has therefore been properly selected; and its position, and distance, and motion, in respect of any plane, is a proper representation of the situation and motion of the whole.

Hence it follows, that if any particle C (fig. 20.) moves from C to N, in the line CS, the centre of the whole will be transferred from P to Q, so that PQ is the mth part of CN; for the sum of all the distances has been diminished by the quantity CN, and therefore the average distance must be diminished by the mth part of CN, or PQ is $=\frac{CN}{m}$.

But it may be doubted whether there is in every body a point, and but one point, such that if a plane pass through it, *in any direction whatever*, the sum of all the distances of the particles on one side of this plane is equal to the sum of all the distances on the other.

It is easy to shew that such a point may be found, with respect to a plane parallel to QR. For if the sum of all the distances DC exceed the sum of all the distances GH, we have only to pass the plane AB a little nearer to QR, but still parallel to it. This will diminish the sum of the lines DC, and increase the sum of the lines GH. We may do this till the sums are equal.

In like manner we can do this with respect to a plane LM (also perpendicular to the paper), perpendicular to the plane AB. The point wanted is somewhere in the plane AB, and somewhere in the plane LM. Therefore it is somewhere in the line in which these two planes intersect each other. This line passes through the point P of the paper where the two lines AB and LM cut each other. These two lines represent planes, but are, in fact, only the intersection of those planes with the plane of the paper. Part of the body must be conceived as being above the paper, and part of it behind or below the paper. The plane of the paper therefore divides the body into two parts. It may be so situated, therefore, that the sum of all the distances from it to the particles lying above it shall be equal to the sum of all the distances of those which are below it. Therefore the situation of the point P is now determined, namely, at the common intersection of three planes perpendicular to each other. It is evident that this point alone can have the condition required in respect of these three planes.

Motions continually deflected.

It still remains to be determined whether the same condition will hold true for the point thus found, in respect to *any other* plane passing through it; that is, whether the sum of all the perpendiculars on one side of *this fourth* plane is equal to the sum of all the perpendiculars on the other side.

Fig. 22.

Let AGHB (fig. 22.), AXYB, and CDEF, be three planes intersecting each other perpendicularly in the point C; and let CIKL be any other plane, intersecting the first in the line CI, and the second in the line CL. Let P be any particle of matter in the body or system. Draw PM, PO, PR, perpendicular to the first three planes respectively, and let PR, when produced, meet the oblique plane in V; draw MN, ON, perpendicular to CB. They will meet in one point N. Then PMNO is a rectangular parallelogram. Also draw MQ perpendicular to CE, and therefore parallel to AB, and meeting CI in S. Draw SV; also draw ST perpendicular to VP. It is evident that SV is parallel to CL, and that STRQ and STPM are rectangles.

All the perpendiculars, such as PR, on one side of the plane CDFE, being equal to all those on the other side, they may be considered as compensating each other; the one being considered as positive or additive qualities, the other as negative or subtractive. There is no difference between their sums; and the sum of both sets may be called 0 or nothing. The same must be affirmed of all the perpendiculars PM, and of all the perpendiculars PO.

Every line, such as RT, or its equal QS, is in a certain invariable ratio to its corresponding QC, or its equal PO. Therefore the positive lines RT are compensated by the negative, and the sum total is nothing.

Every line, such as TV, is in a certain invariable ratio to its corresponding ST, or its equal PM, and therefore their sum total is nothing.

Therefore the sum of all the lines PV is nothing; but each is in an invariable ratio to a corresponding perpendicular from P on the oblique plane CIKL. Therefore the sum of all the positive perpendiculars on this plane is equal to the sum of all the negative perpendiculars, and the proposition is demonstrated, viz. that in every body, or system of bodies, there is a point such, that if a plane be passed through it *in any direction whatever*, the sum of all the perpendiculars on one side of the plane is equal to the sum of all the perpendiculars on the other side.

80. If A and B (fig. 23.) be the centres of position of two bodies, whose quantities of matter (or numbers of equal particles) are a and b, the centre C lies in the straight line joining A and B, and AC : CB$=b:a$, or its distances from the centres of each are inversely as their quantities of matter. For let $\alpha C \beta$ be any plane passing

passing through C. Draw $A\alpha$, $B\beta$, perpendicular to this plane. Then we have $a \times A\alpha = b \times B\beta$, and $A\alpha : B\beta = b : a$, and, by similarity of triangles, $CA : CB = b : a$.

If a third body D, whose quantity of matter is d, be added, the common centre of position E of the three bodies is in the straight line DC, joining the centre D of the third body with the centre C of the other two, and $DE : EC = a+b : d$. For, passing the plane $\delta E \kappa$ through E, and drawing the perpendiculars $D\delta$, $C\kappa$, the sum of the perpendiculars from D is $\delta \times D\delta$; and the sum of the perpendiculars from A and B is $\overline{a+b} \times C\kappa$, and we have $d \times D\delta = \overline{a+b} \times C\kappa$; and therefore $DE : EC = a+b : d$.

In like manner, if a fourth body be added, the common centre is in the line joining the fourth with the centre of the other three, and its distance from this centre and from the fourth is inversely as the quantities of matter; and so on for any number of bodies.

81. If all the particles of any system be moving uniformly, in straight lines, in any directions, and with any velocities whatever, the centre of the system is either moving uniformly in a straight line, or is at rest.

For, let m be the number of particles in the system. Suppose any particle to move uniformly in any direction. It is evident from the reasoning in a former paragraph, that the motion of the common centre is the mth part of this motion, and is in the same direction. The same must be said of every particle. Therefore the motion of the centre is the motion which is compounded of the mth part of the motion of each particle. And because each of these was supposed to be uniform and rectilineal, the motion compounded of them all is also uniform and rectilineal; or it may happen that they will so compensate each other that there will be no diagonal, and the common centre will remain at rest.

COROLLARIES.

82. Cor. 1. *If the centres of any number of bodies move uniformly in straight lines, whatever may have been the motions of each particle of each body, by rotation or otherwise, the motion of the common centre will be uniform and rectilineal.*

Cor. 2. *The quantity of motion of such a system is the sum of the quantities of motion of each body, reduced to the direction of the centre's motion. And it is had by multiplying the quantity of matter in the system by the velocity of the centre.*

Cor. 3. *The velocity of the centre is had by reducing the motion of each particle to the direction of the centre's motion, and then dividing the sum of those reduced motions by the quantity of matter in the system.*

83. If on any two bodies of such an assemblage equal and opposite quantities of matter be impressed, the motion of the centre of the whole is not at all affected by it. Because the motion of the centre, arising from the motion of one of the bodies being compounded with the equal and opposite motion of the diagonal of the parallelogram, becomes a point; or these motions destroy one another; and therefore no change is effected on the motion of the centre.

PART II. OF MOVING BODIES.

84. HAVING in the former part considered the general doctrine of motion, which is the foundation of mechanical investigations, we now proceed to treat of *moving forces* or *dynamics*, properly so called.

Object of dynamics.

It has been already observed, that dynamics includes the abstract doctrine of moving forces, or the necessary results of the relations of our thought concerning motion, the immediate causes of motion, and its changes; and that from the changes observed, we infer agency in nature; and in these changes we are to discover what we know of their causes.

85. When we cast our eyes around us, it cannot escape observation, that the changes which we perceive in the state or condition of any body in respect of motion, are constantly and distinctly related to the situation and distance of other bodies. The motions of the moon, or of a stone projected through the air, have a palpable relation to the earth; the motions of the tides have also an obvious relation to the moon; and the motions of a piece of iron have a palpable dependence on a magnet. The vicinity of the one of these bodies seems to be the occasion, at least, of the motions of the other; and the causes of these motions have an evident connection with, or dependence on, the other body. Such dependences have been called the *mechanical relations* of bodies. They are indications of properties or distinguishing qualities. They accompany the bodies wherever they are, and are usually conceived to be inherent in them. They at least ascertain and determine what is called the mechanical nature of bodies.

Mutual lation of bodies di ferently consider

86. The mutual relation of bodies is differently considered according to the interest we may have in the phenomenon. The cause of the approach of the iron to the magnet is generally ascribed to the magnet. It is said to attract the iron. The approach of a stone to the earth is ascribed to the stone. It is said to tend to the earth. But it is probable that the procedure of nature is the same in both; that both bodies are affected alike, and that the property is distinctive of both. For in all cases that have been observed, the indicating phenomenon is equally connected with both bodies; as in the case of magnetism the magnet and the iron approach each other; and an electrified body and another body near it approach each other. This property is therefore equally inherent in both bodies, between which there is a mutual attraction. But, according to some philosophers, no such mutual tendencies exist either in the one body or the other. The observed approaches or mutual separations of bodies, or their attractions and repulsions, are supposed to depend on the extraneous action of an ethereal fluid.

Powers, &c.

87. These qualities thus inherent in bodies, which constitute their mechanical relations, or the mechanical affections of matter, have been called *powers* or *forces*. The event which is indicated by their presence, is considered

sidered as the effect and mark of their agency. Thus the magnet is said to *act* on the iron, the earth is said to *act* on the stone which falls to its surface; and the iron and the stone are said to act on the magnet and the earth. But all this, it must be observed, is figurative language. *Power, force*, and *action*, when used in their original strict sense, express only the notions of the power, force, and action of sentient, active beings; and cannot be predicated of any thing but the exertions of such beings; for such beings only are agents. In strict propriety, it is perhaps only the exerted influence of the mind on the body which ought to be called action. Language having begun among simple men, such denominations were very properly given to their own exertions; because to move a body they found it necessary to exert their force or power, or to act. But when the changes of motion, observed in the occurrence or vicinity of bodies, were attended to by speculative men, and it was found that the phenomena greatly resembled the results or effects when they exerted their own strength, similar terms were employed to express these occurrences in nature. The old term was retained, in preference to the invention of a new language, to express things which had so near a resemblance. The danger of confounding things from the use of the same terms, was avoided from the differences in other circumstances of the case. It is not, however, to be imagined, that they supposed inanimate bodies exerted force or strength in the same way as living beings. But, in the progress of refinement, the word power or force came at last to be employed to express *any efficiency whatever;* and hence the common expressions, the *force* of arguments, the *action* of motives, the *power* of an acid to dissolve a metal, &c. It is to this idea of conveniency, that the use of the terms *attraction, repulsion, pressure, impulsion*, as well as of the words power and force, which express *efficiency* in general, is to be ascribed. But these terms, excepting in those cases when they are applied to the exertions or actions of living beings, are metaphorical. On account, however, of the resemblance between the phenomena and those which are observed when we draw a thing towards us, push it from us, forcibly compress it, or kick it away, these different actions being analogous to attraction, repulsion, pressure, and impulsion, these words are employed as terms of distinction. The action of the mind on the body is perhaps the only case of pure unfigurative action. But this action being always exerted with the view of effecting some change on external bodies, our attention is only directed to them. The instrument passes unnoticed; and hence it is said that we act on the external body. The *real* action is only the first movement in a long succession of events, and is only the remote cause of the interesting event. In many cases of mechanical phenomena, we find the resemblance to such actions to be very strong. The following is of this description. A ball is projected from a man's hand by the motion of his arm; and in the same way a ball is impelled by the unbending of a spring. In all circumstances there is a resemblance between these two events, excepting in the action of the mind on the corporeal organ. And, hence in general, because the ultimate results of the mutual influence of bodies on each other have a strong resemblance to the ultimate results of our actions on bodies, no new or appropriate terms have been invented; but, as has been already observed, mankind have remained satisfied with the use of those terms that are employed to express their own actions, or the exertions of their own powers or forces.

Action of mechanical powers.

88. When power or force is spoken of as existing or residing in a body, and the effect is ascribed to the exertion of this power, one body considered as possessing it, is said to *act* on another. Thus a magnet is said to act on a piece of iron; a billiard ball is said to act on one which it strikes. But if it be attempted to fix the attention on this action, independent both of the agent and the thing acted on, we shall find that there is no object of contemplation. The exertion or procedure of nature in effecting the change is kept out of view; and if we limit our attention to the action as a thing distinct from the agent, we shall find that it is not the action, strictly speaking, but the act, that is brought under consideration. And in the same way, it is only in the effect produced that the action of a mechanical power can be conceived.

Change implied in action.

89. In the very nature of action some change is implied. Without producing some effect, a man is never said to act. Thought is the act of a thinking principle; and the motion of the limb is the act of the mind on it. In mechanics too there is action only in so far as some mechanical effect is produced. For instance, to begin motion on a piece of ice, or to slide along it, we must act violently; we must exert force; and this force being exerted produces motion. In all cases, the productions of motion are conceived as the exertions of force; but to continue the motion which has been begun along the ice, no exertion seems requisite. Being conscious of no exertion, we ought to infer that no force is necessary for the continuation of motion. It is not the production of any new effect, but the permanency or continuation of an effect already produced. Motion is indeed considered as the effect of some action; but there would be no effect or no change, if the body were not moving. Motion is not to be considered as an action, but the effect of an action.

Division of mechanical forces.

90. Mechanical actions or forces have been divided into *pressures* and *impulsions*. The idea of pressure is very familiar; perhaps it enters into every distinct conception that we can form of a moving force, when the attention is endeavoured to be fixed on it. Changes of motion by the collision of moving bodies are produced by impulsion. Pressures and impulsions are usually considered as of different kinds, the actions or exertions of different powers. It is supposed that there is an essential difference between pressure and impulsion. That we may obtain all the knowledge that these distinctions can give us, let us state some examples of these kinds of forces, instead of attempting to define or describe them.

Examples of pressures,

Let us first take some examples of pressure. Pressure it is known is a moving force; for if a ball lying on the table be gently pressed on one side, it moves toward the other side of the table. If it be followed with the finger, the pressure being continued, its motion is continually increased. There is an acceleration of its motion. By pressing in the same way on the handle of a common kitchen jack, the fly begins to move; and if the pressure be continued on the handle, the motion of the fly becomes very rapid; and there

is

is also a continual acceleration. Such motions as these are the effects of genuine pressure. The unbending of a spring would urge the ball in the same way along the table, and would produce a continually accelerated motion; and a spring coiled up round the axis of the handle of the jack would, by uncoiling itself, urge round the fly with a similar accelerated motion. By comparing the pressure of the finger on the ball with the effects of the spring, we perceive distinctly the perfect similarity. These exertions or actions, or influences, are denoted by the word pressure, which is derived from the most familiar instance of them.

The same motion may be produced in the ball or fly, by pulling the ball or machine by means of a thread having a weight suspended to it. Both being motions accelerated in the same manner, the action of the thread on the ball or machine comes under the same denomination of pressure. Weight is therefore considered as a pressing power. And indeed the same compression is felt from the real pressure of a man on the shoulders and a load laid on them. But in the instance above, the weight acts by the intervention of the thread. By the pressure of the weight it pulls at that part of the thread to which it is attached; this part pulls at the next by the force of cohesion; and this at a third, and so on, till the most remote pulls at the ball or machine. In this way elasticity, weight, cohesion, and other forces, perform the office of a genuine power; and their result being always a motion beginning from nothing, and accelerating to any velocity by perceptible degrees, from this resemblance we are led to give them one familiar name.

91. If the thread by which the weight is suspended be cut, it falls with an accelerated motion. This also is ascribed to some pressing power which acts on the weight; and it is even considered as the cause of the body's weight, which word is a name by which this instance of pressing power is distinguished. Gravitation, therefore, comes under the denomination of pressure. For the same reason the attractions and repulsions of the magnet, or of electric bodies, belong to this class of phenomena; for on bodies placed between them they produce actual compressions, as well as motions which are continually accelerated, in the same way as gravitation does. To all these powers, therefore, the descriptive name of *pressures* may be given, although this name, properly speaking, belongs to one of them only. This great class has been subdivided by some philosophers into pressions and solicitations. Gravity is considered as a solicitation *ab extra*, by which a body is urged downward. The forces of electricity and magnetism, with many other attractions and repulsions, are also called solicitations. But this classification seems to be of little use.

and of impulsion.

92. We have a familiar instance of impulsion in one ball striking another, and putting it in motion. In this case the appearances are very different from the phenomena of pressure. For the body that is struck acquires in the instant of impulse a sensible quantity of motion. But after the stroke this motion is neither accelerated nor retarded, unless by the action of some other force. The rapidity of the motion, it is observed, depends on the previous velocity of the striking ball. If for instance a clay ball, moving with any velocity, strike another equal ball which is at rest, the ball which is struck moves with one half of the velocity of the other. It is farther observed that the striking ball always loses as much motion as the ball which is struck gains. From this remarkable fact there seems to have arisen an indistinct notion of a kind of transference of motion from one body to another. It is not said that the one ball produces motion or causes it in the other, but it is said to *communicate* motion to it; and the phenomenon is usually termed the communication of motion. This, however, is a very inaccurate mode of expression. We distinctly conceive the cause or communication of heat, the communication of saltness, of sweetness, and of many other things; but we have no clear conception of part of the identical motion which existed in one body being transferred to another. From this, therefore, it appears that motion is not a thing which can exist independently, and is susceptible of actual transference; but is a state or condition of which bodies are susceptible, which may be produced in bodies, and which is the effect or characteristic of certain natural properties or powers.

Communi cation o motion.

The notion of the actual transference of something formerly possessed by the striking body, and now separated from it, or transfused into the body which is struck, has obtained support from the remarkable circumstance in the phenomenon, that a rapid motion requiring for its production the action of a pressing power, continued for a sensible, and frequently a long time, is or seems to be effected instantaneously by impulsion. Here then we find room for the employment of metaphor, both in thought and language. We see the striking body affect the body which is struck. It possesses the power of impulsion, or of communicating motion, but it only possesses this power while it is itself in motion; and we therefore conclude that this power is the efficient distinguishing cause of its motion. Hence it has been called *inherent force*, the force inherent in a moving body, *vis insita corpori moto*. This force is communicated to the body impelled, or transfused into it; the transference is instantaneous, and the body thus impelled continues in motion till it is changed by a new force. But if we attend scrupulously to those feelings which have given rise to this metaphorical conception, we shall find, that although at first sight this train of observation seems very plausible, we should entertain very different notions. To begin the motion of sliding on a smooth piece of ice, we are conscious of exertion; but when the ice is very smooth, no exertion that we are conscious of seems requisite to continue the motion. No exertion of power is here necessary; and therefore we have no primitive feeling of power while we slide along. And indeed we cannot think of moving forward without effort otherwise than as a certain mode of existence. It has however been imagined that those who support this opinion have in some way deduced it from their feelings. To move forward in walking, we must continue the exertion with which we began; and unless this power of walking be continually exerted, we must stop our progress. But this is inaccurate observation. In the action of walking there is much more than the continuance in progressive motion. It is the repeated and continued lifting the body up a small height, and allowing it to come down again, and this repeated ascent requires repeated exertion.

93. From

Moving orces.

I ulse s to be i itely g ter t pres- s .

93. From the consideration of the instantaneous production of rapid motion by impulse, some distinguished philosophers have been led to suppose that the force or power of impulsion is not susceptible of being compared with a pressing power. It has been asserted that impulse when compared with pressure is infinitely great. But the similarity of the ultimate results of impulse and pressure, have always led them to adopt a different view. There is no difference between the motion of two balls which move with equal rapidity, one of which descends from a height by the force of gravity, while the other has been struck by another body. In this struggle of the mind attached to preconceived opinions, and at the same time accommodating these opinions to observed phenomena, other singular forms of expression have arisen. Pressure is considered as an effort to produce motion. And here we have another instance of metaphorical expression as well as thought. The weight of a ball on the table is called a power; and this weight is continually *endeavouring* to move the ball downward. But these efforts being ineffectual, the power in this case is said to be dead. It is called *vis mortua*, in contradistinction to the force of impulsion, which is called a living power, *vis viva*. But this mode of expression must appear very inaccurate, if we consider the case of the impelling ball falling perpendicularly on the other ball lying on the table. No motion is induced by this impulsion; and if the table be conceived to be annihilated, the power of gravity becomes a *vis viva*.

Su osed pr

To prove that impulse is infinitely greater than pressure, numerous familiar instances have been adduced by those who support this doctrine. A nail is driven with a moderate blow of a hammer, which would require a pressure many hundred times greater than the impelling effort of the person who employs the hammer. A hard body may be shivered to pieces with a moderate blow, which would support an inconceivable weight gradually applied. This prodigious superiority in impulsion leaves it a difficult matter to account for the production of motion by means of pressure; because the motion of the hammer might have been acquired in consequence of the continued pressure of the carpenter's arm. It is considered as the aggregate of an infinite number of succeeding pressures repeated in every instant of its continuance. The smallness of each effort is compensated by their number.

Th are not o kin of me nical forc

94. After all, it does not appear clear that there are two kinds of mechanical force which are essentially different in their nature. It is, indeed, in a great measure given up by those who support the doctrine that impulse is infinitely greater than pressure: Some method might perhaps be found of explaining satisfactorily this remarkable difference between the two modes of producing motion. But there seems to be no considerable advantage in thus arranging the phenomenon under two distinct heads.

Imp ion the use of ion,

95. The nature of the sole moving force in nature has given rise to much discussion among mechanicians, and produced no small diversity of opinion. According to some, all motion is the effect of pressure; for when impulse is considered as equivalent to the aggregate of an infinite number of pressures, every pressure, however small, is supposed to be a moving force.

Of Moving Forces.

The sole cause of motion, according to other philosophers, is impulsion. Bodies are observed in motion; they impel others, and produce motion in them; and this production of motion is said to be regulated by such laws, that there is only one absolute quantity of motion in the universe, which quantity remains invariably the same. Some portion of this motion, therefore, must be transferred or transfused when bodies come into collision with each other. But besides, there are some cases in which it is perfectly obvious that motion produces pressure. Cases, which are indeed both whimsical and complicated, have been adduced by Euler, to shew that an action, in all respects similar to pressure, may be produced by motion. Such a case is the following. If two balls are connected by a thread, they may be struck in such a way, that they shall not only move forward, but at the same time also wheel round. When this happens, the thread by which they are connected is stretched. Since then, according to this reasoning, motion is observed, and pressure is produced by motion, it would be absurd to suppose that pressure is any thing else than the result of certain motions. The philosophers who are attached to this doctrine of moving forces, proceed to account for those pressing powers or solicitations to motion which are observed in the acceleration of falling bodies, the phenomena of magnetism and electricity, and others of the same kind, where motion is induced on certain bodies which are in the vicinity of other bodies, or, as it is expressed in common language, by the action of other bodies at a distance. To say that a magnet can act on a piece of iron at a distance, is to say that it acts *where* it is not; which is no less absurd than to say that it acts, *when* it is not. Euler assumed it as an axiom, *nihil movetur, nisi à contiguo et moto.*

The methods proposed by these philosophers to produce pressure, are less ingenious and not more satisfactory than that adduced by Euler which was mentioned above; and indeed they do not seem to be very anxious about the manner in which these motions are produced. The phenomena of magnetism are induced, or a piece of iron is put in motion, when it is in the vicinity of a magnet, by a stream of fluid which issues from one pole of a magnet, passes in a circle round the magnet, and enters at the other pole. By this stream of fluid the iron is impelled, and brought to arrange itself in certain determined positions. In the same way all bodies are impelled in lines perpendicular to the surface of the earth by a stream of fluid which is in continual motion towards its centre. In the same way similar phenomena are accounted for, and thus these motions are reduced to simple cases of impulsion. But to say nothing worse of this doctrine, it is not very compatible with the dictates of common sense. It proceeds on the supposition that something acts which we do not see; and of the existence of which there is not the smallest proof.

or pressure.

96. Pressure, according to the opinion of others, is the only moving force in nature; but it is that kind of pressure which has been termed solicitation, not what arises from the mutual contact of solid bodies. Gravitation is an instance of the kind of pressure here alluded to. It is affirmed by these philosophers, that there is no such thing as contact on the instantaneous communication of motion by the real collision of bodies. It is said that the particles of solid bodies exert very strong

repulsions

repulsions to a small distance; and when they are brought by any motion sufficiently near to another body, they exert a repulsive force, and are equally repelled by this body. Motion is thus produced in the one body, while it is diminished in the other. It is then shown by scrupulously considering the state of the bodies, while the one advances and the other retires, in what way they attain a common velocity, the quantity of motion before collision remaining the same, and the one body gaining exactly as much as the other loses. Cases also are adduced, of such mutual action between bodies, where it is obvious they have never come into contact; but where the result is exactly the same as when the motion seemed to be instantaneously changed. And hence it is concluded that there is no such thing as instantaneous communication, or transfusion of motion, by contact in collision or impulse. All moving forces, according to these philosophers, are of that kind which have been named solicitations; such as gravity is.

Exertions of mechanical forces named from their result.

97. Different names have been given to the exertions of mechanical forces, according to the reference that is made to the result. In wrestling, when my antagonist exerts his strength to prevent being thrown down, and I am sensible of his exertion, I thus discover that he resists. But if I oppose him only to prevent him throwing me, I am said to resist. If I strike or endeavour to throw him, I am said to act. The same distinction is applied to the exertion of mechanical powers. If, for instance, one body A change the motion of another body B, the change in the motion of B may be considered either as the indication and measure of the power of A in producing motion, or as the indication and measure of the resistance made by A in being brought to rest, or having any change induced on its motion. The distinction which is here made is not in the thing itself, but exists only in the reference which we are disposed to make of its effect, from other considerations. If a change of motion take place when one of the powers ceases to be exerted, it is conceived that this power has resisted. But this language is metaphorical. Resistance, effort, endeavour, are all words which express motions that relate to sentient beings. There is perhaps no word preferable to the word *reaction*, to express the mutual force which is observed in all the operations of nature which have been successfully investigated.

Supposed to depend on attraction and repulsion.

98. A difficulty has been started with regard to the opinion of those who affirm that all mechanical phenomena are dependent on attracting and repelling forces; because it is here supposed that bodies act on each other at a distance, and however small this distance may be, this is conceived to be absurd. It may however be observed, that the mutual approaches or recesses of bodies may be ascribed to tendencies to, or from each other. Without thinking of any intermediate connection between the iron and the magnet, we conceive the iron to be affected by the magnet; and if this be conceivable, it is not absurd. Our knowledge of the essence or nature of matter is not such as to render this tendency of the iron to the magnet impossible. We do not indeed see intuitively why the iron should approach to the magnet; but this is by no means sufficient to pronounce it impossible or inconsistent with the nature of matter. To suppose therefore in the production of motion, the impulse of an invisible fluid, of which we know not any thing, and of whose existence there is no evidence, is a rash and unwarrantable assumption. But farther, if it be true that bodies do not come into contact, even when one ball strikes another, and drives it before it, the supposition of the existence of this invisible fluid will not assist us in solving the difficulty; for the same difficulty would occur in the action of any one particle of the fluid in the body. At any rate the production of motion without any observed contact, is more familiar to us than the production of motion by one body acting on another by impulsion. Every case of gravitation is an instance of this.

Attracti and repulsion explained.

99. In those cases where the exertions of any mechanical power are observed to be always directed toward any body, that body is said to *attract*. Thus a boat is attracted toward a man when he pulls it toward him by means of a rope. This is a case of pure *attraction*. But when the other body always moves off, the body exhibiting this phenomenon is said to repel; and it is a case of pure *repulsion* when a person pushes any body from him. And because there is a resemblance to the results of real attraction and repulsion, the same terms are employed to express the mechanical phenomena of nature. But that our conceptions may not be embarrassed or rendered obscure by the use of such metaphorical expressions, it is requisite to be careful not to allow these words to suggest to us any opinion about the manner in which mechanical forces produce their effects. If the opinion which is held of the existence of an invisible fluid on which mechanical action depends be well founded, it is obvious that there can be neither attraction nor repulsion in the universe.

Forces measurab quantitie

100. Forces are conceived as measurable quantities. Thus we conceive one man to possess double the strength of another man, when we observe that he can resist the combined efforts of two others. It is in this way that animal force is conceived as a quantity made up of its own parts and measured by them. This however seems not to be a very accurate conception. Our conception of one strain being added to another is obscure, although we have a distinct notion of their being combined. There are no words to express the difference of these two notions in our minds; but we think that the same difference is perceived by others. We have a clear conception of the addition of two lines or two minutes; but our notions of two forces combined are indistinct; although it cannot be affirmed that two equal forces are not double of one of them. They are measured by the effects which they are known to produce.

and such are mech nical.

101. In the same way mechanical forces are conceived as measurable by their effects, and thus become the subject of mathematical discussion. We speak of the proportions of magnetism, electricity, &c. and even of the proportion of gravity to magnetism. These, however, considered in themselves, are quite dissimilar, and do not admit of any proportion; but some of their effects are measurable, and these assumed measures being quantities of the same kind are susceptible of comparison. The acceleration of motion in a falling body, is one of the effects of gravity; magnetism accelerates the motion of a piece of iron; and these two accelerations may be compared together. But because none of the measurable effects of magnetism with which we are acquainted

acquainted, are of the same kind with any of the effects of heat, magnetism and heat are not susceptible of comparison.

parison e ef- s of ity.

When it is said that the gravitation of the moon is the 3600th part of the gravitation of a stone at the sea-shore, it is meant that the fall of a stone in a second is 3600 times greater than the fall of the moon in the same time. But to express the proportion of the tendency of gravitation more purely, if a stone hung on the spring of a steelyard, draw out the rod of the steelyard to the mark 3600, the same stone carried up to the distance of the moon will draw it out only to the mark one. And if the stone at the sea-shore draw out the rod to any mark, it will require 3600 such stones to draw the rod out to the same mark at the distance of the moon. Now, it is not in consequence of an immediate perception of the proportion of gravitation at the moon to that at the surface of the earth that such an assertion is made. It is because these motions being considered as its effects in such situations, and being magnitudes of the same kind, are susceptible of comparison, and have a proportion which can be determined by observation. And although the proportions of the causes or forces are spoken of, yet it is only the proportions of the effects which come under contemplation.

sures be the in and ee.

102. In order that these assumed measures may be accurate, they must be always connected with the magnitudes which they are employed to measure; and the connection must be of that kind, that the degrees of the one must change in the same manner with the degrees of the other. The same thing must also be known of the measure which is employed; the precise and constant relation must be seen. But how is this to be accomplished? Force as a separate existence is not a perceptible object. We do not perceive its proportions, so as to be able to ascertain that they are the same with the proportions of the measures. On the contrary, the very existence of this force is inferred from observation of the acceleration, and its degree is also an inference from the observed extent or magnitude of the acceleration. The measures which are thus assumed are therefore necessarily connected with the magnitudes, and their proportions are the same; the one is an inference from the other both in kind and degree.

Dy mics a on- str ve ci e.

103. It now appears that this subject is susceptible of mathematical investigation. After having selected our measnres, and observing certain mathematical relations of those measures, every inference deduced from the mathematical relations of the proportions of those representations is true of the proportions of the motions, and therefore it is also true of the proportions of the forces. Thus then Dynamics may be reckoned a demonstrative science.

Fo s dif- fer di- rec n.

104. Moving forces are considered as differing also in kind, that is, in direction. The direction of the observed change of motion is assigned to the force; which is not only the indication, but also the measure of the changing force. This force is called an accelerating, retarding, or deflecting force, according as it is observed, that the motion is accelerated, retarded, or deflected. And from these terms it must appear, that we have no knowledge of the forces different from our knowledge of the effects. They are either descriptive of the effects, or they have a reference to the substances in which the forces are supposed to be inherent. Thus of the first kind are the terms *accelerating*, *attractive*, or *repulsive* forces; of the second, are the terms *magnetism*, *electricity*, &c.

Of the Laws of Motion.

105. Such then being our notions of mechanical forces, of the causes of the production of motion and its changes, there are certain results, which by the constitution of the human mind, necessarily arise from the relations of these ideas. These results are laws of human judgment, independent of all experience of external nature. Some of these laws may be intuitive, presenting themselves to the mind as soon as the ideas which they involve are presented to it. These may be called axioms. Others may be as necessary results from the relations of these notions, are less obvious, and may require a process of reasoning to establish their truth.

Of these laws there are three, which were first distinctly proposed by Sir Isaac Newton. These may be considered as the first principles of all discussions in mechanical philosophy, give a sufficient foundation for all the doctrines of Dynamics, and to these principles we may refer for the elucidation of all the mechanical phenomena of nature.

First Law of Motion.

106. *Every body continues in a state of rest, or of uniform rectilineal motion, unless it is affected by some mechanical force.*

Importance of this proposition.

On the truth of this proposition the whole of mechanical philosophy chiefly depends. But with regard to its truth and the foundation on which it rests, the opinions of philosophers are very different. In general these opinions are obscure and unsatisfactory; and, as is usual, they influence the discussions of those who hold them in all their investigations.

Rest supposed to be the natural condition of body.

107. It is not only the popular opinion that a state of rest is the natural state of body, and that motion is something foreign to it, but the same opinion has been supported by many philosophers. They allow that matter unless it is acted on by some moving force will remain at rest; and nothing seems necessary for matter to remain where it is, but its continuing to exist. But the case is widely different, according to these philosophers, with respect to matter in motion. For here the relations of the body to other things are continually changing; and as there is the continual production of an effect, the continual agency of a changing cause is necessary. This metaphysical argument, it is said, is fully confirmed by the most familiar observations. All motions, whatever may have been their violence, terminate in rest, and for their continuance the continual exertion of some force is necessary.

Continual exertion of force necessary in motion.

108. It is affirmed by these philosophers, that the continual action of the moving cause is essentially requisite for the duration of the motion. But their opinions of the nature of this cause are not uniform. According to some, all the motions in the universe are produced and continued by the direct agency of the Deity himself. By others all the motions and changes of every particle of matter are ascribed to a sort of mind which is inherent in it. This is called an *elemental mind*. It is the same as the φυσις and the ὁσπερ ψυχη of Aristotle. Every thing, according to these philoso-

Of Moving Forces.

phers, which moves, is mind, and every thing which is moved is body. But this elemental mind is only known and characterized by the effects which are ascribed to its action; and these are observed in the motions or changes which are produced. These, we learn from uniform experience, are regulated by laws equally precise with the laws of mathematical truth. But there is nothing which indicates any thing like intention or purpose; none of the marks or characters by which mind was brought first into view. They resemble the effects produced by the exertions of corporeal force; and hence the word *force* has been applied to express the causes of motion.

No body is in absolute rest.

109. A state of rest, it has been supposed, is the natural state of matter. But it does not appear that the continued action of some cause is necessary for continuing matter in motion. Experience gives us no authority for supposing that the natural condition of matter is a state of rest. It cannot be affirmed of any body whatever, that it has ever been seen in absolute rest. All the parts of the planetary system are in motion; and even the sun himself with his attendant planets is carried in a certain direction with a great velocity. There is no unquestionable evidence that any of the stars are absolutely fixed; and many of them, it has been ascertained by observation, are in motion. Rest, therefore, being so rare a condition of matter, no experience which we have, supports the notion that this is its natural condition. This opinion seems to be derived from our own experiments on matter. To continue the motion of a body, we find that the continued action of some moving force is necessary, otherwise the motion becomes gradually slower, and at last terminates in rest. Since then we see that our own exertions are constantly necessary in the production of motion, and especially in those cases where we are interested; we are thus induced to ascribe to matter something that is naturally quiescent and inert, and even something that is sluggish and averse from motion. But this is an erroneous conception, which is suggested to our thoughts from the imperfection of language. We ascribe animation to matter, to give it motion, and endow it with a kind of moral character in order to explain the phenomena of motion.

Matter has no aptitude to rest.

110. But more accurate and more extended observation leads us to conclude that matter has no peculiar aptitude to a state of rest. Every observed retardation has a distinct reference to external circumstances. Wherever there is a diminution of motion, it is invariably accompanied by the removal of obstacles; as in the case when a ball moves through sand, or air, or water. The diminution of motion is also owing to opposite motions which are destroyed. And it is found that the more these obstacles are kept out of the way, the less is the diminution of motion. The vibration of a pendulum in water soon ceases; it continues longer in air; and much longer in the exhausted receiver. The conclusion then from these observations is, that if all obstacles could be completely removed, motion would continue for ever. This conclusion is strongly supported by the motions of the heavenly bodies. These motions, so far as we know, are retarded by no obstacles; and accordingly they have been observed to retain them without perceptible diminution for thousands of years.

This is de nied by others.

111. The inactivity of matter has been denied by other philosophers. According to them it is essentially active, and continually undergoing changes in its condition. Some traces of this doctrine are to be found in the writings of some of the ancient philosophers; but it was reduced to a systematic form by Leibnitz. According to this philosopher, every particle of matter is endowed with a principle of individuality. This he calls a *monad*, which is supposed to have a kind of perception of its place in the universe, and of its relation to all other parts of the universe. This monad too is supposed to act on the particle of matter in the same way as the soul acts on the body. The motion of the material particle is modified by the monad, and thus are produced, according however to unalterable laws, all the observed modifications of motion. And thus matter, or the particles of matter, are continually active and continually changing their situation. No information in any way useful can be obtained from this fanciful hypothesis. It is not unlike the system of elemental minds. And should its existence be admitted, it would not, any more than the actions of animals, invalidate the general proposition which is considered as the fundamental law of motion. The powers of the monads or of the elemental minds are supposed to be the causes of all the changes; but the particle of matter itself is subject to the law, and any change of motion which it exhibits is ascribed to the exertion of the monad.

This law deduced from the want of a determining cau

112. By another set of philosophers, the law of motion is deduced from the want of a determining cause. At the head of this sect is Sir Isaac Newton, who maintains the doctrine affirmed in the proposition. But these philosophers are not uniform in their opinion of the foundation on which it rests. It is asserted by some that it is a kind of necessary truth which arises from the nature of the thing. If, for instance, a body be in a state of rest, and if it be asserted that it will not remain at rest, it must move in some direction; and if it be in motion in any direction, and with any velocity, and do not continue its equable, rectilineal motion, it must be either accelerated or retarded; it must either turn to one side or to some other side. The event, whatever it be, is individual and determinate; but no cause which can determine it being supposed, the determination cannot take place, and no change with respect to motion will happen in the condition of the body. It will either remain at rest, or persevere in its rectilineal and equable motion. But to this argument of sufficient reason, as it has been called, considerable objections may be made. In the immensity and perfect uniformity of time and space, there is no determining cause why the visible universe should exist in one place rather than in another, or at this time rather than at another. It is essentially necessary that there should be a cause of determination; for a determination may be without a cause, as well as a motion without a cause.

and from experienc

113. Other philosophers deduce this law of motion from experience. They consider it merely as an experimental truth, of the universality of which there are innumerable proofs. When a stone is thrown from the hand, it is pressed forward, and when the hand has the greatest velocity that we can give it, the stone is let go, and it continues in that state of motion which it gradually acquired along with the hand. A stone may be thrown much farther by means of a sling, because with

a

a very moderate motion of the hand, the stone being whirled round acquires a very great velocity, and when it is let go, it continues its rapid motion. We have a similar illustration in the case of an arrow shot from a bow. The string which presses hard on the notch of the arrow carries it forward with an accelerated motion as it becomes a straight line by the unbending of the bow; and there being nothing to check the arrow, it flies off. In these simple cases of perseverance in a state of motion the procedure of nature is easily traced; it is perceived almost intuitively. In many other phenomena it is not less distinct, although somewhat more complicated. A man can stand on the saddle of a horse at a gallop, and step from it to the back of another horse that gallops along with him at the same rate; and this he seems to do with the same ease as if the horses were standing still. The man is carried along with the same velocity as the horse which gallops under him, and he retains the same velocity while he steps from the back of one horse to that of the other. But if the horse to which he steps were standing still, he would fly over his head, because he is carried forward with the velocity of the galloping horse; or if he stepped from the back of a horse standing still to that of one at a gallop, he would be left behind; because he has not acquired the velocity of the galloping horse. In the same way a man tosses oranges from one hand to the other while he is carried forward with the motion of a horse at a gallop, or while he swings on the slack-wire. In both cases the oranges have the same motion as the man, and while they are in the air are moving forward with the same velocity, so that they drop into the hand at a considerable distance from the place in which they were thrown from the other hand. While a ship sails forward with a rapid motion a ball dropped from the mast head falls at the foot of the mast: for it retains the motion which it had previous to its being dropped, and follows the mast during the whole time of its fall.

ases of ion

of rest.

114. Familiar instances may also be given of a body in a state of rest. A vessel filled with water drawn suddenly along the floor, leaves the water behind, which is dashed over the posterior side of the vessel; and when a boat or coach is suddenly dragged forward, the persons in it find themselves strike against the hinder part of the carriage or boat; or rather it should be said the carriage strikes on them, for it sooner acquires motion from the action of the force applied. A ball discharged from a cannon will pass through a wall and move onward; but the wall remains behind.

om- expe- e in- ent.

115. Common experience is perhaps insufficient for establishing the truth of this fundamental proposition. It must be granted, that we have never seen a body either at rest, or in uniform rectilineal motion; yet this seems necessary before it can be said that the proposition is experimentally established. What is supposed in our experiments to be putting a body, formerly at rest, into motion, is in fact only producing a change of a very rapid motion—a motion not less than 90,000 feet per second.

proof sary.

116. For the purpose of obtaining such experimental proof of the truth of this proposition, it will be necessary to resort to other observations. The relative motions of bodies, which are the differences of their absolute motions, only can be measured. We cannot measure their absolute motions. If then it can be shown by experiment that bodies have equal tendencies to resist the augmentation and diminution of their relative motions, they thus have equal tendencies to resist the augmentation or diminution of their absolute motions.

Let A and B two bodies be put into such a situation that they cannot persevere in their relative motions. The change which we observe produced on A is the effect and measure of the tendency of B to persevere in its former state. From the proportion of these changes therefore we derive the proportion of their tendencies to remain in their former condition. This will be illustrated by the following experiment, which should be made at noon.

117. Let the body moving at the rate of three feet per second to the westward, strike the equal body B which is apparently at rest. Different cases of the results of the changes thus produced may be supposed.

1st. Let A impel B forward without having its own velocity at all diminished. From this result it appears that B shows no tendency to maintain its motion unchanged, but that A retains its motion without diminution.

2d. Suppose that A stops, and that B remains at rest. This case shows that A does not resist a diminution of motion, and that the motion of B is not changed.

3d. Let it be supposed that both move westward at the rate of one foot per second. There is in this case a diminution of the velocity in A, equal to two feet per second. This then is to be considered as the effect and measure of the tendency of B to maintain its velocity unaugmented. B has received an augmentation of one foot per second in its velocity. From this change it appears that the tendency is but half of the former; and the result shows that the resistance to a diminution of velocity is only equal to one half of the resistance to augmentation; and perhaps equal only to one quarter, since the change on B has effected a double change on A.

4th. Let it be supposed that both bodies move forward with the velocity of one and a half feet per second. In this case it is obvious that the tendencies of the two bodies to maintain their states unchanged are equal.

5th. But suppose that $A=2B$, and that the velocity of both after collision is equal to two feet per second. The body B has then received an addition of two feet per second to its former velocity; and this is the effect and measure of the whole tendency of A to preserve its motion undiminished. One half of this change on C measures the persevering tendency of one half of A; but it is supposed that A, which formerly moved with the apparent or relative velocity three, now moves with the velocity two, and thus has lost the velocity of one foot per second. Therefore each half of A has lost this velocity; and the whole loss of motion is two. This then is the measure of the tendency of B to maintain its former state unaugmented; and it is the same with the measure of the tendency of A to preserve its former state undiminished. From such a result therefore the conclusion would be, that bodies have equal tendencies to maintain their former states of motion unaugmented and undiminished.

The suppositions made above in the 4th and 5th cases are the result of all the experiments which have been made; and in all the changes of motion which are produced by the mutual action of bodies on impulsion, this is the regulating law. To this there is no exception. And thus it appears that there exists in bodies no preferable tendency to rest. No fact can be adduced which should lead us to suppose that a motion having once begun should suffer any diminution without the intervening action of some changing cause.

The proof imperfect.

118. It must, however, be observed that this is a very imperfect way of establishing the first law of motion. It is inapplicable to those cases where experiment cannot be made; and at best it is subject to all the inaccuracy of the best managed experiments. If this proposition be examined by means of the general principles which have been adopted in the article PHILOSOPHY (which see), an accurate decision of this question may be given. These principles, which are the foundation of all our knowledge, shew that this proposition is an axiom or intuitive consequence of the relations of those ideas which we have of motion, of its changes, and of their causes.

Existence of forces inferences from motion.

119. Powers or forces, it has been shewn, are not the immediate objects of our perceptions. Their existence, kind, and degree, are inferences from the motions which we observe. And hence it follows, that when no change of motion is observed, no such inference is made; no force or power is supposed to act. But when any change of motion is observed, the inference is made; a power or force is supposed to have acted. By a similar conclusion, it is said, that when no change of motion is supposed, no force is thought of or supposed; and whenever a change of motion is supposed, it always implies a changing force. On the other hand, when the action of a changing force is supposed, the change of motion is also supposed; the action of this force and the change of motion being the same thing. The mind does not admit the idea of the action, without at the same time thinking of the indication of the action, and this indication is the change of motion. And in the same way, when we do not think of the changing force, or do not suppose the action of a changing force, we suppose, although it be not expressed in terms, that there is no indication of this changing force; that there is no change. If, therefore, it be supposed that no mechanical force acts on a body, we suppose in fact that the body remains in its former condition with respect to motion. And if it be supposed that nothing accelerates or retards, or deflects the motion, it is conceived as neither accelerated nor retarded, nor deflected. Hence it follows, that we suppose the body to continue in its former state of rest or motion, unless we suppose that it is changed by some mechanical force.

This law a necessary truth.

120. This proposition then does not depend on the properties of body as a matter of experience or contingency. It is to us a necessary truth. It is not so much any circumstances with regard to body that are expressed in the proposition, as the operations of the mind in considering these circumstances. The truth of the proposition will not be invalidated by taking into view, that it may be essential to move in some particular direction; that it may be essential to body to stop when the moving cause ceases to act; or gradually to diminish its motion, and at last to come to rest. The circumstances in the nature of body which render those modifications essentially necessary, are the causes of those modifications; and they are to be considered as changing forces.

If we should suppose that body of its own nature is capable of producing a change in its condition, this change must be effected according to some law which characterizes the nature of body. But the knowledge of this law can be obtained only by observing the deviations from uniform rectilineal motion. It then becomes indifferent whether external causes operate those changes, or they depend on the nature of the thing; for in considering the various motions of bodies, we must first consider the nature of matter as one of its mechanical affections which operates in every instance; and this brings us back to the law contained in the proposition. This is rendered more certain by reflecting, that the external causes, such for instance are gravity and magnetism, which are acknowledged to operate changes of motion, are not less unknown to us than this essential property of matter. They are, like it, only inferences from the phenomena.

Inadequa notions suggested by inacc rate expr sions.

121. Many philosophers, among which number may be included Newton himself, have introduced modes of expression, which suggest inadequate notions, and such as are incompatible with the doctrine of the proposition; for although they allow that rest is the natural condition of body, and that force is necessary for the continuation of motion, yet they speak of a *power* or *force* residing in a moving body by which it perseveres in its motion. This has been called the *vis insita*, or the *inherent force* of a moving body. Now if the motion be supposed to be continued in consequence of a force, that force must be supposed to be exerted, and it is supposed that if it were not exerted the motion would cease. The proposition, therefore, must be false. To obviate this objection, it is indeed sometimes said, that the body continues in uniform rectilineal motion, unless it is acted on by some external cause. This mode of expression, however, subjects us to the impropriety of asserting that gravity, electricity, and other mechanical forces, are external to the bodies on which they are supposed to act and to put in motion. Every thing which produces a change of motion is very properly called a force; and when a change of motion is observed, the action of such a force is very properly inferred. But to give the same name to what has not this property of producing a change, and to infer the action of a force when no change is observed, is not a very accurate or consistent expression. This error has arisen from the use of analogical language in philosophical discussions.

Motion a continu exertion, but an e fect.

122. But motion is not, as philosophers have imagined, the continual production of an effect. We can conceive there is such a thing as a moving cause, to which the name of *force* has been given. This produces motion, and the character of motion in body, which is a continual change of place. Motion is the effect of an action; and previous to the commencement of the motion, this action is equally incomplete as it is the minute after. The immediate effect of a moving force is a determination to motion, which if not obstructed by some cause would go on for ever. In this determination only the condition of the body differs from a state of rest. Motion then is a condition or mode of existence, which no more requires the continued agency of the moving cause than colour or figure. Some mechanical cause is required to change this condition into the state or condition of rest. When a moving

moving body is brought to rest, some cause of this cessation of motion never fails to occur to the mind. A cause is no less necessary to stop the motion of body than it is to produce it. Now this cause must either reside in the body or be external to it. If it reside in the body, then it possesses a self-determining power or force, by which it may be able to stop its own motion as well as to produce it.

123. Taking this view of the subject, the opinion of a force residing in a moving body by which its motion is continued must be given up; and the remarkable difference between a body in a state of motion and a state of rest must be explained on other principles. Motion, it cannot be doubted, is necessary in the impelling body to permit the forces which are inherent in one or both bodies to continue the pressure long enough for the production of sensible motion. But whether bodies be in the condition of motion or rest, these forces are inherent in them. If we reflect on the motions that are involved in the general conception of one body being impelled and put in motion by another, we shall see that there is nothing individual transferred from the one to the other. Before collision took place, the determination to motion existed only in the impelling body. After collision, both bodies possessed this condition or determination. But we have no conception, we can form no notion, of the thing transferred.

124. An expression not less vague and indefinite is also very common among mechanical philosophers. This is the phrase *inertia*, or *vis inertiæ*. This expression, which was introduced by Kepler, seems to have been generally employed by him, as well as by Newton, to express the fact of the perseverance of body in a state of motion or rest. Sometimes, however, it has been employed by these philosophers to express something like indifference to motion or rest; and this is supposed to be manifested by body requiring the same quantity of force to make an augmentation of its motion, as is necessary to produce an equal diminution of it. To suppose resistance from a body at rest seems to be in direct contradiction to the common use of the word *force;* and yet this expression *vis inertiæ* is very common. It is not less absurd to say that a body remains in the condition of rest by the exertion of a *vis inertiæ*, than to affirm that it maintains itself in a state of motion by the exertion of an inherent force. Such expressions, which are metaphorical, should be carefully avoided, because they are apt to lead to misconception of the procedure of nature.

125. In the phenomena of motion the force employed always produces its complete effect. No resistance whatever is observed. When one man throws down another, and he finds that no more force has been required than to throw down a similar and equal mass of inanimate matter, he concludes that no resistance has been made; but if more force be necessary, the conclusion is that resistance has been made. When, therefore, the exerted force produces its full effect, there is no such thing as resistance properly so called. It is therefore misconceiving the mode in which mechanical forces operate in the collision of bodies, to say that there is any resistance: for there is no more in these cases than in other natural changes of condition. It may be observed, that these terms, *inherent force* and *inertia*, may be employed for the purpose of abbreviating language, provided they are used only for expressing either the simple fact of persevering in the former state, or the necessity of a determinate force to produce a change on that state, being careful to avoid all thought of resistance.

Of Moving Forces.

Deviations from uniform motion indications of force.

126. Thus it appears that deviations from uniform motions are only the indications of the existence and agency of mechanical forces. This indication is simply change of place; and it can only indicate what is very simple, something competent to the production of the observed motion. The same thing is indicated by two similar changes of motion. A compass needle in a state of rest, can be moved some degrees by means of the finger, a magnet, an electrified body, or by the unbending of a spring, &c. in all which cases the indication is precisely the same; and therefore the thing indicated must also be the same. This is the intensity and direction of some moving power. The circumstances of resemblance by which the affections of matter are to be characterized are impulsiveness, intensity, and direction. This leads us to consider the second law of motion.

Second Law of Motion.

Every change of motion is proportional to the force impressed, and it is made in the direction of that force.

Is an identical proposition;

127. This law of motion also may almost be considered as an identical proposition. It is equivalent to saying that the changing force is to be measured by the change produced, and the direction of this force is the direction of the change. Considering the force only in the sense of its being the cause of motion, and withdrawing the attention from the manner or form of its exertion, there can be no doubt of this. In whatever way a body is put in motion, whether by the expansive force of the air, by the unbending of a spring, or by any similar pressure, when it moves off in the same direction, and with the same velocity, the force or the exertion of the force is considered as the same. Even when it is put in motion by instantaneous percussion from a smart stroke, although in this case the manner of the effect being produced is essentially different from the other cases, we cannot conceive the propelling force, as such, but as precisely one and the same. The expression of this law of motion by Newton is equivalent to saying, "that the changes of motion are taken as the measures of the changing forces, and the direction of the change is taken as the indication of the direction of the forces; for it cannot be said that it is a deduction from the acknowledged principle, that effects are proportional to their causes. This law is not affirmed from the proportion of the forces and the proportion of the changes, and that these proportions are the same, having been observed; and that this universally holds in nature. For forces are not objects of observation, and we do not know their proportions. In this way it would be established as a physical law, as indeed it is so in fact. But according to the definition of the term, this does not establish it as a law of motion; or as a law of human thought, the result of the relations of our ideas. Philosophers having attempted to prove this as a matter of observation, have produced great diversity of opinion in the mode of estimating forces. A bullet, it is well known, which moves with double velocity, penetrates four times as far. This is confirmed

but not deduced from the proportion of the forces.

confirmed by other similar facts; and to generate this double velocity in the bullet, it has been observed by philosophers, four times the force is expended, four times as much powder is required. This is the invariable result; and in cases of this kind, it would appear that the ratio of the forces employed has been very accurately ascertained. The conclusion therefore is, that moving forces are not proportional to the velocities produced, but to the squares of the velocities. This is strongly confirmed by observing that moving bodies seem to possess forces in this very proportion, and to produce effects in this proportion; when, for instance, the velocity is only twice as great, they penetrate four times as deep.

Incompatible with the velocity being proportional to the force.

128. If this mode of estimation be just, it is irreconcileable with the concession of those, who admit that the velocity is proportional to the force impressed, in those cases where no previous observation can be had of the ratio of the forces, and of its equality to the ratio of the velocities. Such a case is the force of gravity, which these philosophers also measure by its accelerating power, or the velocity generated in a given time. This must be granted; for there are cases in which the force can be measured by the actual pressure which it exerts. Thus a spring steelyard can be constructed, the rod of which is divided by hanging on successively a number of perfectly equal weights. In the different states of tension of the spring, its elasticity is proportional to the pressures of gravity which it balances. If it be found, that at Quito in Peru, a weight will pull out the rod to the mark 312, and that the same weight at Spitzbergen draws it out to 313, it seems to be a fair inference to say, that the pressure of gravity at Quito is to its pressure at Spitzbergen as 312 to 313; and this is affirmed on the authority of effects being proportional to their causes. Such cases, however, are very rare; for it is seldom, that the whole of a natural power, accurately measured in some other way, is employed in producing the observed motion. Part of it is generally otherwise expended, and therefore it frequently happens that the motions are not in the proportion with the supposed forces. And allowing that this could be done with accuracy, it would only be the proof of a general law or fact: but these philosophers attempt to establish it as an abstract truth.

129. It seems to be considered by Sir Isaac Newton only as a physical law. And in this sense good arguments are not wanting. A ball which moves with a double, triple, or quadruple velocity, generates by impulse in another, a double, triple, or quadruple velocity, or it generates the same velocity in a double, triple, or quadruple quantity of matter, and losing at the same time similar proportions of its own velocity.

Two bodies, having equal quantities of motion, meeting together mutually stop each other.

When two forces, which act similarly during equal times, produce equal velocity in a third body, they will, by acting together during the same time, produce a double velocity.

If a pressure which acts for a second, produce a certain velocity, a double pressure acting during a second, will produce in the same body a double velocity.

A force which is known to act equably, produces in equal times equal increments of velocity, whatever the velocities may be.

In all the examples above adduced, the forces are observed to be in the same proportion with the change of motion effected by them in a similar way.

Hooke's

But the curious discoveries of Dr Hooke, about the middle of the 17th century, seemed to shew, from a great collection of facts, forces to be in a very different proportion. In the production of motion it was found, that four springs equal in strength, and bent to the same degree, generated only a double velocity in the ball which they impelled: nine springs generated only a triple velocity, &c. In the extinction of motion, it was found, that a ball moving with a double velocity, will penetrate four times as deep into a uniformly resisting mass; and a triple velocity will make it penetrate nine times as far, &c.

130. These facts were brought forward by Leibnitz in support of his own pretensions to the discovery of the real nature and measure of mechanical action and force, which he said had been hitherto totally mistaken. He affirmed that the inherent force of a moving body, was in the proportion of the square of the velocity. In this argument he was supported by John Bernoulli, who adduced many simple facts to confirm the relation between the inherent force of a moving body and its velocity. One of the strongest arguments urged by Leibnitz is, that the inherent force of a moving body is to be estimated by all that it is able to do before the total extinction of its motion; and therefore when it penetrates four times as far, it is to be considered as having produced a quadruple effect. In this mode of estimation many things are gratuitously assumed, many contradictions are incurred; and it is only because forces are assumed as proportional to the velocities which they generate, that these facts come to be proportional to the squares of the same velocity. When Leibnitz assumes the quadruple penetration as the proof of the quadruple force of a body having twice the velocities, he has not considered that a double time is employed during this penetration. But a double force, acting equably during a double time, should produce a quadruple effect. This circumstance is lost sight of in all the facts which this philosopher has adduced. It may, however, be observed, that Leibnitz, as well as his followers, holds no difference of opinion in all the consequences which are deduced from the measure which is here adopted. They admit, that a force producing an uniformly accelerated motion must be constant; they agree with the followers of Des Cartes in the valuations both of accelerating and deflecting forces; and have assiduously and successfully cultivated the philosophy of Newton, which proceeds on the principle of estimating the measure of moving forces by the velocity generated.

Moving

131. It ought here to be observed, that *moving forces* only are taken into consideration. When a ball has acquired a certain velocity, whether it has been impelled by the elasticity of the air, by a spring, or struck off by a blow, or urged forward by means of a stream of air or water, or has obtained its velocity by falling; in all these cases it is conceived that it has sustained the same action of moving force. The only distinct notion, perhaps, which we are able to form, is pressure; but

but it is from experience that we derive the information that pressure produces motion. Whatever may be the difference of the circumstances of mechanical forces, in one, namely, production of motion, they all agree. In this circumstance of resemblance they are capable of comparison; and from this they derive a name, *moving force*, which is expressive of this comparison. And therefore the particular faculty of pressure, elasticity, &c. may be measured by the change of motion produced by pressure. In whatever proportion pressure may act on a body in a state of rest, the magnitude of the change of motion measures the pressure actually exerted in its production; and as this is the only change of mechanical condition effected by the pressure in the body moved by it, it may be measured by the velocity. When, therefore, pressure produces the same change of velocity on a soft clay ball, the pressure really exerted is the same whether the velocity has been augmented or diminished. In both cases the same dimple will be observed. The changes of motion, therefore, are proportional to the exerted pressures.

132. The notions which we form of a constant or invariable force lead to the same conclusion. By such a force equal effects or changes of motion are produced in equal times. But equal augmentations of motion are equal augmentations of velocity. This notion of an invariable accelerating force is confirmed by what is observed in the case of a falling body, which receives equal additions of velocity in equal times; and this force, so far as we know, is invariable. The inference then is, that whatever be the force exerted in one second, it will be four times as much in four seconds. And this is really the case, if it be granted that a quadruple velocity is the indication of a quadruple force; but it does not hold in any other estimation of force. Besides, it may be observed, that four springs applied to an ounce ball impel it only twice as fast as one spring does; and if the same four springs be applied to a four-ounce ball, they produce in it the same velocity that one spring produces on an ounce ball. In the last case, it may be demonstrated, that the four springs act during the same time with one spring.

133. The proper measure, therefore, of a changing force is a change of motion in all its circumstances of velocity and direction. This also is the proper measure of a moving force. For, in different states of motion, bodies may sustain the same change of motion. Supposing then one of these bodies to be previously in a state of rest, the change and the motion acquired are the same thing. The force, therefore, producing a change of motion in a moving body, is precisely the same with that force which produces in a body, previously at rest, a motion equivalent to this change; and in this case it is simply a moving force.

This opinion of Leibnitz about the measure of forces has influenced the sentiments of many writers, and in the mechanical investigations of some of them, has not a little affected their practical deductions. No dispute probably could have occurred if philosophers had not been led to consider force as something existing in body; the term on the contrary being only used to express the phenomenon, which is conceived to be its full effect and adequate measure. The simple change of motion observed is the measure of the force by which it is produced.

The following is the enunciation, adapted to the characteristic and measure of a change of motion.

Law of the Changes of Motion.

PROP. XII.

134. *In every change of motion, the new motion is compounded of the former motion, and of the motion which the changing produces in a body at rest.*

Let the change of motion be from AB (fig. 23.) to AD, this new motion AD is compounded of the former motion AB and of the motion AC. Fig. 23.

For it has been shewn, that the change in any motion, is that motion, which when compounded with the former motion, produces the new motion; and the new motion (55.) is the compound of the former motion and the changing motion. Since then the change of motion is the mark and measure of the changing force (133.) by which both the direction and intensity or velocity produced, are determined, the truth of the proposition will appear of course.

135. It has been already observed (54.), that the composition of motions and the similar composition of forces are very different things. The first is a pure mathematical truth; the second, is a physical question dependent on the nature of the mechanical forces as they exist in the universe. Our notions are not very distinct of two forces, each of which separately produces motions, having the directions and velocities expressed by the sides of a parallelogram, producing by their joint action a motion in the diagonal. The demonstrations which have been frequently given, are altogether inconclusive, and only include the composition of motions; while gratuitous postulates have been assumed by those who endeavoured to accommodate their reasonings to physical principles. The celebrated Daniel Bernoulli gave the first legitimate demonstration of this proposition, in which, however, he employs a series of many propositions, some of which are very abstruse. It was greatly simplified by D'Alembert, *Mem. Acad. des Sciences* 1769, still, however, requiring many propositions. Ingenious demonstrations have also been given by other celebrated mechanicians. In the following demonstration by Professor Robison, this distinguished philosopher has attempted to combine the demonstration of Bernoulli, D'Alembert, and others, thus rendering it more expeditious, and at the same time legitimate. This demonstration is entirely limited to pressures, without at all considering or employing the motions supposed to be produced by them.

(A) If two equal and opposite pressures or incitements to motion act at once on a material particle, it suffers no change of motion; for if it yields in either direction by their joint action, one of the pressures prevails, and they are not equal.

Equal and opposite pressures are said TO BALANCE each other; and such as balance must be esteemed equal and opposite.

(B) If a and b are two magnitudes of the same kind, proportional to the intensities of two pressures which act in the same direction, then the magnitude $a+b$ will measure the intensity of the pressure, which is equivalent, and may be called equal, to the combined effort of the other two; for when we try to form a notion of pressure as a measurable magnitude, distinct from motion

tion or any other effect of it, we find nothing that we can measure it by but another pressure. Nor have we any notion of a double or triple pressure different from a pressure that is equivalent to the joint effort of two or three equal pressures. A pressure a is accounted triple of a pressure b, if it balances three pressures, each equal to b, acting together. Therefore, in all proportions which can be expressed by numbers, we must acknowledge the legitimacy of this measurement; and it would surely be affectation to omit those which the mathematicians call *incommensurable*.

The magnitude $a—b$, in like manner, must be acknowledged to measure that pressure which arises from the joint action of two pressures a and b acting in opposite directions, of which a is the greatest.

Fig. 24. (C) Let ABCD and AbCd (fig. 24.) be two rhombuses, which have the common diagonal AC. Let the angles BAb, DAd, be bisected by the straight lines AE and AF.

If there be drawn from the points E and F the lines EG, EH, Fg, Fh, making equal angles on each side of EA and FA, and if Gg, Hh be drawn, cutting the diagonal AC in I and L: then AI+AL will be greater or less than AQ, the half of AC, according as the angles GEH, gFh, are greater or less than GAH gAh.

Draw GH, gh, cutting AE, AF, in O and o, and draw Oo, cutting AC in K.

Because the angles AEG and EAG are respectively equal to AEH and EAH, and AE is common to both triangles, the sides AG, GE are respectively equal to AH, HE, and GH is perpendicular to AE, and is bisected in O; for the same reasons, gh is bisected in o. Therefore the lines Cg, Oo, Hh, are parallel, and IL is bisected in K. Therefore AI+AL is equal to twice AK. Moreover, if the angle GEH be greater than GAH, AO is greater than EO, and AK is greater than KQ. Therefore AI+AL is greater than AQ; and if the angle GEH be less than GAH, AI+AL is less than AQ.

Fig. 25. (D) Two equal pressures, acting in the directions AB and AC (fig. 25.) at right angles to each other, compose a pressure in the direction AD, which bisects the right angle; and its intensity is to the intensity of each of the constituent pressures as the diagonal of a square to one of the sides. It is evident, that the direction of the pressure, generated by their joint action, will bisect the angle formed by their directions; because no reason can be assigned for the direction inclining more to one side than to the other.

In the next place, since a force in the direction AD does, in fact, arise from the joint action of the equal pressures AB and AC, the pressure AB may be conceived as arising from the joint action of two equal forces similarly inclined and proportioned to it. Draw EAF perpendicular to AD. One of these forces must be directed along AD, and the other along AE. In like manner, the pressure AC may arise from the joint action of a pressure in the direction AD, and an equal pressure in the direction AF. It is also plain that the pressures in the directions AE and AF, and the two pressures in the direction AD, must be all equal. And also any one of them must have the same proportion to AB or to AC, that AB or AC has to the force in the direction AD, arising from their joint action.

Therefore, if it be said that AD does not measure the pressure arising from the joint action of AB and AC, let Ad, greater than AD, be its just measure, and make Ad : AB=AB : Ag=AB : Ae. Then Ag and Ae have the same inclination and proportion to AB that AB and AC have to Ad. We determine, in like manner, two forces Af and Ag as constituents of AC.

Now Ad is equivalent to AB and AC, and AB is equivalent to Ae and Ag; and AC is equivalent to Af, and Ag. Therefore Ad is equivalent to Ae, Af, Ag, and Ag. But Ae and Af balance each other, or annihilate each other's effect; and there remain only the two forces or pressures Ag, Ag. Therefore their measure is a magnitude equal to twice Ag. But if Ad be greater than the diagonal AD of the square, whose sides are AB and AC; then Ag must be less than AI, the side of the square whose diagonal is AB. But twice Ag is less than AD, and much less than Ad. Therefore the measure of the equivalent of AB and AC cannot be a line Ad greater than AD. In like manner it cannot be a line Aδ that is less than AD. Therefore it must be equal to AD, and the proposition is demonstrated.

COROLLARY.

(E) Two equal forces AB, AC, acting at right angles, will be balanced by the force AO, equal and opposite to AD, the diagonal of the square whose sides are AB and AC; for AO would balance AD, which is the equivalent of AB and AC.

Fig. 26. (F) Let AECF (fig. 26.) be a rhombus, the acute angle of which EAF is half of a right angle. Two equal pressures, which have the directions and measures AE, AF, compose a pressure, having the direction and measure AC, which is the diagonal of the rhombus.

It is evident, in the first place, that the compound force has the direction AC, which bisects the angle EAF. If AC be not its just measure, let it be AP less than AC. Let ABCD be a square described on the same diagonal, and make AP : AQ=AE : AO, =AF : Ao. Draw KOG, Kog perpendicular to AE, AF; draw GIg, OHo, EG, EK, Fg, FK, PF, and PE.

The angles CAB and FAE are equal, each being half of a right angle. Also the figures AEPF and AGEK are similar, because AP : AQ=AE : AO. Therefore FA : AP=KA : AE, and FA : AP=GA : AE. Therefore, in the same manner that the forces AE, AF are affirmed to compose AP, the forces AG and AK may compose the force AE, and the forces Ag and AK may compose the force AF. Therefore (B) the force AP is equivalent to the four forces AG, AK, Ag, AK. But (D) AG and Ag are the sides of a square, whose diagonal is equal to twice AI: and the two forces AK, AK are equal to, or are measured by, twice AK. Therefore the four forces AG, AK, Ag, AK, are equivalent to 2 AI+2 AK, = 4 AH.

But because AP was supposed less than AC, the angle FPE is greater than FAE, and GEK is greater than GAK, AO is greater than OE, and AH is greater than HQ, and 2 AH is greater than AQ; and therefore 4 AH is greater than AC, and much greater

than

than AP. Therefore AP is not the just measure of the force composed of AE and AF.

In like manner, it is shewn, that AE and AF do not compose a force whose measure is greater than AC. It is therefore equal to AC; and the proposition is demonstrated.

(*G*) By the same process it may be demonstrated, that if BAD be half a right angle, and EAF be the fourth of a right angle, two forces AE, AF will compose a force measured by AC. And the process may be repeated for a rhombus whose acute angle is one-eighth, one-sixteenth, &c. of a right angle; that is, any portion of a right angle that is produced by continual bisection. Two forces, forming the sides of such a rhombus, compose a force measured by the diagonal.

Fi 27.

(*H*) Let ABCD, A *b c d* (fig. 27.) be two rhombuses formed by two consecutive bisections of a right angle. Let AECF be another rhombus, whose sides AE and AF bisect the angles BA*b* and DA*d*.

The two forces AE, AF, compose a force AC.

Bisect AE and AF in O and *o*. Draw the perpendiculars GOH, *g o h*, and the lines GI*g*, OK *o*, HL *h*, and the lines EG, EH, F*g*, F*h*.

It is evident, that AGEH and A *g* F *h* are rhombuses; because AO=OE, and A *o*=*o* F. It is also plain, that since *b* A *d* is half of BAD, the angle GAH is half of *b* A *d*. It is therefore formed by a continual bisection of a right angle. Therefore (*G*) the forces AG, AH, compose a force AE; and A*g*, A *h*, compose the force AF. Therefore the forces AG, AH, A*g*, A *h*, acting together, are equivalent to the forces AE, AF acting together. But AG, A *g* compose a force = 2 AI; and the forces AH, A *h* compose a force = 2 AL. Therefore the four forces acting together are equivalent to 2 AI+2 AL, or to 4 AK. But because AO is $\frac{1}{2}$ AE, and the lines G*g*, O*o*, H*h*, are evidently parallel, 4 AK is equal to 2 AQ, or to AC; and the proposition is demonstrated.

Corollary.

(*I*) Let us now suppose, that by continual bisection of a right angle we have obtained a very small angle *a* of a rhombus; and let us name the rhombus by the multiple of *a* which forms its acute angle.

The proposition (*G*) is true of *a*, 2 *a*, 4 *a*, &c. The proposition (*H*) is true of 3 *a*. In like manner, because (*G*) is true of 4 *a* and 8 *a*, proposition (*H*) is true of 6 *a*; and because it is true of 4 *a*, 6 *a*, and 8 *a*, it is true of 5 *a* and 7 *a*. And so on continually till we have demonstrated it of every multiple of *a* that is less than a right angle.

ite' LXXVI fig. 28.

(*K*) Let RAS (fig. 28.) be perpendicular to AC, and let ABCD be a rhombus, whose acute angle BAD is some multiple of 2 *a* that is less than a right angle. Let A *b c d* be another rhombus, whose sides A *b*, A *d* bisect the angles RAB, SAD. Then the forces A *b* A *d* compose a force AC.

Draw *b* R, *d* S parallel to BA, DA. It is evident, that AR *b* B and AS *d* D are rhombuses, whose acute angles are multiples of *a*, that are each less than a right angle: Therefore (*I*) the forces AR and AB compose the force A *b*, and AS, AD compose A *d*; but AR and AS annihilate each other's effect, and there remains only the forces AB, AD. Therefore A *b* and A *d* are equivalent to AB and AD, which compose the force AC; and the proposition is demonstrated.

Corollary.

(*L*) Thus is the corollary of last proposition extended to every rhombus, whose angle at A is some multiple of *a* less than two right angles. And since *a* may be taken less than any angle that can be named, the proposition may be considered as demonstrated of every rhombus; and we may say,

(*M*) *Two equal forces, inclined to each other in any angle, compose a force which is measured by the diagonal of the rhombus, whose sides are the measures of the constituent forces.*

Fig. 29.

(*N*) Two forces AB, AC (fig. 29.) having the direction and proportion of the sides of a rectangle, compose a force AD, having the direction and proportion of the diagonal.

Draw the other diagonal CB, and draw EAF parallel to it; draw BE, CF parallel to DA.

AEBG is a rhombus; and therefore the forces AE and AG compose the force AB. AFCG is also a rhombus, and the force AC is equivalent to AF and AG. Therefore the forces AB and AC, acting together, are equivalent to the forces AE, AF, AG, and AG acting together, or to AE, AF, and AD acting together: But AE and AF annihilate each other's action, being opposite and equal (for each is equal to the half of BC). Therefore AB and AC acting together, are equivalent to AD, or compose the force AD.

Fig. 30.

(*O*) Two forces, which have the direction and proportions of AB, AC (fig. 30.) the sides of any parallelogram, compose a force, having the direction and proportion of the diagonal AD.

Draw AF perpendicular to BD, and BG and DE perpendicular to AC.

Then AFBG is a rectangle, as is also AFDE: and AG is equal to CE. Therefore, (*N*) AB is equivalent to AF and AG. Therefore AB and AC acting together, are equivalent to AF, AG, and AC acting together; that is, to AF and AE acting together; that is (*N*) to AD; or the forces AB and AC compose the force AD.

Hence arises the most general proposition.

Composition of all incitements to motion.

If a material particle be urged at once by two pressures or incitements to motion, whose intensities are proportional to the sides of any parallelogram, and which act in the directions of those sides, it is affected in the same manner as if it were acted on by a single force, whose intensity is measured by the diagonal of the parallelogram, and which acts in its direction: Or, two pressures, having the direction and proportion of the sides of a parallelogram, generate a pressure, having the direction and proportion of the diagonal.

136. Thus is demonstrated from abstract principles the perfect similarity of the composition of pressures and the composition of forces measured by the motions which are produced. A separate demonstration seems indispensably necessary; for what may be deduced from the one case is not always applicable to the other. The change produced on a motion already existing by a deflecting force, cannot be explained by any composition of pressure; because the changing pressure is the only one that exists, and there is none with which it may be compounded.

compounded. Nor, on the other hand, will our notions of the composition of motions explain the composition of pressures, without assuming that the pressures are proportional to the velocities.

137. Considering this law of motion merely as a universal fact or physical law, abundant proof may be adduced in support of it.

1. The joint action of different forces is quite familiar. A lighter, for example, is dragged in different directions by two ropes on different sides of the canal, the lighter moving in an intermediate direction, as if dragged in that direction by one rope only. A ball moving in a particular direction, which receives a stroke across this direction, takes a direction lying between that of the first motion and that of the transverse stroke.

Fig. 23. 2. If a particle of matter A (fig. 23.) be urged at once by two pressures in the directions AB and AC; and if AB and AC be proportional to the intensities of those pressures, the joint action of these two pressures is equivalent to the action of a third pressure in the direction of the diagonal AD, and having its intensity in the proportion of AD. This is proved by observing, that the point A is withheld from moving by a pressure AE, which is equal and opposite to AD. But pressures are moving forces, producing velocities when they act similarly during equal times, proportional to their intensities. The proportion, therefore, is true with respect to pressures, considered merely as such, and also with respect to the motions which may be produced by their composition.

3. The weight of a ball which is suspended by a thread, and drawn aside from its position in a state of rest, urges it downwards, and the ball is supported obliquely by the thread. Supposing this proposition to be true, the directions and intensities of the forces inciting it to motion in any position, as well as the result of the velocities, can be precisely ascertained.

4. The motions of the planets, computed on these principles of the composition of forces, do not exhibit any perceptible deviation from calculation, at the end of thousands of years.

Nothing, therefore, can be relied on with greater confidence than the perfect agreement between the composition of motions, and the composition of the forces, which, separately taken, would produce those motions, and which are measured by the velocities produced. But it ought to be remarked, that if the moving forces are measured by the squares of the velocities which they generate, the composition cannot possibly hold; namely, from two forces which are represented by the sides of a parallelogram made proportional to the squares of the velocities, there will not result a force which can be represented by the diagonal. But supposing the composition of forces to be as the velocities, nature exhibits them exactly.—This proposition, therefore, whether it be considered as an abstract truth or as a physical law, may be received as fully established. The following is the converse of this proposition.

Prop. XIII.

Fig. 23. 138. *The force by which the motion* AB (fig. 23.) *is changed into* AD, *is that which would produce in a body at rest, the motion* AC, *and this compounded with* AB *produces the observed motion* AD.

Prop. XIV.

139. *The force which will produce in a body at rest a motion having the direction and velocity represented by* AC, (fig. 23.) *when applied to a body moving with the velocity and in the direction* AB, *will change its motion into the motion* AD, *which is the diagonal of the parallelogram* ABDC. For the new motion must be that which is compounded of AB and AC, that is, it must be the motion AD. Fig. 23.

The combination of these two propositions gives rise to the following, which is still more general.

Prop. XV.

140. *A body* A (fig. 23.) *being urged at once by two forces which separately would cause it to describe* AB *and* AC, *the sides of a parallelogram* ABDC, *the body by their joint action will describe the diagonal* AD *in the same time.* Fig. 23.

For if the body had been already moving with the velocity and in the direction AB, and if it had been acted on in A by the force AC, it would describe AD in the same time. But it matters not at what time it acquired the determination to describe AB. Let it be then at the instant that the force AC is applied to it. And because its mechanical condition in A, which has the determination to the motion AB, is the same as in any other point of that line, it must describe AD.

Corollary.

Two forces acting on a body in the same or in opposite directions, will cause it to move with a velocity equal to the sum or to the difference of the velocities which it would have received from the forces separately. For if AC (fig. 23.) approach continually to AB by diminishing the angle BAC, the points C and D will at last fall on *c* and *d*, and then AD is equal to the sum of AB and AC. But if the angle BAC increase continually, the points C and D will at last fall on κ and δ, and then Aδ becomes equal to the difference of AB and AC. In the last case, it is evident, that if AC be equal to AB, the point D or δ will coincide with A, and the two forces being equal, and acting in opposite directions, there will be no motion. Fig. 23.

141. In such cases the equal and opposite forces AC and AB are said to *balance* each other; and it is generally said, that these forces, by whose joint operation no change of motion is produced, balance each other. Such forces are accounted equal and opposite, each producing on the body a change of motion equal to what it would produce on a body at rest, and at the same time equal to the motion produced by the other force on a body at rest. The two motions being equal and opposite, the forces are therefore equal and opposite.

142. What has been demonstrated concerning the affections with respect to the affections of compound motions, may now be applied to the combination of forces; taking care, however, to recollect the essential difference between the composition of motions and the composition of forces. In the combination of forces, the composition is complete, when the determination has been given to the body to move with the proper velocity in the diagonal. When the body has acquired this determination there is no farther composition; and it continues its uniform motion, till its condition be changed

changed by some new force. On the other hand, in the composition of two or more motions, the constituent motions are supposed to continue; and it is only during their continuance that the compound motion exists. If it be possible, which does not appear to be the case, that any force can generate a finite velocity by its instantaneous action, two such forces generate in an instant the determination in the diagonal. But supposing the action to continue for some time, to generate the velocities AB or AC, there must be a continuance of the joint action during the same time to produce the velocity AD. And although the moving powers of the two forces may vary in their intensity, yet it is necessary that they retain the same proportion to each other during the whole time of their joint action. Overlooking this circumstance, experiments have been made for the purpose of comparing this doctrine with the phenomena; and they have been found to exhibit very different results. But experiments made by the combination of pressures, such as weights pulling a body by means of threads, coincide precisely with this doctrine; for it is always found that two weights pulling in the directions AB, AC, and proportional to those lines, are balanced by a third weight in the proportion of AD, and pulling in the direction AE. In this way the composition of pressures is clearly proved; and having no other distinct conception of a moving force, these experiments may be considered as sufficient. But we may go farther; for there is the clearest proof by experiment, that pressures produce motions in proportion to their intensities by their similar action during equal times. In the planetary motions, the directions and intensities of the compound forces are accurately known as moving forces. These motions afford a complete proof of the physical law, by their perfect coincidence with the calculations which proceed on the principles of this doctrine. This coincidence must be acknowledged as a full proof of the propriety of the measure which has been assumed. The assumption of any other measure would exhibit results quite different from the phenomena.

143. Forces which produce motions along the sides of a parallelogram are called *simple forces* or *constituent forces*. And the force which singly produces the motion in the diagonal, is called the *equivalent force*, the *compound force*, or the *resulting force*.

144. Some general conclusions may now be pointed out, which will facilitate greatly the use of the parallelogram of forces.

GENERAL COROLLARIES.

1. The constituent and the resulting forces, or the simple and compound forces, act in the same plane; for the sides and diagonal of a parallelogram are in one plane.

2. The simple and the compound forces are proportional to the sides of any triangle which are parallel to their directions. For if any three lines *ab*, *bd*, *ad*, be drawn parallel to AB, AC, and AD (fig. 31.), they will form a triangle similar to the triangle ABD. For the same reasons they are proportional to the sides of a triangle *a'b'd*, which are respectively perpendicular to their directions.

Fi 31.

3. Therefore each is proportional to the sine of the opposite angle of this triangle; for the sides of any triangle are proportional to the sines of the opposite angles.

4. Each is proportional to the sine of the angle contained by the directions of the other two; for AD is to AB as the sine of the angle ABD to the sine of the angle ADB. Now the sine of ABD is the same with the sine of BAC contained between the directions AB and AC, and the sine of ADB is the same with the sine of CAD; also AB is to AC, or BD, as the sine of ADB (or CAD) to the sine of BAD.

Special uses of the parallelogram of forces.

145. Let us now proceed to the application of this fundamental proposition. And we observe, in the first place, that since AD may be the diagonal of an indefinite number of parallelograms, the motion or the pressure AD may result from the joint actions of many pairs of forces. It may be produced by forces which would separately produce the motions AF and AG. This generally gives us the means of discovering the forces which concur in its production. If one of them, AB, is known in direction and intensity, the direction AC, parallel to BD, and the intensity, are discovered. Sometimes we know the directions of both. Then, by drawing the parallelogram or triangle, we learn their proportions. The force which deflects any motion AB into a motion AD, is had by simply drawing a line from the point B (to which the body would have moved from A in the time of really moving from A to D) to the point D. The deflecting force is such as would have caused the body move from B to D in the same time. And, in the same manner, we get the compound motion AD, which arises from any two simple motions AB and AC, by supposing both of the motions to be accomplished in succession. The final place of the body is the same, whether it moves along AD or along AB and BD in succession.

Equivalent of many forces.

146. This theorem is not limited to the composition of two forces only; for since the combined action of two forces puts the body into the same state as if their equivalent alone had acted on it, we may suppose this to have been the case, and then the action of a third force will produce a change on this equivalent motion. The resulting motion will be the same as if only this third force and the equivalent of the other two had acted on the body. Thus, in fig. 32. the three forces AB, AC, AE, may act at once on a particle of matter. Complete the parallelogram ABDC; the diagonal AD is the force which is generated by AB and AC. Complete the parallelogram AEFD; the diagonal AF is the force resulting from the combined action of the forces AB, AC, and AE. In like manner, completing the parallelogram AGHF, the diagonal AH is the force resulting from the combined action of AB, AC, AE, and AG, and so on of any number of forces.

Fig. 32.

This resulting force and the resulting motion may be much more expeditiously determined, in any degree of composition, by drawing lines in the proportion and direction of the forces in succession, each from the end of the preceding. Thus draw AB, BD, DF, FH, and join AH; AH is the resulting force. The demonstration is evident.

147. In the composition of more than two forces, we are not limited to one plane. The force AD is in the same plane with AB and AC; but AE may be elevated above this plane, and AG may lead below it.

Of Moving Forces

AF is in the plane of AD and AE, and AH is in the plane of AF and AG.

Complete the parallelograms ABLE, ACKE, ELFK. It is evident that ABLFKCD is a parallelopiped, and that AF is one of its diagonals. Hence we derive a more general and very useful theorem.

Three forces having the proportion and direction of the three sides of a parallelopiped, compose a force having the proportion and direction of the diagonal.

148. In the investigation of very complicated phenomena, the mechanician considers every force as resulting from the joint action of three forces at right angles to each other, and he takes the sum or difference of these in the same or opposite directions. Thus he obtains the three sides of a parallelopiped, and from these computes the position and magnitude of the diagonal. This is the force resulting from the composition of all the partial ones. This process is called the *estimation* or *reduction of forces*. Forces may be estimated in the direction of a given line or plane, or they may be reduced to that direction, as has been done with respect to motion. See Cor. 2. Propos. 9. in art. 57.

The laws of motion which have now been considered, are necessary consequences of the relations of those conceptions which we form of motion and mechanical force, and they are universal facts or physical laws. To these Sir Isaac Newton has added another, which is the following.

Third Law of Motion.

149. *Every action is accompanied by an equal and contrary reaction, or the actions of bodies on one another are always mutual, equal, and in contrary directions.*

In all cases which can be accurately examined, this holds to be a universal fact. Newton has made this affirmation on the authority of what he conceives to be a law of human thought; namely, that the qualities discovered in all bodies on which experiments and observations can be made, are to be considered as universal qualities of body. But if the term law of motion be limited to those consequences that necessarily flow from our notions of motion, of the causes of its production and changes, this proposition is not such a result. Because a magnet causes the iron to approach toward it, it by no means follows, from this observation, that the pressure of the iron shall be accompanied by any motion or change of state of the magnet, or it does not appear to be necessarily supposed that the iron attracts the magnet. When this was observed, it was accounted a discovery, and a discovery which is to be ascribed to the moderns. Dr Gilbert, who first mentions it, affirms that the magnet and the iron are observed mutually to attract each other, as well as all electrical substances, and the light bodies which are attracted by them. The discovery was made by Kepler, that a mutual attraction exists between the earth and the moon. Newton discovered that the sun acts on the planets, and that the earth acts on the moon. It had been observed too by Newton that the iron reacts on the magnet, that the actions of electrified bodies are mutual, and that all the actions of solid bodies are accompanied by an equal and contrary reaction. On the authority of the rule of philosophizing which he had laid down, he affirmed that the planets react on the sun, and that the sun is not at rest, but is continually agitated by a small motion round the general centre of gravitation; and he pointed out several of the consequences of this reaction. As the celestial motions were more narrowly examined by astronomers, these consequences were found to obtain, and to produce disturbances in the planetary motions. This reciprocity of action is now found to hold with the utmost precision through the whole of the solar system; and therefore this third proposition of Newton is to be considered as a law of nature. And it is true with respect to all bodies on which experiment or observation can be made.

150. This then being a universal law, we cannot divest our minds of the belief that it depends on a general principle, by which all the matter in the universe is influenced. It strongly induces the persuasion of the ultimate particles of matter being alike, that a certain number of properties belong in the same degree to each atom, and that all the sensible differences of substance which are observed, arise from a different combination of those primary atoms in the formation of a particle of those substances. All this is no doubt perfectly possible. But if each primary atom be so constituted, no action of any kind of particle or collection of particles can take place on another, which is not accompanied by an equal reaction in the opposite direction.

151. Let us now direct our attention to the application of these laws. This answers a twofold purpose. The first is to discover the mechanical powers of natural substances by which they are fitted to become parts of a permanent universe. This is accomplished by observing the changes of motion which always accompany those substances. It is from those changes that the only characteristics of power are derived; and thus is discovered the power of gravity, of magnetism, &c. Another purpose in the employment of these laws is, that, after having obtained the mechanical character of any substance, we may ascertain what will be the result of its being in the vicinity of the bodies mechanically allied, or we may ascertain what is the change induced on the condition of the neighbouring bodies.

152. The mechanical powers of bodies occasionally produce accelerations, retardations, and deflections in the motions of other bodies. These names have been given, because nothing is known of their nature, or of the manner in which they are effective; they are therefore named, as they are measured by the phenomena which are observed and considered as their effects. Let us now attend a little to the principal circumstances relating to the action of these forces.

Of Accelerating and Retarding Forces.

153. Changes of motion are the only marks and measures of changing forces; and having no other mark of the force but the acceleration, it has obtained the name of an *accelerating force*. When the motion is retarded, it is called *retarding force*. Nor is there any other measure of the intensity of an accelerating force, but the acceleration which it produces. To investigate therefore the powers which produce all the changes of motion, it is necessary to obtain measures of the acceleration. What has been said of accelerations and retardations of motion is equally descriptive of the effects of accelerating and retarding forces. Hence the following proposition.

If the abscissa a d, fig. 5. *represent the time of and motion, and if the areas* a b f e, a c g e, &c. *are as the velocities at the instants* b c, &c. *the ordinates* a e, b f, c g, &c. *are as the accelerating forces at those instants.*

COROLLARIES.

Cor. 1. The momentary change of velocity is as the force *f* and the time *t* jointly. It may be thus expressed,

$$\dot{v}, \text{ or } -\dot{v} \doteqdot f\dot{t}.$$

Also, the accelerating or retarding force is proportional to the momentary variation of the velocity, directly, and to the moment of time in which it is generated, inversely (48.)

$$f \doteqdot \frac{\dot{v}}{\dot{t}}, \text{ or } \doteqdot \frac{-\dot{v}}{\dot{t}}.$$

Indeed all that we know of force is that it is something which is always proportional to $\frac{\dot{v}}{\dot{t}}$.

Cor. 2. *Uniformly accelerated or retarded motion is the indication of a constant or invariable accelerating force.* For, in this case, the areas *a b f e*, *a c g e*, &c. increase at the same rate with the times *a b*, *a c*, &c. and therefore the ordinates *a e*, *b f*, *c g*, &c. must all be equal; therefore the forces represented by them are the same, or the accelerating force does not change its intensity, or, it is constant. If, therefore, the circumstances mentioned in articles 37 and 38, are observed in any motion, the force is constant. And if the force is known to be constant, those propositions are true respecting the motions.

Cor. 3. *No finite change of velocity is generated in an instant by an accelerating or retarding force.* For the increment or decrement of velocity is always expressed by an area, or by a product $f\dot{t}$, one side or factor of which is a portion of time. As no finite space can be described in an instant, and the moveable must pass in succession through every point of the path, so it must acquire all the intermediate degrees of velocity. It must be *continually* accelerated or retarded.

Cor. 4. The change of velocity produced in a body in any time, by a force varying in any manner, is the proper measure of the accumulated or whole action of the force during this time. For, since the momentary change of velocity is expressed by $f\dot{t}$, the aggregate of all these momentary changes, that is, the whole change of velocity, must be expressed by the sum of all the quantities $f\dot{t}$. This is equivalent to the area of the figure employed in art. 148, and may be expressed by $\int f\dot{t}$.

154. *If the abscissa* AE (fig. 8.) *of the line* a c e *be the path along which a body is urged by the action of a force, varying in any manner, and if the ordinates* A *a*, B *b*, C *c*, &c. *be proportional to the intensities of the force in the different points of the path, the intercepted areas will be proportional to the changes made on the square of the velocity during the motion along the corresponding portions of the path.*

For, by art. 49. the areas are in this proportion when the ordinates are as the accelerations. But the accelerations are the measures of, and are therefore proportional to, the accelerating forces. Therefore the proposition is manifest.

COROLLARY.

Of Moving Forces.

The momentary change on the square of the velocity is as the force, and as the small portion of space along which it acts, jointly;

$$v\dot{v} \doteqdot f\dot{s}$$

and

$$f \doteqdot \frac{v\dot{v}}{\dot{t}}.$$

155. It deserves remark here, that as the momentary change of the simple velocity by any force *f* depends only on the time of its action, it being $= f\dot{t}$ (148.) Cor. 1. so the change on the square of the velocity depends on the space, it being $= f\dot{s}$. It is the same, whatever is the velocity thus changed, or even though the body be at rest when the force begins to act on it. Thus, in every second of the falling of a heavy body, the velocity is augmented 32 feet per second, and, in every foot of the fall, the square of the velocity increases by 64.

156. The whole area AE *e a*, expressed by $\int f\dot{s}$, expresses the whole change made on the square of the velocity which the body had in A, whatever this velocity may have been. We may therefore suppose the body to have been at rest in A. The area then measures the square of the velocity which the body has acquired in the point E of its path. It is plain that the change on v^2 is quite independent on the time of action, and therefore a body, in passing through the space AE with any initial velocity whatever, sustains the same change of the square of that velocity, if under the influence of the same force.

157. This proposition is the same with the 39th of the First Book of Newton's Principia, and is perhaps the most generally useful, of all the theorems in Dynamics, in the solution of practical questions. It is to be found, without demonstration, in his earliest writings, the Optical Lectures, which he delivered in 1669 and following years.

158. One important use may be made of it at present. It gives a complete solution of all the facts which were observed by Dr Hooke, and adduced by Leibnitz with such pertinacity in support of his measure of the force of moving bodies. All of them are of precisely the same nature with the one mentioned in art. 157, or with the fact, "that a ball projected directly upwards "with a double velocity, will rise to a quadruple height, "and that a body, moving twice as fast, will penetrate "four times as far into a uniformly tenacious mass." The uniform force of gravity, or the uniform tenacity of the penetrated body, makes a uniform opposition to the motion, and may therefore be considered as a uniform retarding force. It will therefore be represented, in fig. 8. by an ordinate always of the same length, and the areas which measure the square of the velocity lost will be portions of a rectangle AE *e a*. If therefore AE be the penetration necessary for extinguishing the velocity 2, the space AB, necessary for extinguishing the velocity 1, must be $\frac{1}{4}$ of AE, because the square of 1 is $\frac{1}{4}$ of the square of 2.

159. What particularly deserves remark here, is, that this proposition is true, *only on the supposition that forces are proportional to the velocities generated by them in equal times.* For the demonstration of this proposition proceeds entirely on the previously established measure

of acceleration. We had $\dot{v} \doteqdot f \dot{t}$; therefore $v \dot{v} \doteqdot f \dot{t} v$. But $\dot{t} v \doteqdot \dot{s}$; therefore $v \dot{v} \doteqdot f \dot{s}$, which is precisely this proposition.

160. Those may be called *similar* points of space, and *similar* instants of time, which divide given portions of space or time in the same ratio. Thus, the beginning of the 5th inch, and of the 2d foot, are similar points of a foot, and of a yard. The beginning of the 21st minute, and of the 9th hour, are similar instants of an hour, and of a day.

Forces may be said to act *similarly* when, in similar instants of time, or similar points of the path, their intensities are in a constant ratio.

Fig. 33. 161. *Lemma.* If two bodies be similarly accelerated during given times $a c$ and $h k$ (fig. 33.), they are also similarly accelerated along their respective paths AC and HK.

Let a, b, c, be instants of the time ac, similar to the instants h, i, k of the time $h k$. Then by the similar accelerations, we have the force $a e : h l = b f : i m$. This being the case throughout, the area $a f$ is to the area $h m$ as the area $a g$ to the area $h n$. These areas are as the velocities in the two motions (48.) Therefore the velocities in similar instants are in a constant ratio, that is, the velocity in the instant b is to that in the instant i, as the velocity in the instant c to that in the instant k.

The figures may now be taken to represent the times of the motion by their abscissæ, and the velocities by their ordinates, as in art. 28. The spaces described are now represented by the areas. These being in a constant ratio, as already shewn, we have A, B, C, and H, I, K, similar points of the paths. And therefore, in similar instants of time, the bodies are in similar points of the paths. But in these instants, they are similarly accelerated, that is, the accelerations and the forces are in a constant ratio. They are therefore in a constant ratio in similar points of the paths, and the bodies are similarly accelerated along their respective paths (155.).

162. *If two particles of matter are similarly urged by accelerating or retarding forces during given times, the whole changes of velocity are as the forces and times jointly; or* v $\doteqdot$ ft.

For the abscissæ $a c$ and $h k$ will represent the times, and the ordinates $a e$ and $h l$ will represent the forces, and then the areas will represent the changes of velocity, by art. 47. And these areas are as $a c \times a e$ to $h k \times h l$.

Hence $t \doteqdot \frac{v}{f}$, and $f \doteqdot \frac{v}{t}$.

163. *If two particles of matter are similarly impelled or opposed through given spaces, the changes in the squares of velocity are as the forces and spaces jointly; or* $\doteqdot$ f s.

This follows, by similar reasoning, from art. 49.

It is evident that this proposition applies directly to the argument so confidently urged for the propriety of the Leibnitzian measure of forces, namely, that four springs of equal strength, and bent to the same degree, generate, or extinguish only a double velocity.

164. *If two particles of matter are similarly impelled through given spaces, the spaces are as the forces and the squares of the times jointly.*

For the moveables are similarly urged during the times of their motion (converse of 156.). Therefore $v \doteqdot f t$, and $v^2 \doteqdot f^2 t^2$; but (158.) $v^2 \doteqdot f s$. Therefore $f s \doteqdot f^2 t^2$ and $s \doteqdot f t^2$.

COROLLARY.

$t^2 \doteqdot \frac{s}{f}$, and $f \doteqdot \frac{s}{t^2}$. That is, the squares of the times are as the spaces, directly, and as the forces, inversely; and the forces are as the spaces, directly, and as the squares of the times, inversely.

165. The quantity of motion in a body is the sum of the motions of all its particles. Therefore, if all are moving in one direction, and with one velocity v, and if m be the number of particles, or quantity of matter, $m v$ will express the quantity of motion q, or $q \doteqdot m v$.

166. In like manner, we may conceive the accelerating forces f, which have produced this velocity v in each particle, as added into one sum, or as combined on one particle. They will thus compose a force, which, for distinction's sake, it is convenient to mark by a particular name. We shall call it the MOTIVE FORCE, and express it by the symbol p. It will then be considered as the aggregate of the number m of equal accelerating forces f, each of which produces the velocity v on one particle. It will produce the velocity $m v$, and the same quantity of motion q.

167. Let there be another body, consisting of n particles, moving with one velocity u. Let the moving force be represented by π. It is measured in like manner by $n u$. Therefore we have, $p : \pi = m v : n u$, and $v : u = \frac{p}{m} : \frac{\pi}{n}$; that is,

The velocities which may be produced by the similar action of different motive forces, in the same time, are directly as these forces, and inversely as the quantities of matter to which they are applied.

In general, $\dot{v} \doteqdot \frac{p}{m}$.

And f being $= \frac{\dot{v}}{\dot{t}}$, $f \doteqdot \frac{p}{m \dot{t}}$.

REMARK.

168. In the application of the theorems concerning accelerating or retarding forces, it is necessary to attend carefully to the distinction between an accelerative and a motive force. The caution necessary here has been generally overlooked by the writers of Elements, and this has given occasion to very inadequate and erroneous notions of the action of accelerating powers. Thus, if a leaden ball hangs by a thread, which passes over a pulley, and is attached to an equal ball, moveable along a horizontal plane, without the smallest obstruction, it is known that, in one second, it will descend 8 feet, dragging the other 8 feet along the plane, with a uniformly accelerated motion, and will generate in it the velocity 16 feet per second. Let the thread be attached to three such balls. We know that it will descend 4 feet in a second, and generate the velocity 8 feet per second. Most readers are disposed to think that it should generate no greater velocity than $5\frac{1}{3}$ feet per second, or $\frac{1}{3}$ of 16, because it is applied to three times as much matter (162.). The

error

error lies in considering the motive force as the same in both cases, and in not attending to the quantity of matter to which it is applied. Neither of these conjectures is right. The motive force changes as the motion accelerates, and in the first case it moves two balls, and in the second it moves four. The motive force decreases similarly in both motions. When these things are considered, we learn by articles 202 and 207, that the motions will be precisely what we observe.

Of Deflecting Forces, in General.

169. It was observed, in art. 71, that a curvilineal motion is a case of *continual* deflection. Therefore, when such motions are observed, we know that the body is under the *continual* influence of some natural force, acting in a direction which crosses that of the motion in every point. We must infer the magnitude and direction of this deflecting force by the magnitude and direction of the observed deflection. Therefore, all that is affirmed concerning deflections in the 71st and subsequent articles, may be affirmed concerning deflecting forces. It follows, from what has been established concerning the action of accelerating forces, that no force can produce a finite change of velocity in an instant. Now, a deflection is a composition of a motion already existing with a motion accelerated from rest by insensible degrees. Supposing the deflecting force of invariable direction and intensity, the deflection is the composition of a motion having a finite velocity with a motion uniformly accelerated from rest. Therefore the linear deflection from the rectilineal motion must increase by insensible degrees. The curvilineal path, therefore, must have the line of undeflected motion for its tangent. To suppose any finite angle contained between them would be to suppose a polygonal motion, and a subsultory deflection.

Therefore *no finite change of direction can be produced by a deflecting force in an instant.*

170. The most general and useful proposition on this subject is the following, founded on art. 75.

The forces by which bodies are deflected from the tangents in the different points of their curvilineal paths are proportional to the squares of the velocities in those points directly, and inversely to the deflective chords of the equicurve circles in the same points. We may still express the proposition by the same symbol,

$$f \doteqdot \frac{v^2}{c},$$

where f means the intensity of the deflecting force.

171. We may also retain the meaning of the proposition expressed in article 76, where it is shewn that the actual linear deflection from the tangent is the third proportional to the deflective chord and the arch described in a very small moment. For it was demonstrated in that article (see fig. 18.) that BZ : BC=BC : BO.

We see also that B *b*, the double of BO, is the measure of the velocity, generated by the uniform action of the deflecting force, during the motion in the arch BC of the curve.

172. The art. 77. also furnishes a proposition of frequent and important use, viz.

The velocity in any point of a curvilinear motion is that which the deflecting force in that point would generate in the body by uniformly impelling it along the fourth part of the deflective chord of the equicurve circle.

Of Moving Forces.

REMARK.

137. The propositions now given proceed on the supposition that, when the points A and C of fig. 18. after continually approaching to B, at last coalesce with it, the last circle which is described through these three points has the same curvature which the path has in B. It is proper to render this mode of solving these questions more plain and palpable.

If ABCD (fig. 34.) be a material curve or mould, and a thread be made fast to it at D, this thread may be lapped on the convexity of this curve, till its extremity meets it in A. Let the thread be now unlapped or EVOLVED from the curve, keeping it always tight. It is plain that its extremity A will describe another curve line A *b c*. All curves, in which the curvature is neither infinitely great nor infinitely small, may be thus described by a thread evolved from a proper curve. The properties of the curve A *b c* being known, Mr Huyghens (the author of this way of generating curve lines) has shewn how to construct the evolved curve ABC which will produce it.

Fig. 34.

From this genesis of curves we may infer, 1st, that the detached portion of the thread is always a tangent to the curve ABC; 2dly, that when this is in any situation B *b*, it is perpendicular to the tangent of the curve A *b c* in the point *b*, and that it is, at the same time, describing an element of that curve, and an element of a circle *α b κ*, whose momentary centre is B, and which has B *b* for its radius. 3dly, That the part *b* A of the curve, being described with radii growing continually shorter, is *more* incurvated than the circle *b α*, which has B *b* for its constant radius. For similar reasons the arch *b c* of the curve A *b c* is *less* incurvated than the circle *α b κ*. 4thly, That the circle *α b κ* has the same curvature that the curve has in *b*, or is an equicurve circle. B *b* is the radius, and B the centre of curvature in the point *b*.

ABC is the CURVA EVOLUTA or the EVOLUTE. A *b c* is sometimes called the INVOLUTE of ABC, and sometimes its EVOLUTRIX.

174. By this way of describing curve lines, we see clearly that a body, when passing through the point *b* of the curve A *b c* may be considered as in the same state, in that instant, as in passing through the same point *b* of the circle *α b κ*; and the ultimate ratio of the deflections in both is that of equality, and they may be used indiscriminately.

The chief difficulty in the application of the preceding theorems to the curvilineal motions which are observed in the spontaneous phenomena of nature, is in ascertaining the direction of the deflection in every point of a curvilineal motion. Fortunately, however, the most important cases, namely those motions, where the deflecting forces are always directed to a fixed point, afford a very accurate method. Such forces are called by the general name of

Central Forces.

175. *If bodies describe circles with a uniform motion, the deflecting forces are always directed to the centres of the*

the circles, and are proportional to the square of the velocities, directly, and to their distances from the centre, inversely.

For, since their motion in the circumference is uniform, the areas formed by lines drawn from the centre are as the times, and therefore (72.) the deflections, and the deflecting forces (164.) are directed to the centre. Therefore, the deflective chord is, in this case, the diameter of the circle, or twice the distance of the body from the centre. Therefore, if we call the distance from the centre d, we have $f \doteqdot \frac{v^2}{d}$.

176. *These forces are also as the distances, directly, and as the square of the time of a revolution, inversely.*

For the time of a revolution (which may be called the PERIODIC TIME) is as the circumference, and therefore as the distance, directly, and as the velocity, inversely. Therefore $t \doteqdot \frac{d}{v}$, and $v \doteqdot \frac{d}{t}$, and $v^2 \doteqdot \frac{d^2}{t^2}$, and $\frac{v^2}{d} \doteqdot \frac{d}{t^2}$.

177. *These forces are also as the distances, and the square of the angular velocity, jointly.*

For, in every uniform circular motion, the angular velocity is inversely as the periodic time. Therefore, calling the angular velocity, a, $a^2 \doteqdot \frac{1}{t^2}$, and $\frac{d}{t^2} \doteqdot d\,a^2$, and therefore $f \doteqdot d\,a^2$.

178. *The periodic time is to the time of falling along half the radius by the uniform action of the centripetal force in the circumference, as the circumference of a circle is to the radius.*

For, in the time of falling through half the radius, the body would describe an arch equal to the radius (37.—6.) because the velocity acquired by this fall is equal to the velocity in the circumference (167.). The periodic time is to the time of describing that arch as the circumference to the arch, that is, as the circumference is to the radius.

179. *When a body describes a curve which is all in one plane, and a point is so situated in that plane, that a line drawn from it to the body describes round that point areas proportional to the times, the deflecting force is always directed to that point* (72.)

180. Conversely. *If a body is deflected by a force always directed to a fixed point, it will describe a curve line lying in one plane which passes through that point, and the line joining it with the centre of forces will describe areas proportional to the times* (73.)

The line joining the body with the centre is called the RADIUS VECTOR. The deflecting force is called CENTRIPETAL, or ATTRACTIVE, if its direction be always *toward* that centre. It is called REPULSIVE, or CENTRIFUGAL, if it be directed outwards *from* the centre. In the first case, the curve will have its *concavity* toward the centre, but, in the second case, it will be *convex* toward the centre. The force which urges a piece of iron towards a magnet is centripetal, and that which causes two electrical bodies to separate is centrifugal.

181. *The force by which a body may be made to describe circles round the centre of forces, with the angular velocities which it has in the different points of its curvilineal path, are inversely as the cubes of its distances from the centre of forces.* For the centripetal force in circular motions is proportional to $d\,a^2$ (172.). But when the deflections (and consequently the forces) are directed to a centre, we have $a \doteqdot \frac{1}{d^2}$ (75.) and $a^2 \doteqdot \frac{1}{d^4}$, therefore $d\,a^2 \doteqdot d \times \frac{1}{d^4}, \doteqdot \frac{1}{d^3}$, therefore $f \doteqdot \frac{1}{d^3}$.

This force is often called centrifugal, *the centrifugal force of circular motion;* and it is conceived as always acting in every case of curvilineal motion, and to act in opposition to the centripetal force which produces that motion. But this is inaccurate. We suppose this force, merely because we must employ a centripetal force, just as we suppose a *resisting* vis inertiæ, because we must employ force to move a body.

Fig. 35. 182. *If a body describe a curve line* ABC *by means of a centripetal* (fig. 35.) *force directed to* S, *and varying according to some proportion of the distances from it, and if another body be impelled toward* S *in the straight line* a b S *by the same force, and if the two bodies have the same velocity in any points* A *and* a *which are equidistant from* S, *they will have equal velocities in any other two points* C *and* c, *which are also equidistant from* S.

Describe round S, with the distance SA, the circular arch A a, which will pass through the equidistant point a. Describe another arch B b, cutting off a small arc AB of the curve, and also cutting AS in D. Draw DE perpendicular to the curve.

The distances AS and a S being equal, the centripetal forces are also equal, and may be represented by the equal line AD and $a\,b$. The velocities at A and a being equal, the times of describing AB and $a\,b$ will be as the spaces (14.). The force $a\,b$ is wholly employed in accelerating the rectilineal motion along a S. But the force AD, being transverse or oblique to the motion along AB, is not wholly employed in thus accelerating the motion. It is equivalent to the two forces AE and ED, of which ED, being perpendicular to AB, neither promotes nor opposes it, but incurvates the motion. The accelerating force in A therefore is AE. It was shewn, in art. 48, that the change of velocity is as the force and as the time jointly, and therefore it is as AE × AB. For the same reason, the change of the velocity at a is as $a\,b \times a\,b$, or $a\,b^2$. But, as the angle ADB is a right angle, as also AED, we have $\mathrm{AE} : \mathrm{AD} = \mathrm{AD} : \mathrm{AB}$, and $\mathrm{AE} \times \mathrm{AB} = \mathrm{AD}^2$, $= ab^2$. Therefore, the increments of velocity acquired along AB and $a\,b$ are equal. But the velocities at A and a were equal. Therefore the velocities at B and b are also equal. The same thing may be said of every subsequent increase of velocity, while moving along BC and $b\,c$; and therefore the velocities at C and c are equal.

The same thing holds when the deflecting force is directed in lines parallel to a S, as if to a point S′ infinitely distant, the one body describing the curve line VA′B′, while the other describes the straight line VS.

183. The propositions in art. 73. and 74. are also true in curvilineal motions by means of central forces.

When

When the path of the motion is a line returning into itself, like a circle or oval, it is called an ORBIT; otherwise it is called a TRAJECTORY.

The time of a complete revolution round an orbit is called the PERIODIC TIME.

184. The formula $f \doteqdot \frac{v^2}{c}$ serves for discovering the law of variation of the central force by which a body describes the different portions of its curvilineal path; and the formula $f \doteqdot \frac{d}{t^2}$ serves for comparing the forces by which different bodies describe their respective orbits.

185. It must always be remembered, in conformity to art. 77. that $f = \frac{v^2}{c}$ or $f = \frac{\text{arc}^2}{c}$ expresses the linear deflection from the tangent, which may be taken for a measure of the deflecting force, and that $f = \frac{2\,v^2}{c}$, or $f = \frac{2\,\text{arc}^2}{c}$ expresses the velocity generated by this force, during the description of the arc, or the velocity which may be compared directly with the velocity of the motion in the arc. The last is the most accurate, because the velocity generated is the real change of condition.

186. *A body may describe, by the action of a centripetal force, the direction of which passes through* C (fig. 36.), *a figure* VPS, *which figure revolves (in its own plane) round the centre of forces* C, *in the same manner as it describes the quiescent figure, provided that the angular motion of the body in the orbit be to that of the orbit itself in any constant ratio, such as that of* m *to* n.

For, if the direction of the orbit's motion be the same with that of the body moving in it, the angular motion of the body in every point of its motion is increased in the ratio of m to $n+m$, and it will be in the same ratio in the different parts of the orbit as before, that is, it will be inversely as the square of the distance from S (75.). Moreover, as the distances from the centre in the simultaneous positions of the body, in the quiescent and in the revolving orbit, are the same, the momentary increments of the area are as the momentary increments of the angle at the centre; and therefore in both motions, the areas increase in the constant ratio of m to $m+n$ (75.). Therefore the areas of the absolute path, produced by the composition of the two motions, will still be proportional to the times; and therefore (73.) the deflecting force must be directed to the centre S; or, a force so directed will produce this compound motion.

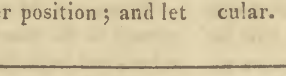
187. *The differences between the forces by which a body may be made to move in the quiescent and in the moveable orbit are in the inverse triplicate ratio of the distances from the centre of forces.*

Let VKSBV (fig. 36.) be the fixed orbit, and upk bu the same orbit moved into another position; and let $VpnNoNtQV$ be the orbit described by the body in absolute space by the composition of its motion in the orbit with the motion of the orbit itself. If the body be supposed to describe the arch VP of the fixed orbit while the axis VC moves into the situation uC, and if the arch up be made equal to VP, then p will be the place of the body in the moveable orbit, and in the compound path Vp. If the angular motion in the fixed orbit be to the motion of the moving orbit as m to n, it is plain that the angle VCP is to VCp as m to $m+n$. Let PK and pk be two equal and very small arches of the fixed and moving orbits. PC and pc are equal, as are also KC and kC, and a circle described round C with the radius CK will pass through k. If we now make VCK to VCn as m to $m+n$: the point n of the circle Kkn will be the point of the compound path, at which the body in the moving orbit arrives when the body in the fixed orbit arrives at K, and pn is the arch of the absolute path described, while PK is described in the fixed path.

In order to judge of the difference between the force which produces the motion PK in the fixed orbit and that which produces pn in the absolute path, it must be observed that, in both cases, the body is made to approach the centre by the difference between CP and CK. This happens, because the centripetal forces, in both cases, are greater than what would enable the body to describe circles round C, at the distance CP, and with the same angular velocities that obtain in the two paths, viz. the fixed orbit and the absolute path. We shall call the one pair of forces the *circular forces*, and the other the *orbital*. Let C and c represent the forces which would produce circles, with the angular velocities which obtain in the fixed and moving orbits, and let O and o be the forces which produce the orbital motions in these two paths.

These things being premised, it is plain that $o-c$ is equal to O—C, because the bodies are equally brought towards the centre by the difference between O and C and by that between o and c. Therefore $o-$O is equal to $c-$C (A). The difference, therefore, of the forces which produce the motions in the fixed and moving orbits is always equal to the difference of the forces which would produce a circular motion at the same distances, and with the same angular velocity. But the forces which produce circular motions, with the angular motion that obtains in an orbit at different distances from the centre of forces, are as the cubes of the distances inversely (175.). And the two angular motions at the same distance are in the constant ratio of m to $m+n$. Therefore the forces are in a constant ratio to each other, and their differences are in a constant ratio to either of the forces. But the circular force at different distances is inversely as the cube of the distance (121.). Therefore the difference of them in the fixed and moveable orbits is in the same proportion. But the difference of the orbital forces is equal to that of the circular. Therefore, finally, the difference of the centripetal

---



(A) For let A o, AO, A c, AC represent the four forces o, O, c, and C. By what has been said, we find that oc=OC. To each of these add O c, and then it is plain that o O=c C, that is, that the difference of the circular forces c and C is equal to that of the orbital forces o and O.

petal forces by which a body may be retained in a fixed orbit, and in the same orbit moving as determined in article 180. is always in the inverse triplicate ratio of the distances from the centre of forces.

In this example, the motion of the body in the orbit is in the same direction with that of the orbit, and the force to be joined with that on the fixed orbit is always additive. Had the orbit moved in the opposite direction, the force to be joined would have been subtractive, unless the retrograde motion of the orbit exceeded twice the angular motion of the body. But in all cases, the reasoning is similar.

188. Thus we have considered the motions of bodies influenced by forces directed to a fixed point. But we cannot conceive a mere mathematical point of space as the cause or occasion of any such exertion of forces. Such relations are observed only between existing bodies or masses of matter. The propositions which have been demonstrated may be true in relation to bodies placed on those fixed points. That continual tendency towards a centre, which produces an equable description of areas round it, becomes intelligible, if we suppose some body placed in the centre of forces, attracting the revolving body. Accordingly, we see very remarkable examples of such tendencies towards a central body in the motions of the planets round the sun, and of the satellites round the primary planet.

But, since it is a universal fact that all the relations between bodies are mutual, we are obliged to suppose that whatever force inclines the revolving body towards the body placed in the centre of forces, an equal force (from whatever source it is derived) inclines the central body towards the revolving body, and therefore it cannot remain at rest, but must move towards it. The notion of a fixed centre of forces is thus taken away again, and we seem to have demonstrated propositions inapplicable to any thing in nature. But more attentive consideration will shew us that our propositions are most strictly applicable to the phenomena of nature.

189. For, in the first place, the motion of the common centre of position of two, or of any number of bodies, is not affected by their mutual actions. These, being equal and opposite, produce equal and opposite motions, or changes of motion. In this case, it follows from art. 115. that the state of the common centre is not affected by them.

Fig. 37. 190. Now, suppose two bodies S and P, situated at the extremities of the line SP (fig. 37.). Their centre of position is in a point C, dividing their distance in such a manner that SC is to CP as the number of material atoms in P to the number in S or $SC : PC = P : S$. Suppose the mutual forces to be centripetal. Then, being equal, exerted between every atom of the one, and every particle of the other, the vis motrix may be expressed by $P \times S$. This must produce equal quantities of motion in each of the bodies, and therefore must produce velocities inversely as the quantities of matter. In any given portion of time, therefore, the bodies will move towards each other, to *s* and *p*, and S *s* will be to P *p*, as P to S, that is, as SC to PC. Therefore we shall still have $sC : pC = SC : PC$. Their distances from C will always be in the same proportion. Also we shall have $SC : SP = P : S+P$, and $sC : pC = P : S+P$; and therefore $SC : SP = sC : sP$. Consequently, in whatever manner the mutual forces vary by a variation of distance from each other, they will vary in the same manner by the same variation of distance from C. And, conversely, in whatever manner the forces vary by a change of distance from C, they vary in the same manner by the same change of distance from each other.

Let us now suppose that when the bodies are at S and P, equal moving forces are applied to each in the opposite directions SA and PB. Did they not attract each other at all, they would, at the end of some small portion of time, be found in the points A and B of a straight line drawn through C, because they will move with equal quantities of motion, or with velocities SA and PB inversely as their quantities of matter. Therefore $SA : PB = SC : PC$, and A, C, and B are in a straight line. But let them now attract, when impelled from S and P. Being equally attracted towards each other, they will describe curve lines S *a* and P *b*, so that their deflections A *a* and B *b* are as SC and PC; and we shall have $aC : bC = SC : PC$. As this is true of every part of the curve, it follows that they describe similar curves round C, which remains in its original place.

Lastly, If the motion of P be considered by an observer placed in S, unconscious of its motion, since he judges of the motion of P only by its change of direction and of distance, we may make a figure which will perfectly represent this motion. Draw the line EF equal and parallel to PS, and EG equal and parallel to *a b*. Do this for every point of the curve S *a* and P *b*. We shall then form a curve FG similar to the curves S *a* and P *b*, having the homologous lines equal to the sum of the homologous lines of these two curves. Thus the bodies will describe round each other curve lines which are similar and equal (lineally) to the lines which they describe round their common centre by the same forces. They may appear to describe areas proportional to the times round each other; and they really describe areas proportional to the times round their common centre of position, and the forces, which really relate to the body which is *supposed* to be central, have the same mathematical relation to their common centre.

Thus it appears that the mechanical inferences, drawn from a supposed relation to a mere point of space, are true in the real relations to the supposed central body, although it is not fixed in one place.

191. The time of describing any arch FG of the curve described round the other body at rest in a centre of forces (where we may suppose it forcibly withheld from moving) is to the time of describing the similar srch P *b* round the common centre of position in the subduplicate ratio of S+P to S, that is, in the ratio of $\sqrt{S+P}$ to $\sqrt{S}$. For the forces being the same in both motions, the spaces described by their similar actions, that is, their deflections from the tangent, are as the squares of the times T and *t* (204.). That is, $HG : Bb = T^2 : t^2$, and $T : t = \sqrt{HG} : \sqrt{Bb}, = \sqrt{S+P} : \sqrt{S}$.

Hence it follows that the two bodies S and P are moved in the same way as if they did not act on each other, but were both acted upon by a third body, placed in their common centre C, and acting with the same forces on each; and the law of variation of the forces by a change of distance from each other, and from this third body, is the same.

192. If a body P (fig. 38.) revolve around another body Fig. 38

DYNAMICS. PLATE CLXXXIV.

Fig. 1.

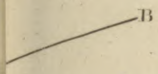


Fig. 2.

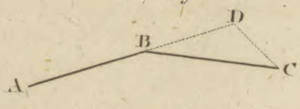


Fig. 3.

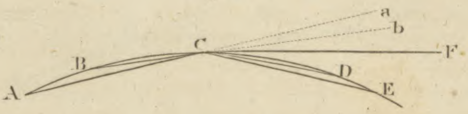


Fig. 4.

Fig. 5.

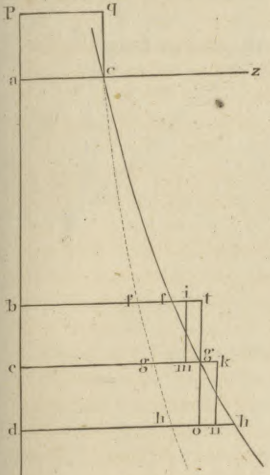


Fig. 6.

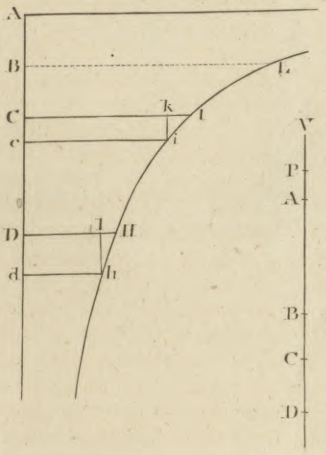


Fig. 7.

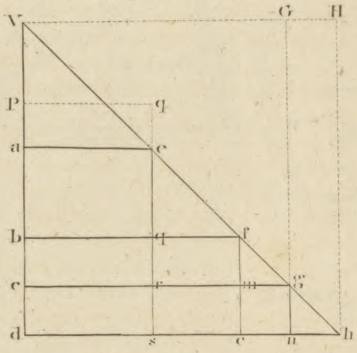


Fig. 8.

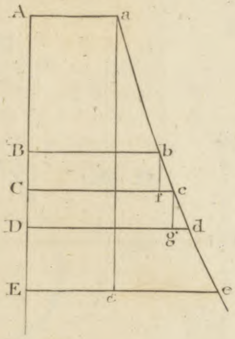


Fig. 9.

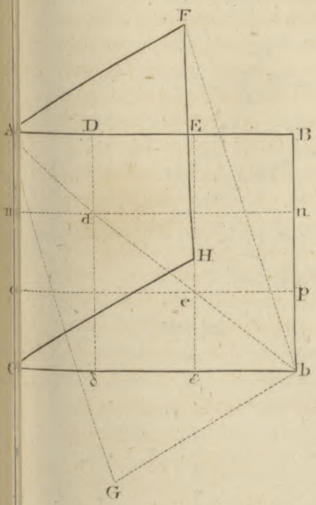


Fig. 10.

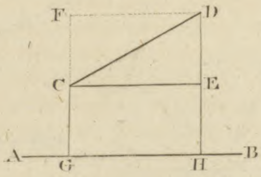


Fig. 11.

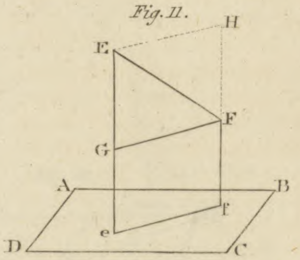


Fig. 12.

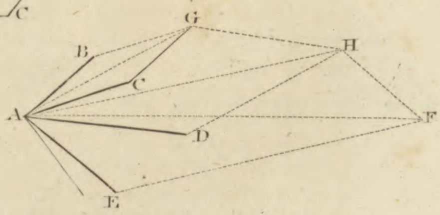


Fig. 13.

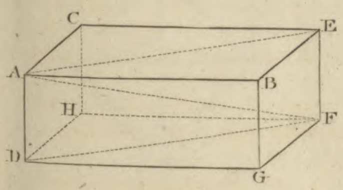


Fig. 14.

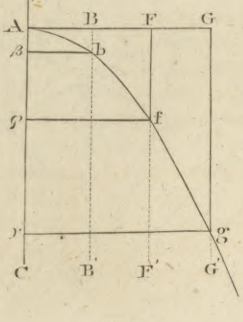
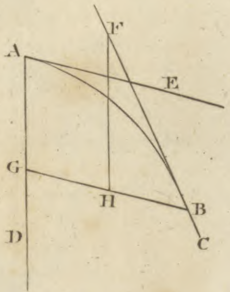


Fig. 15.



W. Archibald Sculp.t

Fig. 16.

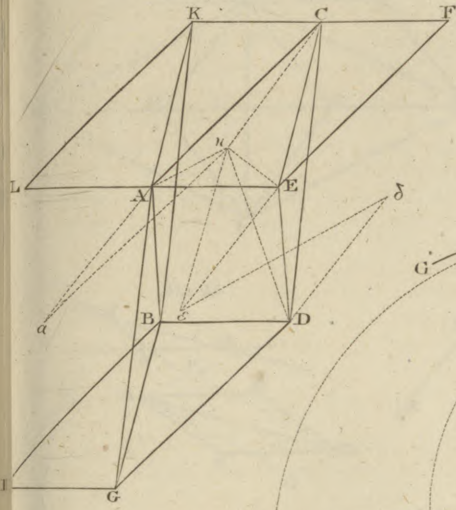


Fig. 17.

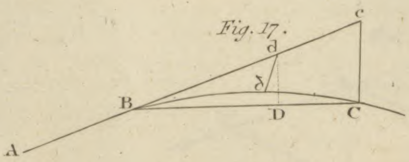


Fig. 19.

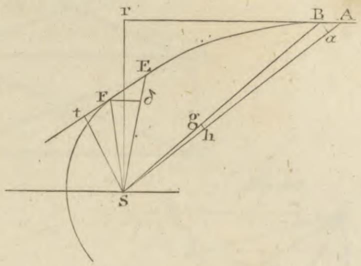


Fig. 18.

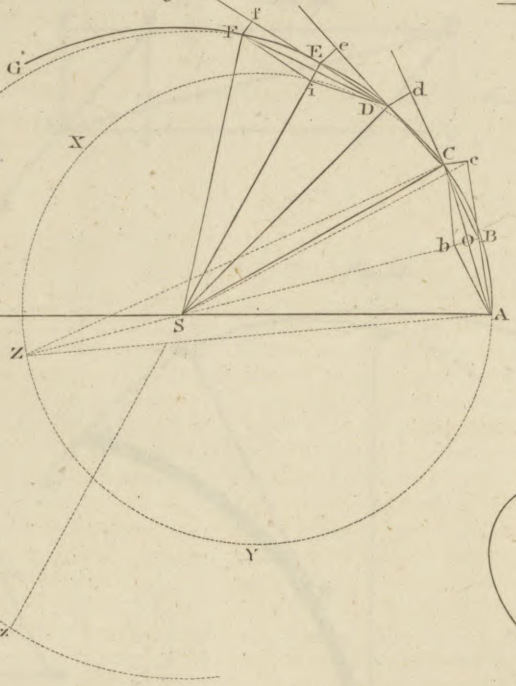


Fig. 20.

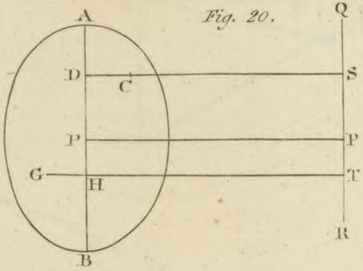


Fig. 21.

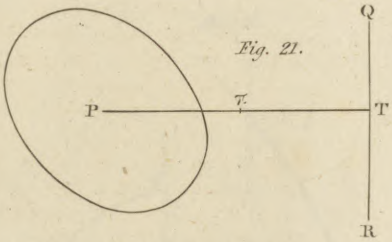


Fig. 22.

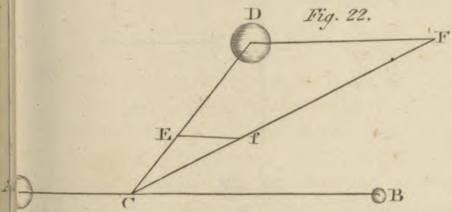


Fig. 23.

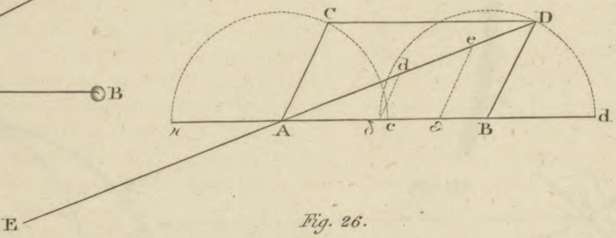


Fig. 24.

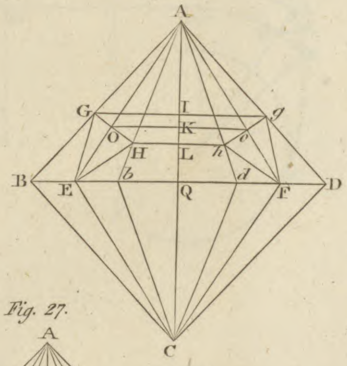


Fig. 25.

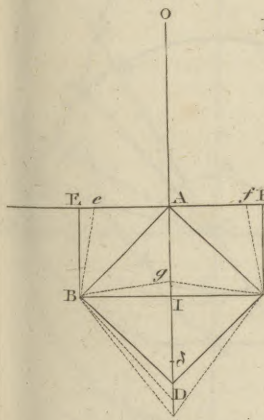


Fig. 26.

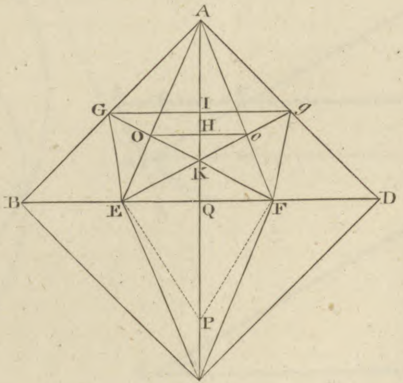
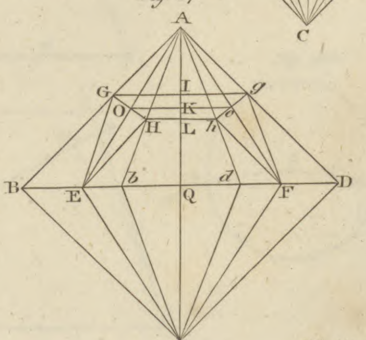


Fig. 27.



W. Archibald Sculp^t

Fig. 28.

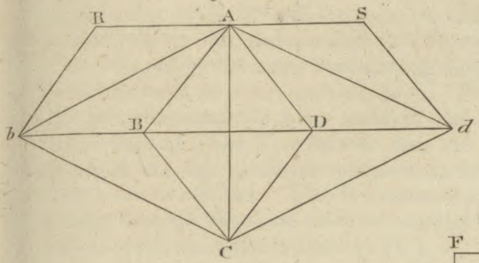


Fig. 29.

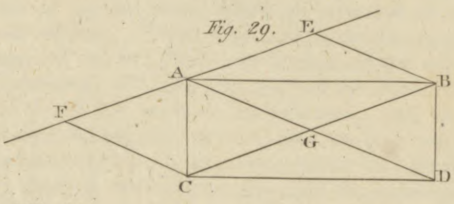


Fig. 30.

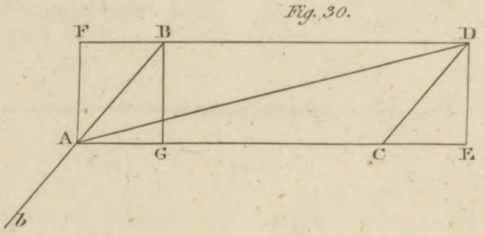


Fig. 32.

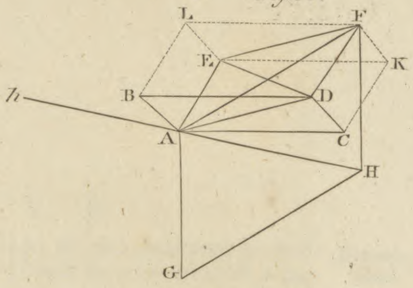


Fig. 31.

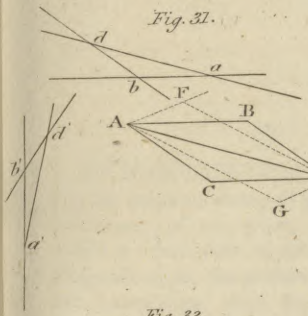


Fig. 34.

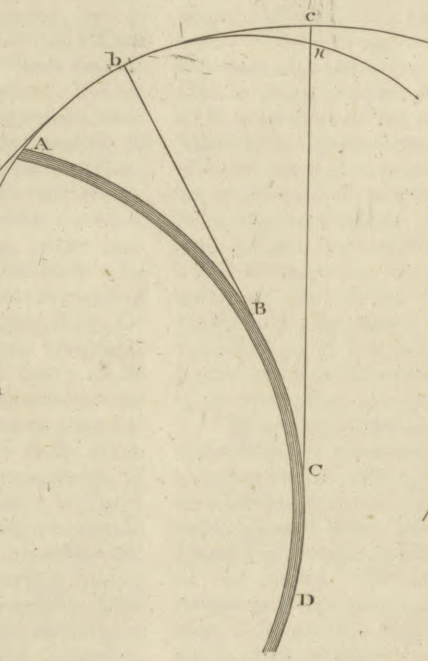


Fig. 33.

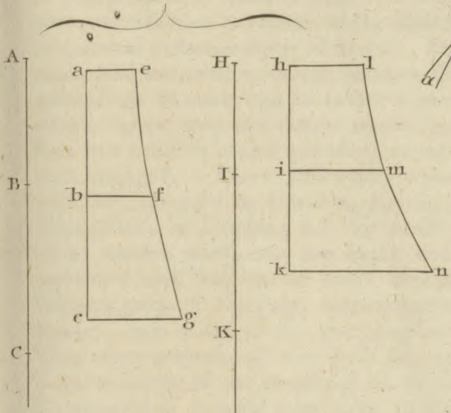


Fig. 35.

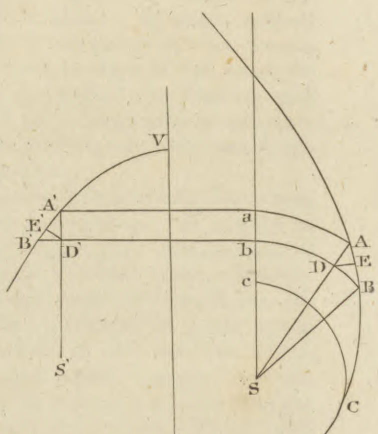


Fig. 36.

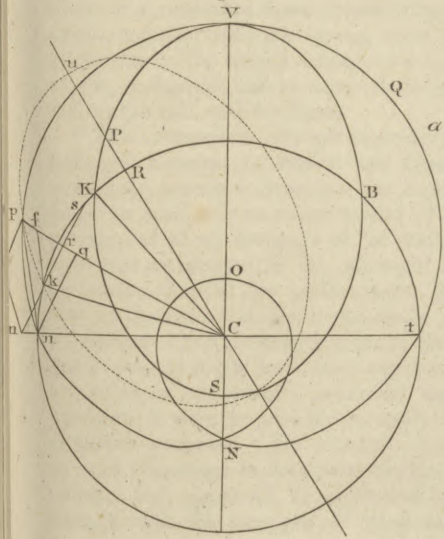


Fig. 37.

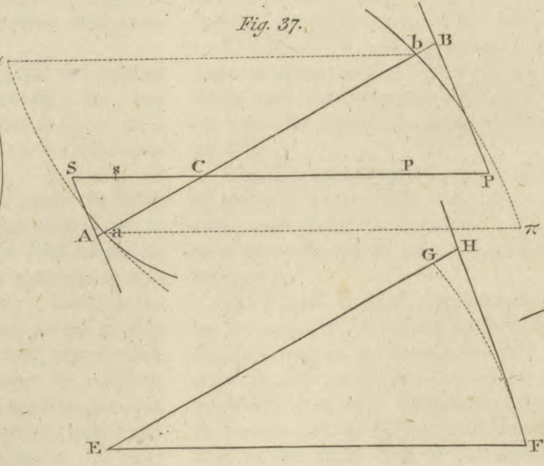
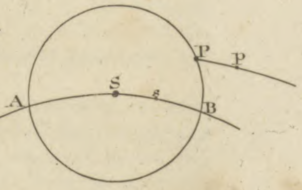


Fig. 38.



W. Archibald Sculp.t

Of Moving Forces.

body S, by the action of a central force, while S moves in any path ASB, P will continue to describe areas proportional to the times round S, if every particle in P be affected by the same accelerating force that acts, in that instant, on every particle in S. For, such action will compound the same motions P*p* and S *s* with the motions of S and P, whatever they are; and it was shown in art. 69. that such composition does not affect their relative motions. This is another way of making a body describe the same orbit in motion which it describes while the orbit is fixed (186.)

Such is the view of the abstract doctrines of motion and of moving forces which we proposed to lay before our readers. Those who have heard the excellent lecture of the late Professor Robison of the university of Edinburgh will probably see that we have availed ourselves of his valuable instructions; and the learned reader will readily perceive that we have enriched our treatise with much important matter by borrowing freely from the writings of the same distinguished philosopher.

Dynanometer ‖ Dyrrachium.

DYNANOMETER, an instrument for ascertaining the relative strength of men and animals. Of an instrument of this kind, invented by Regnier, and of which a description is given in vol. ii. *Jour. de l'Ecole Polytechnique*, the author thus speaks. "Some important knowledge, says he, might be acquired, had we the easy means of ascertaining, in a comparative manner, our relative strengths at the different periods of life, and in different states of health. Buffon and Gueneau, who had some excellent ideas on this subject, requested me to endeavour to invent a portable machine, which, by an easy and simple mechanism, might conduct to a solution of this question, on which they were then engaged. These philosophers were acquainted with that invented by Graham, and improved by Dr Desaguliers, at London; but this machine, constructed of wooden work, was too bulky and heavy to be portable; and, besides, to make experiments on the different parts of the body, several machines were necessary, each suited to the part required to be tried. They were acquainted also with the dynanometer of Citizen Leroy of the Academy of Sciences at Paris. It consisted of a metal tube 10 or 12 inches in length, placed vertically on a foot like that of a candlestick, and containing in the inside a spiral spring, having above it a graduated shank terminating in a globe. This shank, together with the spring, sunk into the tube in proportion to the weight acting upon it, and thus pointed out, in degrees, the strength of the person who pressed on the ball with his hand.

"This instrument, though ingenious, did not appear sufficient however to Buffon and Gueneau; for they wished not merely to ascertain the muscular force of a finger or hand, but to estimate that of each limb separately, and of all the parts of the body. I shall not here give an account of the attempts I made to fulfil the wishes of these two philosophers, but only observe, that in the course of my experiments I had reason to be convinced that the construction of the instrument was not so easy as might have been expected. Besides the use which an enlightened naturalist may make of this machine, it may be possible to apply it to many other important purposes. For example, it may be employed with advantage to determine the strength of draught cattle; and, above all, to try that of horses, and compare it with the strength of other animals. It may serve to make known how far the assistance of well-constructed wheels may favour the movement of a carriage, and what is its *vis inertiæ* in proportion to the load. We might appreciate by it, also, what resistance the slope of a mountain opposes to a carriage, and be able to judge whether a carriage is sufficiently loaded in proportion to the number of horses that are to be yoked to it. In the arts, it may be applied to machines of which we wish to ascertain the resistance, and when we are desirous to calculate the moving force that ought to be adapted to them. It may serve, also, as a Roman balance to weigh burdens. In short, nothing would be more easy than to convert it into an anemometer, to discover the absolute force of the wind, by fitting to it a frame of a determined size filled up with wax cloth; and it would not be impossible to ascertain by this machine the recoil of fire-arms, and consequently the strength of gun-powder.

"This dynanometer, in its form and size, has a near resemblance to a common graphometer. It consists of a spring twelve inches in length, bent into the form of an ellipsis; from the middle of which arises a semicircular piece of brass, having engraved upon it the different degrees that express a force of the power acting on the spring. The whole of this machine, which weighs only two pounds and a half, opposes, however, more resistance than may be necessary to determine the action of the strongest and most robust horse." For a fuller description, see Phil. Mag. vol. i.

DYNASTY, among ancient historians, signifies a race or succession of kings of the same line or family. Such were the dynasties of Egypt. The word is formed from the Greek δυναϛεια, of δυναϛευω, *to be powerful*, or *king*.

The Egyptians reckon 30 dynasties within the space of 36,525 years; but the generality of chronologers look upon them as fabulous. And it is very certain, that these dynasties are not continually successive, but collateral.

DYRRACHIUM, in *Ancient Geography*, a town on the coast of Illyricum, before called *Epidamnum*, or *Epidamnus*, an inauspicious name, changed by the Romans to *Dyrrachium*; a name taken from the peninsula on which it stood. Originally built by the Corcyreans. A Roman colony (Pliny). A town famous in story: its port answered to that of Brundusium, and the passage between both was very ready and expeditious. It was also a very famous mart for the people living on the Adriatic; and the free admission of strangers contributed much to its increase: A contrast to the conduct of the Apollonians; who, in imitation of the Spartans, discouraged strangers from settling among them.

DYSÆ, in *Mythology*, inferior goddesses among the Saxons, being the messengers of the great Woden, whose province it was to convey the souls of such as died in battle to his abode, called *Valhall*, i. e. the hall of slaughter; where they were to drink with him and their other gods *cervisia*, or a kind of malt liquor, in the skulls of their enemies. The *Dysæ* conveyed those who died a natural death to *Hela*, the goddess of hell, where they were tormented with hunger, thirst, and every kind of evil.

DYSCRASY, among physicians, denotes an ill habit or state of the humours, as in the scurvy, jaundice, &c.

DYSENTERY, in *Medicine*, a diarrhœa or flux, wherein the stools are mixed with blood, and the bowels miserably tormented with gripes. See MEDICINE *Index*.

DYSENTERIC FEVER. See MEDICINE *Index*.

DYSERT, a borough town of Scotland, in the county of Fife, situated on the northern shore of the frith of Forth, about eleven miles north of Edinburgh.

DYSOREXY, among physicians, denotes a want of appetite, proceeding from a weakly stomach.

DYSPEPSY, a difficulty of digestion.

DYSPNOEA, a difficulty of breathing, usually called *asthma*. See MEDICINE *Index*.

DYSURY, in *Medicine*, a difficulty of making water, attended with a sensation of heat and pain. See MEDICINE *Index*.

DYTISCUS, WATER-BEETLE. See ENTOMOLOGY *Index*.

DYVOUR, in *Scots Law*; otherwise *Bare-man*: A person who, being involved in debt, and unable to pay the same,—for avoiding imprisonment and other pains, makes cession of his effects in favour of his creditors; and does his *devoir* and duty to them, proclaiming himself bare-man and indigent, and becoming debt bound to them of all that he has. The word is used in the same sense as BANKRUPT: see that article; and LAW *Index*.

E.

E, THE second vowel, and fifth letter of the alphabet. The letter E is most evidently derived from the old character Ǝ in the ancient Hebrew and Phœnician alphabets, inverted by the Greeks to this position E, and not from the Hebrew He ה. From the same origin is also derived the Saxon *e*, which is the first letter in their alphabet that differs from the Latin one. It is formed by a narrower opening of the larynx than the letter A; but the other parts of the mouth are used nearly in the same manner as in that letter.

It has a long and short sound in most languages. The short sound is audible in *bed*, *fret*, *den*, and other words ending in consonants: its long sound is produced by a final *e*, or an *e* at the end of words; as in *glebe*, *here*, *hire*, *scene*, *sphere*, *interfere*, *revere*, *sincere*, &c. in most of which it sounds like *ee*; as also in some others by coming after *i*, as in *believe*, *chief*, *grief*, *reprieve*, &c. and sometimes this long sound is expressed by *ee*, as in *bleed*, *beer*, *creed*, &c. Sometimes the final *e* is silent, and only serves to lengthen the sound of the preceding vowel, as in *rag*, *rage*, *stag*, *stage*, *hug*, *huge*, &c. The sound of *e* is obscure in the following words *oxen*, *heaven*, *bounden*, *fire*, *massacre*, *maugre*, &c.

The Greeks have their long and short *e*, which they call *epsilon* and *eta*. The French have at least six kinds of ε's: the Latins have likewise a long and short *e*; they also write *e* instead of *a*, as *dicem* for *dicam*, &c. and this is no doubt the reason why *a* is so often changed into *e* in the preter tense, as *ago*, *egi*; *facio*, *feci*, &c.

As a numeral, E stands for 250, according to the verse,

E, quoque ducentos et quinquaginta tenebit.

In music it denotes the tone *e-la-mi*. In the kalendar it is the fifth of the dominical letters. And in sea charts it distinguishes all the easterly points: thus, E alone denotes East; and E. by S. and E. by N. East by South, and East by North.

EACHARD, JOHN, an English divine of great learning and wit in the 17th century, bred at Cambridge, author (in 1670) of *The Grounds and Occasions of the Contempt of the Clergy and Religion inquired into.* In 1675 he was chosen master of Catharine-hall upon the decease of Dr John Lightfoot; and the year following was created D. D. by royal mandate. He died in 1696.

EACHARD, *Laurence*, an eminent English historian of the 18th century, nearly related to Dr John Eachard. He was the son of a clergyman, who, by the death of his elder brother, became master of a good estate in Suffolk. He was educated in the university of Cambridge, entered into holy orders, and was presented to the living of Welton and Elkington in Lincolnshire, where he spent above 20 years of his life, and distinguished himself by his writings, especially his History of England, which was attacked by Dr Edmund Calamy and by Mr John Oldmixon. His "General Ecclesiastical History from the Nativity of Christ to the first Establishment of Christianity by Human Laws under the emperor Constantine the Great," has passed through several editions. He was installed archdeacon of of Stowe and prebend of Lincoln in 1712. He died in 1730.

EADMERUS, an esteemed historian, was an Englishman; but his parents, and the particular time and place of his nativity, are not known. He received a learned education, and very early discovered a taste for history, by recording every remarkable event that came to his knowledge. Being a monk in the cathedral of Canterbury, he had the happiness to become the bosom friend and inseparable companion of two archbishops of that see, St Anselm and his successor Ralph. To the former of these he was appointed spiritual director by the pope; and that prelate would do nothing without his permission. In the year 1120, he was sent for by King Alexander I. of Scotland, to be raised to the primacy of that kingdom; and having obtained leave of King Henry and the archbishop of Canterbury, he departed for Scotland, where he was kindly received by the king; and on the third day after his arrival, he was elected bishop of St Andrew's with much unanimity. But on the day after his election, an unfortunate dispute arose between the king and him, in a private conference about his consecration. Eadmerus having been a constant companion of the late and of the present archbishop of Canterbury, was a violent stickler for the prerogatives of that see. He therefore told the king, that he was determined to be consecrated by none but the archbishop of Canterbury, who he believed to be the primate of all Britain. Alexander, who was a fierce prince, and supported the independency of his crown and kingdom with great spirit, was so much offended, that he broke off the conference in a violent passion, declaring, that the see of Canterbury had no pre-eminency over that of St Andrew's. This breach between the king and the bishop-elect became daily wider, till at length Eadmerus, despairing of recovering the royal favour, sent his pastoral ring to the king, and laid his pastoral staff on the high altar, from whence he had taken it, and abandoning his bishopric returned to England. He was kindly received by the archbishop and clergy of Canterbury, though they disapproved of his stiffness, and thought him too hasty in forsaking the honourable station to which he had been called. Nor was it long before Eadmerus became sensible of his error, and desirous of correcting it. With this view he wrote a long submissive letter to the king of Scotland, entreating his leave to return to his bishopric, promising compliance with his royal pleasure in every thing respecting his consecration, which was accompanied by an epistle to the same purpose from the archbishop. These letters, however, which were written A. D. 1122, did not produce the desired effect. But Eadmerus is most worthy of the grateful remembrance of posterity for his historical works, particularly for his excellent history of the affairs of England in his own time, from A. D. 1066 to A. D. 1122; in which he hath inserted many original papers, and preserved many important facts, that are nowhere else to be found. This work hath been highly commended, both by ancient and modern writers, for its authenticity, as well as for regularity of composition and purity of style. It is indeed more free from legendary tales than any other work of this period; and it is impossible to peruse it with attention, without conceiving a favourable opinion of the learning, good sense, sincerity, and candour of its author.

EAGLE. See FALCO, ORNITHOLOGY *Index*.

EAGLE, in *Heraldry*, is accounted one of the most noble bearings in armory; and, according to the learned in this science, ought to be given to none but such as greatly excel in the virtues of generosity and courage, or for having done singular services to their sovereigns; in which case they may be allowed a whole eagle, or an eagle naissant, or only the head or other parts thereof, as may be most agreeable to their exploits.

The eagle has been borne by way of ensign or standard, by several nations. The first who seem to have assumed the eagle are the Persians; according to the testimony of Xenophon. Afterwards it was taken by the Romans; who, after a great variety of standards, at length fixed on the eagle, in the second year of the consulate of C. Marius: till that time, they used indifferently wolves, leopards, and eagles, according to the humour of the commander.

The Roman eagles, it must be observed, were not painted on a cloth or flag; but were figures in relievo, of silver or gold, borne on the tops of pikes; the wings being displayed, and frequently a thunderbolt in their talons. Under the eagle on the pike, were piled bucklers, and sometimes crowns. Thus much we learn from the medals.

Constantine is said to have first introduced the eagle with two heads, to intimate, that though the empire seemed divided, it was yet only one body. Others say, that it was Charlemagne who resumed the eagle as the Roman ensign, and added to it a second head; but that opinion is destroyed, by an eagle with two heads, noted by Lipsius, on the Antonine column; as also by the eagle's only having one head on the seal of the golden bull of the emperor Charles IV. The conjecture, therefore, of F. Menestrier appears more probable, who maintains that as the emperors of the East, when there were two on the throne at the same time, struck their coins with the impression of a cross, with a double traverse, which each of them held in one hand, as being the symbol of the Christians; the like they did with the eagle in their ensigns; and instead of doubling their eagles, they joined them together, and represented them with two heads. In which they were followed by the emperors of the West.

F. Papebroche wishes that this conjecture of Menestrier was confirmed by ancient coins; without which, he rather inclines to think the use of the eagle with two heads to be merely arbitrary; though he grants it probable, that it was first introduced on occasion of two emperors on the same throne.

The eagle on medals, according to M. Spanheim, is a symbol of divinity and providence; and, according to all other antiquaries, of empire. The princes on whose medals it is most usually found, are the Ptolemies and the Seleucides of Syria. An eagle with the word CONSECRATIO, expresses the apotheosis of an emperor.

EAGLES, a name found very frequently in the ancient histories of Ireland, and used to express a sort of base money that was current in that kingdom in the first

first years of the reign of Edward I. that is, about the year 1272. There were, besides the eagles, lionines, rosades, and many other coins of the same sort, named according to the figures they were impressed with.

The current coin of the kingdom was at that time a composition of copper and silver, in a determined proportion; but these were so much worse than the standard proportion of that time, that they were not intrinsically worth quite half so much as the others. They were imported out of France and other foreign countries. When this prince had been a few years established on the throne, he set up mints in Ireland for the coining sufficient quantities of good money, and then decried the use of these eagles, and other the like kinds of base coins, and made it death, with confiscation of effects, to import any more of them into the kingdom.

Eagle, in *Astronomy*, is a constellation of the northern hemisphere, having its right wing contiguous to the equinoctial. See Aquila.

There are also three several stars, particularly denominated among the Arab astronomers, *nasr*, i. e. "eagle." The first, *nasr sohail*, the "eagle of Canopus," called also *sitareh jemen*, the star of Arabia Felix, over which it is supposed to preside; the second, *nasr althair*, the "flying eagle;" and the third, *nasr alveke*, the "resting eagle."

White Eagle, is a Polish order of knighthood, instituted in 1325 by Uladislaus V. on marrying his son Casimir with a daughter of the great duke of Lithuania.

The knights of this order were distinguished by a gold chain, which they wore on the stomach, whereon hung a silver eagle crowned.

Black Eagle, was a like order, instituted in 1701 by the elector of Brandenburgh, on his being crowned king of Prussia.

The knights of this order wear an orange-coloured ribbon, to which is suspended a black eagle.

Eagle, in *Architecture*, is a figure of that bird anciently used as an attribute or cognizance of Jupiter, in the capital and friezes of the columns of temples consecrated to that god.

Eagle-flower. See Balsamine.

Eagle-stone, in *Natural History*, in a stone by the Greeks called *ætites*, and by the Italians *pietra d'aquila*, as being supposed to be sometimes found in the eagle's nest. It is of famous traditionary virtue, either for forwarding or preventing the delivery of women in labour, according as it is applied above or below the womb. Matthiolus tells us, that birds of prey could never hatch their young without it, and that they go in search of it as far as the East Indies. Bausch has an express Latin treatise on the subject. See Ætites.

EAGLET, a diminutive of eagle, properly signifying a young eagle. In heraldry, when there are several eagles on the same escutcheon, they are termed *eaglets*.

EALDERMAN, or Ealdorman, among the Saxons, was of like import with earl among the Danes.

The word was also used for an elder, senator, or statesman. Hence, at this day, we call those *aldermen* who are associates to the chief officer in the common council of a city or corporate town.

EAR. See Anatomy *Index*.

Several naturalists and physicians have held, that cutting off the ear rendered persons barren and unprolific; and this idle notion was what first occasioned the legislators to order the ears of thieves, &c. to be cut off, lest they should produce their like.

The ear has its beauties, which a good painter ought by no means to disregard; where it is well formed, it would be an injury to the head to be hidden. Suetonius insists, particularly, on the beauties of Augustus's ears; and Ælian, describing the beauties of Aspasia, observes, she had short ears. Martial also ranks large ears among the number of deformities.

Among the Athenians, it was a mark of nobility to have the ears bored or perforated. And among the Hebrews and Romans, this was a mark of servitude.

Loss of one ear is a punishment enacted by 5 and 6 Edw. VI. cap. 4. for fighting in a churchyard; and by 2 and 3 Edw. VI. cap. 15. for combinations to raise the price of provisions, labour, &c. if it be the third offence, beside pillory, and perpetual infamy, or a fine of 40l.

By a statute of Henry VIII. maliciously cutting off the ear of a person is made a trespass, for which treble damages shall be recovered; and the offender is to pay a fine of ten pounds to the king, 37 Hen. VIII. cap. 6. § 4. In the Index to the Statutes at Large, it is said, that this offence may be punished as felony, by 22 and 23 Car. II. cap. 1. § 7. commonly called *Coventry's act;* but ear is not mentioned in that statute.

Ear of Fishes. See Anatomy *Index*.

Ear, in *Music*, denotes a kind of internal sense, whereby we perceive and judge of harmony and musical sounds. See Music.

In music we seem universally to acknowledge something like a distinct sense from the external one of hearing; and call it a *good ear*. And the like distinction we should probably acknowledge in other affairs, had we got distinct names to denote these powers of perception by. Thus a greater capacity of perceiving the beauties of painting, architecture, &c. is called a *fine taste*.

Ear is also used to signify a long cluster of flowers or seeds, produced by certain plants; usually called by botanists *spica*. The flowers and seeds of wheat, rye, barley, &c. grow in ears. The same holds of the flowers of lavender, &c. We say the stem of the ear, i. e. its tube or straw; the knot of the ear; the lobes or cells wherein the grains are enclosed; the beard of the ear, &c.

Ear-Ach. See Medicine *Index*.

EARING, in the sea language, is that part of the bolt rope which at the four corners of the sail is left open, in the shape of a ring. The two uppermost parts are put over the ends of the yard arms, and so the sail is made fast to the yard; and into the lowermost earings, the sheets and tacks are seized or bent at the clew.

Ear-Pick, an instrument of ivory, silver, or other metal, somewhat in form of a probe, for cleansing the ear. The Chinese have a variety of these instruments, with

with which they are mighty fond of tickling their ears; but this practice, Sir Hans Sloane observes, must be very prejudicial to so delicate an organ, by bringing too great a flow of humours on it.

Ear-Ring. See Pendent.

Ear-Wax. See Anatomy *Index.*

EARWIG. See Forficula, Entomology *Index.*

EARL, a British title of nobility, next below a marquis, and above a viscount.

The title is so ancient, that its original cannot be clearly traced out. Thus much, however, seems tolerably certain, that among the Saxons they were called *ealdormen, quasi* elder men, signifying the same with *senior* or *senator* among the Romans; and also *schiremen*, because they had each of them the civil government of a several division or shire. On the irruption of the Danes they changed their names to *eorels*, which, according to Camden, signified the same in their language. In Latin they are called *comites*, (a title first used in the empire), from being the king's attendants; *à societate nomen sumpserunt, reges enim tales sibi associant.* After the Norman conquest they were for some time called *counts*, or *countées*, from the French; but they did not long retain that name themselves, though their shires are from thence called *counties* to this day. It is now become a mere title; they having nothing to do with the government of the county; which is now entirely devolved on the sheriff, the earl's deputy, or *vicecomes.* In writs, commissions, and other formal instruments, the king, when he mentions any peer of the degree of an earl, usually styles him "trusty and well beloved *cousin*;" an appellation as ancient as the reign of Henry IV.; who being either by his wife, his mother, or his sisters, actually related or allied to every earl in the kingdom, artfully and constantly acknowledged that connection in all his letters and other public acts; whence the usage has descended to his successors, though the reason has long ago failed.

An earl is created by cincture of sword, mantle of state put upon him by the king himself, a cap and a coronet put upon his head, and a charter in his hand.

Earl Marshal. See Marshal.

EARNEST (arrhæ), money advanced to bind the parties to the performance of a verbal bargain. By the civil law, he who recedes from his bargain loses his earnest, and if the person who received the earnest give back, he is to return the earnest double. But with us, the person who gave it, is in strictness obliged to abide by his bargain; and in case he decline it, is not discharged upon forfeiting his earnest, but may be sued for the whole money stipulated.

EARTH, among ancient philosophers, one of the four elements of which the whole system of nature was thought to be composed. See Element.

Earths, in *Chemistry*, are such substances as have neither taste nor smell, are incombustible, are nearly insoluble in water, and have a specific gravity under 5. Such are lime, barytes, &c. See Chemistry *Index.*

Earth, in *Astronomy* and *Geography*, one of the primary planets; being this terraqueous globe which we inhabit.

For the astronomical facts with regard to the earth, see Astronomy; for its geographical history, see Geography; and for the opinions or theories of its formation and changes, see Geology *Index.*

EARTHQUAKE. See Geology *Index.*

EARTH-worm. See Helminthology *Index.*

EASEL pieces, among painters, such small pieces, either portraits or landscapes, as are painted on the easel, *i. e.* the frame whereon the canvas is laid. They are thus called to distinguish them from larger pictures drawn on walls, ceilings, &c.

EASEMENT, in *Law*, a privilege or convenience which one neighbour has of another, whether by charter or prescription, without profit: such are, a way through his lands, a sink, or the like. These, in many cases, may be claimed.

EASING, in the sea language, signifies the slackening a rope or the like. Thus, to ease the bow line, or sheet, is to let them go slacker; to ease the helm, is to let the ship go more large, more before the wind, or more larboard.

EAST, one of the four cardinal points of the world; being that point of the horizon where the sun is seen to rise when in the equinoctial.

The word *east* is Saxon. In Italy, and throughout the Mediterranean, the east wind is called the *levante:* in Greek, ανατολη and απηλιωτης, because it comes from the side of the sun, απ' ἡλιȣ; in Latin *eurus.*

EASTER, a festival of the Christian church, observed in memory of our Saviour's resurrection.

The Greeks call it *pasga*, the Latins *pascha*, a Hebrew word signifying *passage*, applied to the Jewish feast of the passover. It is called *easter* in English, from the goddess Eostre, worshipped by the Saxons with peculiar ceremonies in the month of April.

The Asiatic churches kept their easter upon the very same day the Jews observed their passover, and others on the first Sunday after the first full moon in the new year. This controversy was determined in the council of Nice; when it was ordained that easter should be kept upon one and the same day, which should always be a Sunday, in all Christian churches in the world. For the method of finding easter by calculation, see Chronology.

Easter Island, an island in the South Sea, lying in N. Lat. 27. 5. W. Long. 109. 46. It is thought to have been first discovered in 1686 by one Davis an Englishman, who called it *Davis's Land.* It was next visited by Commodore Roggewein, a Dutchman, in 1722; who gave it the name of *Easter Island*, and published may fabulous accounts concerning the country and its inhabitants. It was also visited by a Spanish ship in 1770, the captain of which gave it the name of *St Carlos.* The only authentic accounts of this island, however, which have yet appeared, are those published by Captain Cook and Mr Forster, who visited it in the month of March 1774. According to these accounts, the island is about 10 or 12 leagues in circumference, and of a triangular figure; its greatest length from north-west to south-east is about four leagues, and its greatest breadth two. The hills are so high, that they may be seen at the distance of 15 or 16 leagues. The north and east points of the island are of a considerable height; between them, on the south-east side, the shore forms an open bay, in which Captain Cook thinks the Dutch anchored in 1722. He himself anchored on the west side of the island, three miles northward from the south point. This, he says, is a good road with easterly winds; but a dangerous one when the wind blows from the contrary quarter, as the other on the south-east side must be with easterly winds; so that there is no good accommodation to be had for shipping round the whole island.

The island itself is extremely barren; and bears evident marks not only of a volcanic origin, but of having been not very long ago entirely ruined by an eruption. As they approached the south point, Mr Forster informs us, that they observed the shore to rise perpendicularly. It consisted of broken rocks, whose cavernous appearance, and black or ferruginous colour, seemed to indicate that they had been thrown up by subterraneous fire. Two detached rocks lie about a quarter of a mile off this point: one of them is singular on account of its shape, and represents a huge column or obelisk; and both these rocks were inhabited by multitudes of sea fowls. On landing and walking into the country, they found the ground covered with rocks and stones of all sizes, which appeared to have been exposed to a great fire, where they seemed to have acquired a black colour and porous texture. Two or three shrivelled species of grasses grew among these stones, and in some measure softened the desolate appearance of the country. The farther they advanced, the more ruinous the face of the country seemed to be. The roads were intolerably rugged, and filled with heaps of volcanic stones, among which the Europeans could not make their way but with the greatest difficulty; but the natives leaped from one stone to another with surprising agility and ease. As they went northward along the island, they found the ground still of the same nature; till at last they met with a rock of large black melted lava, which seemed to contain some iron, and on which was neither soil nor grass, nor any mark of vegetation. Notwithstanding this general barrenness, however, there are several large tracts covered with cultivated soil, which produces potatoes of a gold yellow colour as sweet as carrots, plantains, and sugar canes. The soil is a dry hard clay; and the inhabitants use the grass which grows between the stones in other parts of the island as a manure, and for preserving their vegetables when young from the heat of the sun.

The most remarkable curiosity belonging to this island is a number of colossal statues; of which, however, very few remain entire. These statues are placed only on the sea coast. On the east side of the island were seen the ruins of three platforms of stone work, on each of which had stood four of these large statues; but they were all fallen down from two of them, and one from the third: they were broken or defaced by the fall. Mr Wales measured one that had fallen, which was 15 feet in length, and six broad over the shoulders; each statue had on its head a large cylindric stone of a red colour, wrought perfectly round. Others were found that measured near 27 feet, and upwards of eight feet over the shoulders; and a still larger one was seen standing, the shade of which was sufficient to shelter all the party, consisting of near 30 persons, from the rays of the sun. The workmanship is rude, but not bad, nor are the features of the face ill formed; the ears are long, according to the distortion practised in the country, and the bodies have hardly any thing of a human figure about them. How these islanders, wholly unacquainted with any mechanical power, could raise such stupendous figures, and afterwards place the large cylindric stones upon their heads, is truly wonderful! The most probable conjecture seems to be, that the stone is factitious; and that each figure was gradually erected, by forming a temporary platform round it, and raising it as the work advanced; but they are at any rate very strong proofs of the ingenuity and perseverance of the islanders in the age when they were built, as well as that the ancestors of the present race had seen better days than their descendants enjoy. The water of this island is in general brakish, there being only one well that is perfectly fresh, which is at the east end of the island: and whenever the natives repair to it to slake their thirst, they wash themselves all over; and if there is a large company, the first leaps into the middle of the hole, drinks, and washes himself without ceremony; after which another takes his place, and so on in succession. This custom was much disrelished by their new friends, who stood greatly in need of this valuable article, and did not wish to have it contaminated by such ablutions.

The people are of a middle size. In general they are rather thin; go entirely naked; and have punctures on their bodies, a custom common to all the inhabitants of the South Sea islands. Their greasest singularity is the size of their ears, the lobe of which is stretched out so that it almost rests on their shoulder; and is pierced with a very large hole, capable of admitting four or five fingers with ease. The chief ornaments for their ears are the white down of feathers, and rings which they wear in the inside of the hole, made of the sugar cane, which is very elastic, and for this purpose is rolled up like a watch spring. Some were seen clothed in the same cloth used in the island of Otaheite, tinged of a bright orange colour with turmeric; and these our voyagers supposed to be chiefs. Their colour is a chesnut brown; their hair black, curling, and remarkably strong; and that on the head as well as the face is cut short. The women are small, and slender limbed: they have punctures on the face, resembling the patches sometimes used by European ladies; they paint their face all over with a reddish brown ruddle, and above this they lay a fine orange colour extracted from turmeric root; the whole is then variegated with streaks of white shell lime. But the most surprising circumstance of all with regard to these people, is the apparent scarcity of women among them. The nicest calculation that could be made, never brought the number of inhabitants in this island to above 700, and of these the females bore no proportion in number to the males. Either they have but few females, or else their women were restrained from appearing during the stay of the ship; notwithstanding, the men showed no signs of a jealous disposition, or the women any scruples of appearing in public: in fact, they seemed to be neither reserved nor chaste; and the large pointed cap which they wore gave them the appearance of professed wantons. But as all the women who were seen were liberal of their favours, it is more than probable that all the married and modest ones had concealed themselves from their impetuous visitants in some inscrutable parts of the island; and what further strengthens this supposition is, that

Eau de Luce
‖
Ebionites.

that heaps of stones were seen piled up into little hillocks, which had one steep perpendicular side, where a hole went under ground. The space within, says Mr Forster, could be but small; and yet it is probable that these cavities served, together with their miserable huts, to give shelter to the people at night; and they may communicate with natural caverns, which are very common in the lava currents of volcanic countries. The few women that appeared were the most lascivious of their sex perhaps that have been ever noticed in any country; shame seemed to be entirely unknown to them.

EATON, a town of Buckinghamshire, situated on the north side of the Thames, opposite to Windsor, and famous for its collegiate school, founded by King Henry VI. being a seminary for King's College, Cambridge, the fellows of which are all from this school. See Eton.

EAU de Carmes. See Pharmacy.

Eau de Luce, a fragrant alkaline liquor which was some years ago in great repute, especially among the fair sex, and of which the leading perfection is, that it shall possess and retain a milky opacity.

Mr Nicholson, in the second number of his valuable Journal, tells us, that being informed by a philosophical friend, that the usual recipes for making this compound do not succeed, and that the use of mastic in it has hitherto been kept a secret, he made the following trials to procure a good eau de luce.

One dram of the rectified oil of amber was dissolved in four ounces of the strongest ardent spirit of the shops; its specific gravity being 840 at 60 degrees of Fahrenheit. A portion of the clear spirit was poured upon a larger quantity of fine powdered mastic than it was judged could be taken up. This was occasionally agitated without heat; by which means the gum resin was for the most part gradually dissolved. One part of the oily solution was poured into a phial, and to this was added one part of the solution of mastic. No opacity or other change appeared. Four parts of strong caustic volatile alkali were then poured in, and immediately shaken. The fluid was of a dense opaque white colour, affording a slight ruddy tinge when the light was seen through a thin portion of it. In a second mixture, four parts of the alkali were added to one of the solution of mastic; it appeared of a less dense and more yellowish white than the former mixture. More of the gum resinous solution was then poured in; but it still appeared less opaque than that mixture. It was ruddy by transmitted light. The last experiment was repeated with the oily solution instead of that of mastic. The white was much less dense than either of the foregoing compounds, and the requisite opacity was not given by augmenting the dose of the oily solution. No ruddiness nor other remarkable appearance was seen by transmitted light. These mixtures were left at repose for two days; no separation appeared in either of the compounds containing mastic; the compound, consisting of the oily solution and alkali, became paler by the separation of a cream at the top.

It appears, therefore, that the first of these three mixtures, subject to variation of the quantity of its ingredients, and the odorant additions which may be made, is a good eau de luce.

In a subsequent number of the same Journal, we have the following recipe by one of the author's correspondents, who had often proved its value by experience. "Digest ten or twelve grains of the whitest pieces of mastic, selected for this purpose and powdered, in two ounces of alcohol; and, when nearly dissolved, add twenty grains of elemi. When both the resins are dissolved, add ten or fifteen drops of rectified oil of amber, and fifteen or twenty of essence of bergamot: shake the whole well together, and let the fæces subside. The solution will be of a pale amber colour. It is to be added in very small portions to the best *aqua ammoniæ puræ*, until it assumes a milky whiteness, shaking the phial well after each addition, as directed by Macquer. The strength and causticity of the ammoniac are of most essential consequence. If, upon the addition of the first drop or two of the tincture, a dense opaque coagulated precipitate is formed, not much unlike that which appears on dropping a solution of silver into water slightly impregnated with common salt, it is too strong, and must be diluted with alcohol."

EAVES, in *Architecture*, the margin or edge of the roof of a house; being the lowest tiles, slates, or the like, that hang over the walls, to throw off water to a distance from the wall.

Eaves-Droppers, are such persons as stand under the eaves, or walls, and windows of a house, by night or day, to hearken after news, and carry it to others, and thereby cause strife and contention in the neighbourhood. They are called *evil members of the commonwealth* by the stat. of West. 1. c. 33. They may be punished either in the court leet by way of presentment and fine, or in the quarter sessions by indictment and binding to good behaviour.

EBBING of the Tides. See Tide.

EBDOMARIUS, in ecclesiastical writers, an officers formerly appointed weekly to superintend the performance of divine service in cathedrals, and prescribe the duties of each person attending in the choir, as to reading, singing, praying, &c. To this purpose the ebdomary, at the beginning of his week, drew up in form a bill or writing of the respective persons, and their several offices, called *tabula*, and the persons there entered were styled *intabulati*.

EBDOME, Εβδομη, in antiquity, a festival kept on the seventh of every lunar month, in honour of Apollo, to whom all seventh days were sacred, because one of them was his birth-day; whence he was sometimes called *Ebdomagenes*. For the ceremonies of this solemnity see *Potter's Archæol. Græc.* lib. ii. cap. 20.

EBENUS, the Ebony Tree. See Botany *Index*.

EBERHARD, John Augustus, an eminent German theologian. See Supplement.

EBION, the author of the heresy of the Ebionites, was a disciple of Cerinthus, and his successor. He improved upon the errors of his master, and added to them new opinions of his own. He began his preaching in Judea: he taught in Asia, and even at Rome. His tenets infected the isle of Cyprus. St John opposed both Cerinthus and Ebion in Asia; and it is thought, that this apostle wrote his gospel, in the year 97, particularly against this heresy.

EBIONITES, ancient heretics, who rose in the church in the first ages, and formed themselves into a sect in the second century, denying the divinity of Jesus Christ.

Ebionites.

Origen takes them to have been so called from the Hebrew word *ebion*, which in that language signifies *poor*; because, says he, they were poor in sense, and wanted understanding. Eusebius, with a view to the same etymology, is of opinion they were thus called, as having poor thoughts of Jesus Christ, taking him for no more than a mere man.

It is more probable the Jews gave this appellation to the Christians in general out of contempt; because in the first times there were few but poor people that embraced the Christian religion. This opinion Origen himself seems to give into, in his book against Celsus, where he says that they called *Ebionites*, such among the Jews as believed that Jesus was truly the expected Messiah.

It might even be urged, with some probability, that the primitive Christians assumed the name themselves, in conformity to their profession. It is certain Epiphanius observes, they valued themselves on being poor, in imitation of the apostles. The same Epiphanius, however, is of opinion, that there had been a man of the name of Ebion, the chief and founder of the sect of Ebionites, contemporary with the Nazarenes and Cerinthians. He gives a long and exact account of the origin of the Ebionites, making them to have risen after the destruction of Jerusalem, when the first Christians, called *Nazarenes*, went out of the same to live at Pella.

The Ebionites were little else than a branch of Nazarenes: only that they altered and corrupted in many things the purity of the faith held among those first adherents to Christianity. For this reason Origen distinguishes two kinds of Ebionites, in his answer to Celsus; the one believed that Jesus Christ was born of a virgin; and the other, that he was born after the manner of other men.

The first were orthodox in every thing, except that to the Christian doctrine they joined the ceremonies of the Jewish law, with the Jews, Samaritans, and Nazarenes; together with the traditions of the Pharisees. They differed from the Nazarenes, however, in several things, chiefly as to what regards the authority of the sacred writings; for the Nazarenes received all for Scripture contained in the Jewish canon; whereas the Ebionites rejected all the prophets, and held the very names of David, Solomon, Isaiah, Jeremiah, and Ezekiel, in abhorrence. They also rejected all St Paul's epistles, whom they treated with the utmost disrespect.

They received nothing of the Old Testament but the Pentateuch; which should intimate them to have descended rather from the Samaritans than from the Jews. They agreed with the Nazarenes in using the Hebrew gospel of St Matthew, otherwise called the Gospel of the Twelve Apostles; but they had corrupted their copy in abundance of places; and particularly, had left out the genealogy of our Saviour, which was preserved entire in that of the Nazarenes, and even in those used by the Cerinthians.

Some, however, have made this gospel canonical, and of greater value than our present Greek gospel of St Matthew: See Nazarenes. These last, whose sentiments, as to the birth of our Saviour, were the same with those of the Ebionites, built their error on this very genealogy.

Besides the Hebrew gospel of St Matthew, the Ebionites had adopted several other books, under the names of St James, John, and the other apostles: they also made use of the Travels of St Peter, which are supposed to have been written by St Clement; but had altered them so, that there was scarce any thing of truth left in them. They even made that saint tell a number of falsehoods, the better to authorise their own practices. See St Epiphanius, who is very diffusive on the ancient heresy of the Ebionites, *Hær.* 30. But his account deserves little credit, as, by his own confession, he has confounded the other sects with the Ebionites, and has charged them with errors to which the first adherents of this sect were utter strangers.

EBONY of Crete. See Ebenus, Botany *Index*.

Ebony Wood is brought from the Indies, exceedingly hard and heavy, susceptible of a very fine polish, and on that account used in mosaic and inlaid works, toys, &c. There are divers kinds of ebony; the most usual among us are black, red, and green, all of them the product of the island of Madagascar, where the natives call them indifferently *hazon mainthi*, q. d. *black wood*. The island of St Maurice, belonging to the Dutch, likewise furnishes part of the ebonies used in Europe.

Authors and travellers give very different accounts of the tree that yields the black ebony. By some of their descriptions, it should be a sort of palm tree; by others a cytisus, &c. The most authentic of them is that of M. Falcourt, who resided many years in Madagascar as governor thereof; he assures us, that it grows very high and big, its bark being black, and its leaves resembling those of our myrtle, of a deep dusky green colour.

Tavernier assures us, that the islanders always take care to bury their trees when cut down, to make them the blacker, and to prevent their splitting when wrought. F. Plumier mentions another black ebony tree, discovered by him at St Domingo, which he calls *spartium portulacæ foliis aculeatum ebeni materiæ*. Candia also bears a little shrub, known to the botanists under the name of *Ebenus Cretica*, above described.

Pliny and Dioscorides say the best ebony comes from Ethiopia, and the worst from India; but Theophrastus prefers that of India. Black ebony is much preferred to that of other colours. The best is a jet black, free of veins and rind, very massive, astringent, and of an acrid pungent taste. Its rind, infused in water, is said to purge pituita, and cure venereal disorders; whence Matthiolus took guaiacum for a sort of ebony. It yields an agreeable perfume when laid on burning coals; when green, it readily takes fire from the abundance of its fat. If rubbed against a stone, it becomes brown. The Indians make statues of their gods, and sceptres for their princes, of this wood. It was first brought to Rome by Pompey, after he subdued Mithridates. It is now much less used among us than anciently, since the discovery of so many ways of giving other hard woods a black colour.

As to the green ebony, besides Madagascar and St Maurice, it likewise grows in the Antilles, and especially in the isle of Tobago. The tree that yields it is very bushy; its leaves are smooth, and of a fine green colour. Beneath its bark is a white blea, about two inches thick; all beneath which, to the very heart, is a deep green, approaching towards a black, though sometimes streaked with yellow veins. Its use is not

confined

confined to mosaic work: it is likewise good in dyeing, as yielding a fine green tincture. As to red ebony, called also *grenadilla*, we know little of it more than the name.

The cabinet-makers, inlayers, &c. make pear tree and other woods pass for ebony, by giving them the black colour thereof. This some do by a few washes of a hot decoction of galls; and when dry, adding writing ink thereon, and polishing it with a stiff brush, and a little hot wax; and others heat or burn their wood black.

EBORACUM, in *Ancient Geography*, a famous city of the Brigantes in Britain, the residence of Septimius Severus and Constantius Chlorus, and where they both died; a Roman colony; and the station of the Legio Sexta Victrix. Now *York*. W. Long. 50. Lat. 54. *Caer-frock*, or *Caer-effroc*, in British (Camden).

EBRO, anciently IBERUS, a large river of Spain, which, taking its rise in Old Castile, runs through Biscay and Arragon, passes by Saragossa, and, continuing its course through Catalonia, discharges itself with great rapidity into the Mediterranean, about 20 miles below the city of Tortosa.

EBUDÆ, or HEBUDES, in *Ancient Geography*, islands on the west of Scotland. The ancients differ greatly as to their situation, number, and names; said in general to lie in the north of Ireland and west of Scotland. Now called the *Western Isles*, also *Hebrides*; this last a modern name, the reason of which does not appear, unless it be a corruption of *Hebudes*. By Beda called *Mevaniæ*, an appellation equally obscure.

EBULLITION, the same with BOILING. The word is also used in a synonymous sense with EFFERVESCENCE.

EBUSUS, in *Ancient Geography*, the greater of the two islands called Pityusæ, in the Mediterranean, near the east coast of Spain, to the south-west of Majorca. Famous for its pastures for cattle, and for its figs. Now *Ivica*, 100 miles in compass, without any noxious animals but rabbits, who often destroy the corn.

ECALESIA, Εκαλησια, in antiquity, a festival kept in honour of Jupiter, surnamed *Hecalus*, or *Hecalesius*, from *Hecale*, one of the borough towns in Attica.

ECASTOR, in antiquity, an oath wherein Castor was invoked. It was a custom for the men never to swear by Castor, nor the women by Pollux.

ECATEA, Εκατεια, in antiquity, statues erected to the goddess Hecate, for whom the Athenians had a great veneration, believing that she was the overseer of their families, and that she protected their children.

ECATESIA, Εκατησια, in antiquity, an anniversary solemnity, observed by the Stratonicensians, in honour of Hecate. The Athenians likewise had a public entertainment or supper every new moon, in honour of the same goddess. The supper was provided at the charge of the richer sort; and was no sooner brought to the accustomed place but the poor people carried all off, giving out that Hecate had devoured it. For the rest of the ceremonies observed on this occasion, see *Pott. Arch. Græc.* lib. ii. cap. 20.

ECATOMBÆON, Εκατομβαιων, in *Chronology*, the first month of the Athenian year. It consisted of 30 days, and began on the first new moon after the summer solstice, and consequently answered to the latter part of our June and beginning of July. The Bœotians called it *Hippodromus*, and the Macedonians *Lous*. See MONTH. The word is a derivation from the Greek ἑκατομβη, a *hecatomb*, because of the great number of hecatombs sacrificed in it.

ECAVESSADE, in the manege, is used for a jerk of the cavesson.

ECBATANA, in *Ancient Geography*, the royal residence and the capital of Media, built by Deioces king of the Medes, according to Herodotus: Pliny says, by Seleucus; but that could not be, because it is mentioned by Demosthenes. It was situated on a gentle declivity, distant 12 stadia from Mount Orontes, and was in compass 150 stadia. Here stood the royal treasury and tombs. It was an open unwalled town, but had a very strong citadel, encompassed with seven walls, one within and rising above another. The extent of the outmost was equal to the whole extent of Athens, according to Herodotus; the situation favouring this construction, as being a gentle ascent, and each wall was of a different colour.—Another *Ecbatana* of Persia, a town of the Magi (Pliny).—A third of Syria.

ECCENTRICITY. See EXCENTRICITY.

ECCHELLENSIS, ABRAHAM, a learned Maronite, whom the president Le Jai employed in the edition of his Polyglott Bible. Gabriel Sionita, his countryman, drew him to Paris, in order to make him his fellow labourer in publishing that Bible. They fell out; Gabriel complained to the parliament, and cruelly defamed his associate; their quarrel made a great noise. The congregation *de propaganda fide* associated him, 1636, with those whom they employed in making an Arabic translation of the Scriptures. They recalled him from Paris, and he laboured in that translation at Rome in the year 1652. While he was professor of the Oriental languages at Rome, he was pitched upon by the great duke Ferdinand II. to translate from Arabic into Latin, the 5th, 6th, and 7th books of Apollonius's Conics; in which he was assisted by John Alphonso Borelli, who added commentaries to them. He died at Rome in 1644.

ECCHYMOSIS, from εκχυω, to *pour out*, or from εξ, *out of*, and χυμος, *juice*. It is an effusion of humours from their respective vessels, under the integuments; or, as Paulus Ægineta says, "When the flesh is bruised by the violent collision of any object, and its small veins broken, the blood is gradually discharged from them." This blood, when collected under the skin, is called *ecchymosis*, the skin in the mean time remaining entire; sometimes a tumour is formed by it, which is soft and livid, and generally without pain. If the quantity of blood is not considerable, it is usually resorbed; if much, it suppurates; it rarely happens that any further inconvenience follows; though, in case of a very bad habit of body, a mortification may be the result, and in such case regard must be had thereto.

ECCLAIRCISSEMENT. See ESCLAIRCISSEMENT.

ECCLESIASTES, a canonical book of the Old Testament, the design of which is to shew the vanity of all sublunary things.

It was composed by Solomon; who enumerates the several

Ecclesiastes, Ecclesiastical.

several objects on which men place their happiness, and then shows the insufficiency of all worldly enjoyments.

The Talmudists made King Hezekiah to be the author of it: Grotius ascribes it to Zorobabel, and others to Isaiah; but the generality of commentators believe this book to be the produce of Solomon's repentance, after having experienced all the follies and pleasures of life.

ECCLESIASTICAL, an appellation given to whatever belongs to the church: thus we say, ecclesiastical polity, jurisdiction, history, &c.

Blackst. Comment.

Ecclesiastical *Courts.* In the time of the Anglo-Saxons there was no sort of distinction between the lay and the ecclesiastical jurisdiction: the county court was as much a spiritual as a temporal tribunal: the rights of the church were ascertained and asserted at the same time, and by the same judges, as the rights of the laity. For this purpose the bishop of the diocese, and the alderman, or in his absence the sheriff of the county, used to sit together in the county court, and had there the cognizance of all causes as well ecclesiastical as civil; a superior deference being paid to the bishop's opinion in spiritual matters, and to that of the lay judges in temporal. This union of power was very advantageous to them both: the presence of the bishop added weight and reverence to the sheriff's proceedings; and the authority of the sheriff was equally useful to the bishop, by enforcing obedience to his decrees in such refractory offenders as would otherwise have despised the thunder of mere ecclesiastical censures.

But so moderate and rational a plan was wholly inconsistent with those views of ambition that were then forming by the court of Rome. It soon became an established maxim in the papal system of policy, that all ecclesiastical persons, and all ecclesiastical causes, should be solely and entirely subject to ecclesiastical jurisdiction only: which jurisdiction was supposed to be lodged in the first place and immediately in the Pope, by divine indefeasible right and investiture from Christ himself, and derived from the Pope to all inferior tribunals. Hence the canon law lays it down as a rule, that "*sacerdotes à regibus honorandi sunt, non judicandi;*" and places an emphatical reliance on a fabulous tale which it tells of the emperor Constantine, That when some petitions were brought to him, imploring the aid of his authority against certain of his bishops accused of oppression and injustice; he caused, (says the holy canon) the petitions to be burnt in their presence, dismissing them with this valediction: "*Ite, et inter vos causas vestras discutite, quia dignum non est ut nos judicemus Deos.*"

It was not, however, till after the Norman conquest, that this doctrine was received in England, when William I. (whose title was warmly espoused by the monasteries which he liberally endowed, and by the foreign clergy whom he brought over in shoals from France and Italy, and planted in the best preferments of the English church) was at length prevailed upon to establish this fatal encroachment, and separate the ecclesiastical court from the civil: whether actuated by principles of bigotry, or by those of a more refined policy, in order to discountenance the laws of King Edward abounding with the spirit of Saxon liberty, is not altogether certain. But the latter, if not the cause, was undoubtedly the consequence of this separation: for the Saxon laws were soon overborne by the Norman justiciaries, when the county court fell into disregard by the bishop's withdrawing his presence, in obedience to the charter of the Conqueror; which prohibited any spiritual cause from being tried in the secular courts, and commanded the suitors to appear before the bishop only, whose decisions were directed to conform to the canon law.

King Henry I. at his accession, among other restorations of the laws of King Edward the Confessor, revived this of the union of the civil and ecclesiastical courts. Which was, according to Sir Edward Coke, after the great heat of the conquest was past, only a restitution of the ancient law of England. This however was ill relished by the Popish clergy, who, under the guidance of that arrogant prelate Archbishop Anselm, very early disapproved of a measure that put them on a level with the profane laity, and subjected spiritual men and causes to the inspection of the secular magistrates; and therefore, in their synod at Westminster, 3 Hen. I. they ordained, that no bishop should attend the discussion of temporal causes; which soon dissolved this newly effected union. And, when upon the death of King Henry I. the usurper Stephen was brought in and supported by the clergy, we find one article of the oath which they imposed upon him was, that ecclesiastical persons and ecclesiastical causes should be subject only to the bishop's jurisdiction. And as it was about that time that the contest and emulation began between the laws of England and those of Rome, the temporal courts adhering to the former, and the spiritual adopting the latter as their rule of proceeding; this widened the breach between them, and made a coalition afterwards impracticable; which probably would else have been effected at the general reformation of the church.

Ecclesiastical courts are various; as the Archdeacon's, the Consistory, the court of Arches, the Peculiars, the Prerogative, and the great court of appeal in all ecclesiastical causes, viz. the Court of Delegates. See these articles.

Black Comm

As to the method of proceeding in the spiritual courts, it must (in the first place) be acknowledged to their honour, that though they continue to this day to decide many questions which are properly of temporal cognizance, yet justice is in general so ably and impartially administered, in those tribunals (especially of the superior kind), and the boundaries of their power are now so well known and established, that no material inconvenience at present arises from this jurisdiction still continuing in the ancient channel. And, should any alteration be attempted, great confusion would probably arise, in overturning long established forms, and new-modelling a course of proceedings that has now prevailed for seven centuries.

The establishment of the civil law process in all the ecclesiastical courts was indeed a masterpiece of papal discernment, as it made a coalition impracticable between them and the national tribunals, without manifest inconvenience and hazard. And this consideration had undoubtedly its weight in causing this measure to be adopted, though many other causes concurred. In particular, it may be here remarked, that the Pandects, or or collections of civil law, being written in the Latin tongue, and referring so much to the will of the prince and his delegated officers of justice, sufficiently recommended them to the court of Rome, exclusive of their intrinsic merit. To keep the laity in the darkest ignorance, and to monopolize the little science which then existed entirely among the monkish clergy, were deep-rooted principles of papal policy. And as the bishops of Rome affected in all points to mimic the imperial grandeur, as the spiritual prerogatives were moulded on the pattern of the temporal, so the canon law process was formed on the model of the civil law; the prelates embracing, with the utmost ardour, a method of judicial proceedings, which was carried on in a language unknown to the bulk of the people, which banished the intervention of a jury (that bulwark of Gothic liberty), and which placed an arbitrary power of decision in the breast of a single man.

The proceedings in the ecclesiastical courts are therefore regulated according to the practice of the civil and canon laws; or rather to a mixture of both, corrected and new-modelled by their own particular usages, and the interposition of the courts of common law. For, if the proceedings in the spiritual court be ever so regularly consonant to the rules of the Roman law, yet if they be manifestly repugnant to the fundamental maxims of the municipal laws, to which, upon principles of sound policy, the ecclesiastical process ought in every state to conform (as if they require two witnesses to prove a fact, where one will suffice at common law); in such cases, a prohibition will be awarded against them. But under these restrictions, their ordinary course of proceeding is, first, by *citation*, to call the party injuring before them. Then by *libel* (*libellus*, "a little book"), or by articles drawn out in a formal *allegation*, to set forth the complainant's ground of complaint. To this succeeds the *defendant's answer* upon oath; when, if he denies or extenuates the charge, they proceed to *proofs* by witnesses examined, and their depositions taken down in writing by an officer of the court. If the defendant has any circumstances to offer in his defence, he must also propound them in what is called his *defensive allegation*, to which he is entitled in his turn to the *plaintiff's answer* upon oath, and may from thence proceed to *proofs* as well as his antagonist. The canonical doctrine of *purgation*, whereby the parties were obliged to answer upon oath, to any matter, however criminal, that might be objected against them (though long ago overruled in the court of chancery, the genius of the English law having broken through the bondage imposed on it by its clerical chancellors, and asserted the doctrines of judicial as well as civil liberty), continued till the middle of the last century to be upheld by the spiritual courts; when the legislature was obliged to interpose, to teach them a lesson of similar moderation. By the statute of 13 Car. II. c. 12. it is enacted, that it shall not be lawful for any bishop, or ecclesiastical judge, to tender or administer to any person whatsoever, the oath usually called the oath *ex officio*, or any other oath whereby he may be compelled to confess, accuse, or purge himself of any criminal matter or thing, whereby he may be liable to any censure or punishment. When all the pleadings and proofs are concluded, they are referred to the consideration, not of a jury, but of a single judge; who *takes information* by hearing advocates on both sides, and thereupon forms his *interlocutory decree* or *definitive sentence*, at his own discretion, from which there generally lies an *appeal*, in the several stages mentioned in the articles above referred to; though, if the same be not appealed from him in 15 days, it is final, by the statute 25 Henry VIII. c. 19.

But the point in which these jurisdictions are the most defective, is that of enforcing their sentences when pronounced; for which they have no other process but that of *excommunication;* which would be often despised by obstinate or profligate men, did not the civil law step in with its aid. See EXCOMMUNICATION.

ECCLESIASTICAL Corporations, are where the members that compose them are *spiritual* persons. They were erected for the furtherance of religion and perpetuating the rights of the church. See CORPORATIONS.

ECCLESIASTICAL State. See CLERGY.

ECCLESIASTICUS, an apocryphal book, generally bound up with the Scriptures; so called, from its being read in the church, *ecclesia*, as a book of piety and instruction, but not of infallible authority.

The author of this book was a Jew, called *Jesus the son of Sirach*. The Greeks call it the *Wisdom of the son of Sirach*.

ECCOPROTICS, in *Medicine*, laxative or loosening remedies, which purge gently, by softening the humours and excrements, and fitting them for expulsion.—The word is composed of the Greek particle εκ, and κοπρος, *excrement*.

ECDICI, Εκδικοι, among the ancients, patrons of cities, who defended their rights, and took care of the public money. Their office resembled that of the modern syndics.

ECHAPE, in the manege, a horse begot between a stallion and a mare of different breeds and countries.

ECHAPER, in the manege, a gallicism used in the academies, implying to give a horse head, or to put on at full speed.

ECHENEIS, the REMORA. See ICHTHYOLOGY *Index*.

ECHEVIN, in the French and Dutch polity, a magistrate elected by the inhabitants of a city or town, to take care of their common concerns, and the decoration and cleanliness of the city.

At Paris, there is a prevôt and four echevins; in other towns, a mayor and echevins. At Amsterdam, there are nine echevins; and at Rotterdam, seven.

In France, the echevins take cognizance of rents, taxes, and the navigation of rivers, &c. In Holland, they judge of civil and criminal causes; and if the criminal confesses himself guilty, they can see their sentence executed without appeal.

ECHINATE, or ECHINATED, an appellation given to whatever is prickly, thereby resembling the hedgehog.

ECHINITES, in *Natural History*, the name by which authors call the fossil centronia, frequently found in chalk pits.

ECHINOPHORA. See BOTANY *Index*.

ECHINOPS. See BOTANY *Index*.

ECHINUS, a genus of animals belonging to the order of vermes mollusca. See HELMINTHOLOGY *Index*.

ECHINUS, in *Architecture*, a member or ornament near the bottom of the Ionic, Corinthian, and Composite capitals.

ECHITES. See BOTANY *Index*.

ECHIUM, VIPER'S BUGLOSS. See BOTANY *Index*.

ECHO, or ECCHO, a sound reflected or reverberated from a solid, concave, body, and so repeated to the ear †. The word is formed from the Greek ηχος, *sound*, which comes from the verb ηχεω, *sono*.

† See Acoustics, N° 26

The ancients being wholly unacquainted with the true cause of the echo, ascribed it to several causes sufficiently whimsical. The poets, who were not the worst of their philosophers, imagined it to be a person of that name metamorphosed, and that she affected to take up her abode in particular places; for they found by experience, that she was not to be met with in all. (See below, ECHO in *fabulous history*). But the moderns, who know sound to consist in a certain tremor or vibration in the sonorous body communicated to the contiguous air, and by that means to the ear, give a more consistent account of echo.

For a tremulous body, striking on another solid body, it is evident, may be repelled without destroying or diminishing its tremor; and consequently a sound may be redoubled by the resilition of the tremulous body, or air.

But a simple reflection of the sonorous air is not enough to solve the echo: for then every plain surface of a solid hard body, as being fit to reflect a voice or sound, would redouble it, which we find does not hold.

To produce an echo, therefore, it should seem that a kind of concameration or vaulting were necessary, in order to collect, and by collecting to heighten and increase, and afterwards reflect, the sound; as we find is the case in reflecting the rays of light, where a concave mirror is required.

In effect, as often as a sound strikes perpendicularly on a wall, behind which is any thing of a vault or arch, or even another parallel wall, so often will it be reverberated in the same line, or other adjacent ones.

For an echo to be heard, therefore, it is necessary the ear be in the line of reflection: for the person who made the sound to hear its echo, it is necessary he be perpendicular to the place which reflects it: and for a manifold or tautological echo, it is necessary there be a number of walls, and vaults or cavities, either placed behind or fronting each other.

A single arch or concavity, &c. can scarce ever stop and reflect all the sound; but if there be a convenient disposition behind it, part of the sound propagated thither, being collected and reflected as before, will present another echo: or, if there be another concavity, opposed at a due distance to the former, the sound reflected from the one upon the other will be tossed back again by this latter, &c.

Many of the phenomena of echoes are well considered by the bishop of Leighs, &c. who remarks, that any sound, falling either directly or obliquely on any dense body of a smooth, whether plain or arched, superficies, is reflected, or echoes, more or less. The surface, says he, must be smooth; otherwise the air, by reverberation, will be put out of its regular motion, and the sound thereby broken and extinguished. He adds, that it echoes more or less, to show, that when all things are as before described, there is still an echoing, though it be not always heard, either because the direct sound is too weak to beat quite back again to him that made it; or that it does return to him, but so weak, that it cannot be discerned; or that he stands in a wrong place to receive the reflected sound, which passes over his head, under his feet, or on one side of him; and which therefore may be heard by a man standing in the place where the reflected sound does come, provided no interposed body intercepts it, but not by him that first made it.

Echoes may be produced with different circumstances. For, 1. A *plane* obstacle reflects the sound back in its due tone and loudness; allowance being made for the proportionable decrease of the sound, according to its distance.

2. A *convex* obstacle reflects the sound somewhat smaller and somewhat quicker, though weaker, than otherwise it would be.

3. A *concave* obstacle echoes back the sound, bigger, slower, and also inverted; but never according to the order of words.

Nor does it seem possible to contrive any single echo, that shall invert the sound, and repeat backwards; because, in such case, the word last spoken, that is, which last occurs to the obstacle, must be repelled first; which cannot be. For where in the mean time should the first words hang and be concealed; or how, after such a pause, be revived, and animated again into motion?

From the determinate concavity or archedness of the reflecting bodies, it may happen that some of them shall only echo back one determinate note, and only from one place.

4. The echoing body being removed farther off, it reflects more of the sound than when nearer; which is the reason why some echoes repeat but one syllable, some one word, and some many.

5. Echoing bodies may be so contrived and placed, as that reflecting the sound from one to the other, either directly and mutually, or obliquely and by succession, out of one sound, a multiple echo or many echoes shall arise.

Add, that a multiple echo may be made, by so placing the echoing bodies at unequal distances, that they may reflect all one way, and not one on the other; by which means, a manifold successive sound will be heard; one clap of the hands, like many; one *ha*, like a laughter; one single word, like many of the same tone and accent; and so one viol, like many of the same kind, imitating each other.

Lastly, Echoing bodies may be so ordered, that from any one sound given, they shall produce many echoes different both as to tone and intension. By which means a musical room may be so contrived, that not only one instrument playing therein shall seem many of the same sort and size, but even a concert of different ones, only by placing certain echoing bodies so, that any note placed shall be returned by them in 3ds, 5ths, and 8ths.

ECHO is also used for the place where the repetition of the sound is produced or heard.

Echoes are distinguished into divers kinds, viz.

1. *Single*, which return the voice but once. Whereof some are *tonical*, which only return a voice when modulated into some particular musical tone: Others, *polysyllabical*, which return many syllables, words, and sentences. Of this last kind is that fine echo in Woodstock park, which Dr Plot assures us, in the day time, will return very distinctly seventeen syllables, and in the night twenty.

2. *Multiple* or *tautological;* which return syllables and words the same oftentimes repeated.

In echoes, the place where the speaker stands is called the *centrum phonicum*, and the object or place that returns the voice, the *centrum phonocampticum*.

At the sepulchre of Metella, wife of Crassus, was an echo, which repeated what a man said five times. Authors mention a tower at Cyzicus, where the echo repeated seven times. One of the finest echoes we read of is that mentioned by Barthius, in his notes on Statius's *Thebais*, lib. vi. 30. which repeated the words a man uttered 17 times: it was on the banks of the Naha, between Coblentz and Bingen. Barthius assures us, he had proved what he writes; and had told 17 repetitions. And whereas, in common echoes, the repetition is not heard till some time after hearing the word spoke, or the notes sung; in this, the person who speaks or sings is scarce heard at all; but the repetition most clearly, and always in surprising varieties; the echo seeming sometimes to approach nearer, and sometimes to be further off. Sometimes the voice is heard very distinctly, and sometimes scarce at all. One hears only one voice, and another several; one hears the echo on the right, and another on the left, &c. At Milan in Italy, is an echo which reiterates the report of a pistol 56 times; and if the report is very loud, upwards of 60 reiterations may be counted. The first 20 echoes are pretty distinct; but as the noise seems to fly away, and answer at a greater distance, the reiterations are so doubled, that they can scarce be counted. See an account of a remarkable echo under the article PAISLEY.

ECHO, in *Architecture*, a term applied to certain kinds of vaults and arches, most commonly of the elliptic and parabolic figures, used to redouble sounds, and produce artificial echoes.

ECHO, in *Poetry*, a kind of composition wherein the last words or syllables of each verse contain some meaning, which, being repeated apart, answers to some question or other matter contained in the verse; as in this beautiful one from Virgil:

Crudelis mater magis, an puer improbus ille?
Improbus ille puer, crudelis tu quoque mater.

The elegance of an echo consists in giving a new sense to the last words; which reverberate, as it were, the motions of the mind, and by that means affect it with surprise and admiration.

ECHO, in fabulous history, a daughter of the Air and Tellus, who chiefly resided in the vicinity of the Cephisus. She was once one of Juno's attendants, and became the confidant of Jupiter's amours. Her loquacity, however, displeased Jupiter, and she was deprived of the power of speech by Juno, and only permitted to answer to the questions which were put to her. Pan had formerly been one of her admirers, but he never enjoyed her favours. Echo, after she had been punished by Juno, fell in love with Narcissus; but being despised by him, pined herself to death, having nothing but her voice left.

ECHOMETER, among musicians, a kind of scale or rule, with several lines thereon, serving to measure the duration and length of sounds, and to find their intervals and ratios.

ECHOUERIES. See under TRICHECUS.

ECKIUS, JOHN, an eminent and learned divine, professor in the university at Ingolstadt, memorable for the opposition he gave to Luther, Melancthon, Caralostadius, and other leading protestants in Germany. He wrote many polemical tracts; and among the rest, a *Manual of Controversies*, printed in 1535, in which he discourses upon most of the heads contested between the Protestants and Papists. He was a man of uncommon learning, parts, and zeal, and died in 1543.

ECLECTICS, (*eclectici*), a name given to some ancient philosophers, who without attaching themselves to any particular sect, took what they judged good and solid from each. Hence their denomination; which, in the original Greek, signifies, "that may be chosen," or "that chooses;" of the verb εκλεγω, *I choose.*—Laertius notes, that they were also, for the same reason, denominated *analogetici;* but that they call themselves *Philalethes*, i. e. lovers of truth.

The chief or founder of the eclectici was one Potamon of Alexandria, who lived under Augustus and Tiberius; and who, weary of doubting of all things with the Sceptics and Pyrrhonians, formed the eclectic sect; which Vossius calls the *eclective.*

Towards the close of the second century, a sect arose in the Christian church under the denomination of *Eclectics*, or modern *Platonics*. They professed to make truth the only object of their inquiry, and to be ready to adopt from all the different systems and sects such tenets as they thought agreeable to it.—However, they preferred Plato to the other philosophers, and looked upon his opinions concerning God, the human soul, and things invisible, as conformable to the spirit and genius of the Christian doctrine. One of the principal patrons of this system was Ammonius Saccas, who at this time laid the foundation of that sect, afterwards distinguished by the name of the new *Platonics*, in the Alexandrian school. See AMMONIUS and PLATONISTS.

ECLECTICS were also a certain sect of physicians among the ancients, of whom Archigenes, under Trajan, was the chief, who selected from the opinions of all the other sects that which appeared to them best and most rational; hence they are called *eclectics*, and their prescriptions *medicina eclectica.*

ECLIPSE, in *Astronomy*, the deprivation of the light of the sun, or of some heavenly body, by the interposition of another heavenly body between our sight and it. See ASTRONOMY *Index.*

ECLIPTA, in *Botany*, a genus of the polygamia superflua order, belonging to the syngenesia class of plants. The receptacle is chaffy; there is no pappus, and the corollulæ of the disk quadrifid.

ECLIPTIC, in *Astronomy*, a great circle of the sphere, supposed to be drawn through the middle of the zodiac, making an angle with the equinoctial of about

23° 30′, which is the sun's greatest declination; or, more strictly speaking, it is that path or way among the fixed stars, that the earth appears to describe to an eye placed in the sun. See ASTRONOMY *Index*.

Some call it *via solis*, "the way of the sun;" because the sun in his apparent annual motion never deviates from it, as all the other planets do more or less.

ECLIPTIC, in *Geography*, a great circle on the terrestrial globe, not only answering to, but falling within, the plane of the celestial ecliptic. See GEOGRAPHY.

ECLOGUE, in *Poetry*, a kind of pastoral composition, wherein shepherds are introduced conversing together. The word is formed from the Greek εκλογη, *choice;* so that, according to the etymology, *eclogue* should be no more than a select or choice piece; but custom has determined it to a farther signification, viz. a little elegant composition in a simple natural style and manner.

Idyllion and eclogue, in their primary intention, are the same thing: thus, the idyllia, ειδυλλια, of Theocritus, are pieces wrote perfectly in the same vein with the *eclogæ* of Virgil. But custom has made a difference between them, and appropriated the name *eclogue* to pieces wherein shepherds are introduced speaking: *idyllion*, to those wrote like the eclogue, in a simple natural style, but without any shepherds in them.

ECLUSE, a small but strong town of the Dutch Low Countries, with a good harbour and sluices. The English besieged it in vain in 1405, and the people of Bruges in 1436. It is defended by several forts, and stands near the sea. E. Long. 3. 20. N. Lat. 51. 21.

ECONOMISTS, a sect of philosophers, who have explained and illustrated the principles of political science. See SUPPLEMENT.

ECONOMY, POLITICAL. See *POLITICAL Economy*.

ECPHRACTICS, in *Medicine*, remedies which attenuate and remove obstructions. See ATTENUANTS, and DEOBSTRUENTS, MATERIA MEDICA *Index*.

ECSTACY. See EXTASY.

ECSTATICI, Εκϛατικοι, from εξιϛεμι, *I am entranced*, in antiquity, a kind of diviners who were cast into trances or ecstasies, in which they lay like dead men, or asleep, deprived of all sense and motion; but, after some time, returning to themselves, gave strange relations of what they had seen or heard.

ECTHESIS, in church history, a confession of faith, in the form of an edict, published in the year 639, by the emperor Heraclius, with a view to pacify the troubles occasioned by the Eutychian heresy in the eastern church. However, the same prince revoked it, on being informed that Pope Severinus had condemned it, as favouring the Monothelites; declaring at the same time, that Sergius, patriarch of Constantinople, was the author of it.

ECTHLIPSIS, among Latin grammarians, a figure of prosody, whereby the *m* at the end of a word, when the following word begins with a vowel, is elided, or cut off, together with the vowel preceding it, for the sake of the measure of the verse: thus they read *mult' ille*, for *multum ille*.

ECTROPIUM, in *Surgery*, is when the eyelids are inverted, or retracted, so that they show their internal or red surface, and cannot sufficiently cover the eye.

ECTYLOTICS, in *Pharmacy*, remedies proper for consuming callosities.

ECU, or ESCU, a French crown; for the value of which, see MONEY.

EDAY, one of the Orkney isles, is about five miles and a half long, and about a mile and a half broad. It has several good harbours, and contains about 600 inhabitants.

EDDA, in antiquities, is a system of the ancient Icelandic or Runic mythology, containing many curious particulars of the theology, philosophy, and manners, of the northern nations of Europe; or of the Scandinavians, who had migrated from Asia, and from whom our Saxon ancestors were descended. Mr Mallet apprehends that it was originally compiled, soon after the Pagan religion was abolished, as a course of poetical lectures, for the use of such young Icelanders as devoted themselves to the profession of a *scald* or poet. It consists of two principal parts; the *first* containing a brief system of mythology, properly called the *Edda;* and the *second* being a kind of art of poetry, and called *scalda* or *poetics*. The most ancient Edda was compiled by Soemund Sigfusson, surnamed the *Learned*, who was born in Iceland about the year 1057. This was abridged, and rendered more easy and intelligible, about 120 years afterwards, by Snorro Sturleson, who was supreme judge of Iceland in the years 1215 and 1222; and it was published in the form of a dialogue. He added also the second part in the form of a dialogue, being a detail of different events transacted among the divinities. The only three pieces that are known to remain of the more ancient Edda of Soemund, are the Volupsa, the Havamaal, and the Runic chapter. The Volupsa, or prophecy of Vola or Fola, appears to be the text, on which the Edda is the comment. It contains, in two or three hundred lines, the whole system of mythology disclosed in the Edda, and may be compared to the Sibylline verses, on account of its laconic yet bold style, and its imagery and obscurity. It is professedly a revelation of the decrees of the Father of nature, and the actions and operations of the gods. It describes the chaos, the formation of the world, with its various inhabitants, the functions of the gods, their most signal adventures, their quarrels with Loke their great adversary, and the vengeance that ensued; and concludes with a long description of the final state of the universe, its dissolution and conflagration, the battle of the inferior deities and the evil beings, the renovation of the world, the happy lot of the good, and the punishment of the wicked. The Havamaal, or Sublime Discourse, is attributed to the god Odin, who is supposed to have given these precepts of wisdom to mankind; it is comprised in about 120 stanzas, and resembles the book of Proverbs. Mr Mallet has given several extracts of this treatise on the Scandinavian ethics. The Runic chapter contains a short system of ancient magic, and especially of the enchantments wrought by the operation of Runic characters, of which Mr Mallet has also given a specimen. A manuscript copy of the Edda of Snorro is preserved in the library of the university of Upsal; the first part of which hath been published with a Swedish and Latin version by M. Goranson. The Latin version is printed as a supplement to M. Mallet's Northern Antiquities. The first edition of the Edda was published by Resenius, professor at Copenhagen, in a large quarto volume, in the year 1665; containing the text of the Edda, a Latin translation by an Icelandic priest, a Danish version, and various readings from different MSS. M. Mallet has also given an English translation of the first part, accompanied with remarks; from which we learn, that the Edda teaches the doctrine of the Supreme, called the *Universal Father*, and *Odin*, who lives forever, governs all his kingdom, and directs the great things as well as the small; who formed the heaven, earth, and air; made man, and gave him a spirit or soul, which shall live after the body shall have mouldered away; and then all the just shall dwell with him in a place *Gimle* or *Vingolf*, the palace of friendship; but wicked men shall go to Hela, or death, and from thence to Niflheim, or the abode of the wicked, which is below in the ninth world. It inculcates also the belief of several inferior gods and goddesses, the chief of whom is Frigga or Frea, i. e. *lady*, meaning hereby the earth, who was the spouse of Odin or the Supreme God; whence we may infer that, according to the opinion of these ancient philosophers, this Odin was the active principle or soul of the world, which uniting itself with matter, had thereby put it into a condition to produce the intelligences or inferior gods, and men and all other creatures. The Edda likewise teaches the existence of an evil being called *Loke*, the calumniator of the gods, the artificer of fraud, who surpasses all other beings in cunning and perfidy. It teaches the creation of all things out of an abyss or chaos; the final destruction of the world by fire; the absorption of the inferior divinities, both good and bad, into the bosom of the grand divinity, from whom all things proceeded, as emanations of his essence, and who will survive all things; and the renovation of the earth in an improved state.

EDDISH, or EADISH, the latter pasture or grass that comes after mowing or reaping; otherwise called *eagrase* or *earsh*, and *etch*.

EDDOES, or EDDERS, in *Botany*, the American name of the ARUM *esculentum*.

EDDY, (Saxon), of *ed*, "backward," and *ea*, "water," among seamen, is where the water runs back contrary to the tide; or that which hinders the free passage of the stream, and so causes it to return again. That eddy water, which falls back, as it were, on the rudder of a ship under sail, the seamen call the *dead water*.

EDDY *Wind* is that which returns or is beat back from a sail, mountain, or any thing that may hinder its passage.

EDELINCK, GERARD, a famous engraver, born at Antwerp, where he was instructed in drawing and engraving. He settled at Paris, in the reign of Louis XIV. who made him his engraver in ordinary. Edelinck was also counsellor in the Royal Academy of Painting. His works are particularly esteemed for the neatness of the engraving, their brilliant cast, and the prodigious ease apparent in the execution; and to this facility is owing the great number of plates we have of his; among which are excellent portraits of a great number of illustrious men of his time. Among the most admired of his prints, the following may be specified as holding the chief place. 1. A battle between four horsemen, with three figures lying slain upon the ground, from Leonardo da Vinci. 2. A holy family, with Elizabeth, St John, and two angels, from the famous picture of Raphael in the king of France's collection. The first impressions are before the arms of M. Colbert were added at the bottom of the plate; the second are with the arms; and in the third the arms are taken out, but the place where they had been inserted is very perceptible. 3. Mary Magdalen bewailing her sins, and trampling upon the riches of the world, from Le Brun. The first impressions are without the narrow border which surrounds the print. 4. Alexander entering into the tent of Darius, a large print on two plates, from Le Brun. This engraving belongs to the three battles, and triumphal entry of Alexander into Babylon, by Girard Audran, and completes the set. The first impressions have the name of *Goyton* the printer at the bottom. 5. Alexander entering into the tent of Darius (finished by P. Drevet), from Peter Mignard. Edelinck died in 1707, in an advanced age, at the Hotel Royal at the Gobelins, where he had an apartment. He had a brother named *John*, who was a skilful engraver, but died young.

EDEN, (Moses) the name of a country, with a garden, in which the progenitors of mankind were settled by God himself: The term denotes pleasure or delight. It would be endless to recount the several opinions concerning its situation, some of them very wild and extravagant. Moses says, that "a river went out of Eden to water the garden, and from thence it was parted and became into four heads." The river is supposed to be the common channel of the Euphrates and Tigris, after their confluence; which parted again, below the garden, into two different channels; so that the two channels before, and the other two after their confluence, constitute the heads mentioned by Moses. Which will determine the situation of the garden to have been in the south of Mesopotamia, or in Babylonia. The garden was also called *Paradise*; a term of Persic original, denoting a garden. See PARADISE.

EDGINGS, in *Gardening*, the series of small but durable plants set round the edges or borders of flower beds, &c. The best and most durable of all plants for this use is box; which, if well planted and rightly managed, will continue in strength and beauty for many years. The seasons for planting this are the autumn, and very early in the spring: and the best species for this purpose is the dwarf Dutch box.

Formerly, it was also a very common practice to plant borders, or edgings, of aromatic herbs; as thyme, savory, hyssop, lavender, and the like; but these are all apt to grow woody, and to be in part, or wholly, destroyed in hard winters. Daisies, thrift, or sea july-flower, and chamomile, are also used by some for this purpose: but they require yearly transplanting, and a great deal of trouble, else they grow out of form; and they are also subject to perish in very hard seasons.

EDHILING, EDHILINGUS, an ancient appellation of the nobility among the Anglo-Saxons.

The Saxon nation, says Nithard (Hist. lib. iv.) is divided into three orders or classes of people; the *edhilingi*, the *frilingi*, and the *lazzi*: which signify the nobility, the freemen, and the vassals or slaves.

Instead of *edhiling*, we sometimes meet with *atheling*, or *ætheling*; which appellation was likewise given to the king's son, and the presumptive heir of the crown. See Atheling.

EDICT, in matters of polity, an order or instrument, signed and sealed by a prince, to serve as a law to his subjects. We find frequent mention of the edicts of the prætor, the ordinances of that officer in the Roman law.

EDINBURGH.

1 Origin of the name.

EDINBURGH, a city of Mid-Lothian, in Scotland, situated in W. Long. 3°, and N. Lat. 56°, near the southern bank of the river Forth.—The origin of the name, like that of most other cities, is very uncertain. Some imagine it to be derived from Eth, a supposed king of the Picts; others from Edwin, a Saxon prince of Northumberland, who overran the whole or greatest part of the territories of the Picts, about the year 617; while others choose to derive it from two Gaelic words *Dun Edin*, signifying the face of a hill. The name *Edinburgh* itself, however, seems to have been unknown in the time of the Romans. The most ancient title by which we find this city distinguished is that of *Castelh Mynyd Agned;* which, in the British language, signifies "the fortress of the hill of St Agnes." Afterwards it was named *Castrum Puellarum*, because the Pictish princesses were educated in the castle (a necessary protection in those barbarous ages) till they were married.—The ages in which these names were given cannot indeed now be exactly ascertained: but the town certainly cannot boast of very great antiquity; since, as Mr Whittaker informs us, the celebrated King Arthur fought a battle on the spot where it is situated towards the end of the fifth century.

2 Time of its foundation uncertain.

The Romans, during the time they held the dominion of part of this island, divided their possessions into six provinces. The most northerly of these was called *Valentia*, which comprehended all the space betwixt the walls of Adrian and Severus. Thus Edinburgh, lying on the very outskirts of that province which was most exposed to the ravages of the barbarians, became perpetually subject to wars and devastations; by means of which, the time of its first foundation cannot now be guessed at.

The castle is certainly very ancient. It continued in the hands of the Saxons or English from the invasion of Octa and Ebusa in the year 452 till the defeat of Egfrid king of Northumberland in 685 by the Picts, who then repossessed themselves of it. The Saxon kings of Northumberland reconquered it in the ninth century; and it was retained by their successors till the year 956, when it was given up to Indulphus king of Scotland. In 1093 it was unsuccessfully besieged by the usurper Donald Bane. Whether the city was at that time founded or not is uncertain. Most probably it was: for as protection from violence was necessary in those barbarous ages, the castle of Edinburgh could not fail of being an inducement to many people to settle in its neighbourhood; and thus the city would gradually be founded and increase.—In 1128, King David I. founded the abbey of Holyroodhouse, for certain canons regular: and granted them a charter, in which he styled the town *Burgo meo de Edwinesburgh*, "my borough of Edinburgh." By the same charter he granted these canons 40 shillings yearly out of the town revenues; and likewise 48 shillings more from the same, in case of the failure of certain duties payable from the king's revenue; and likewise one half of the tallow, lard and hides, of all the beasts killed in Edinburgh.

3 Castle rendere the Eng

In 1174, the castle of Edinburgh was surrendered to Henry II. of England, in order to purchase the liberty of King William I. who had been defeated and taken prisoner by the English. But when William recovered his liberty, he entered into an alliance with Henry, and married his cousin Ermengarde; upon which the castle was restored as part of the queen's dower.

In 1215, this city was first distinguished by having a parliament and provincial synod held in it.—In 1296, the castle was besieged and taken by Edward I. of England; but was recovered in 1313 by Randolph earl of Moray, who was afterwards regent of Scotland during the minority of King David II. At last King Robert destroyed the fortress, as well as all others in Scotland, lest they should afford shelter to the English in any of their after incursions into Scotland.—It lay in ruins for a considerable number of years; but was afterwards rebuilt by Edward III. of England, who placed a strong garrison in it.

In 1341 it was reduced by the following stratagem. A man pretending to be an English merchant, came to the governor, and told him that he had on board his ship in the Forth, some wine, beer, biscuits, &c. which he would sell him on very reasonable terms. A bargain being made, he promised to deliver the goods next morning at a very reasonable rate: but at the time appointed, twelve men, disguised in the habit of sailors, entered the castle with the goods and supposed merchant: and having instantly killed the porter and centinels, Sir William Douglas, on a preconcerted signal, rushed in with a band of armed men, and quickly made himself master of the place, after having cut most of the garrison in pieces.

4 Cruel e cution the mur derers James I

The year 1437 is remarkable for the execution of the earl of Athol and his accomplices, who had a concern in the murder of James I. The crime, it must be owned, was execrable; but the punishment was altogether shocking to humanity. For three days successively the assassins were tortured by putting on their heads iron crowns, heated red hot, dislocating their joints, pinching their flesh with red hot pincers, and carrying them in that dreadful situation through the streets upon hurdles. At last an end was put to their sufferings, by cutting them up alive, and sending the parts of their mangled bodies to the principal towns of the kingdom.

5 Edinbur becomes the capi of Scotla

About the end of the 14th century it was customary to consider Edinburgh as the capital of the kingdom. The town of Leith, with its harbour and mills, had been bestowed upon it by Robert I. in 1329; and his grandson John earl of Carrick, who afterwards ascended the throne by the name of Robert III. conferred upon all the burgesses the singular privilege of building houses in the castle, upon the sole condition that they should be persons of good fame; which we must undoubtedly consider as a proof that the number of these burgesses was at that time very small. In 1461, a very considerable privilege was conferred on the city by Henry VI. of England when in a state of exile; viz. that its inhabitants should have liberty to trade to all the English ports on the same terms with the city of London. This extraordinary privilege was bestowed in consequence of the kindness with which that king was treated in a visit to the Scottish monarch at Edinburgh; but as Henry was never restored, his gratitude was not attended with any benefit to this city. From this time, however, its privileges continued to be increased from various causes. In 1482 the citizens had an opportunity of liberating King James from the oppression of his nobles, by whom he had been imprisoned in the castle. On this account the provost was by that monarch made hereditary high sheriff within the city, an office which he continues still to enjoy. The council at the same time were invested with the power of making laws and statutes for the government of the city; and the trades, as a testimony of the royal gratitude for their loyalty, received the banner known by the name of the *Blue Blanket*; an ensign formerly capable of producing great commotions, but which has not now been displayed for many years past. However, it still exists; and the convener of the trades has the charge of keeping it.

Ve real dis e im- po d.

It was not long after the discovery of America that the venereal disease, imported from that country, made its way to Edinburgh. As early as 1497, only five years after the voyage of Columbus, we find it looked upon as a most dreadful plague; and the unhappy persons affected with it were separated as effectually as possible from society. The place of their exile was Inchkeith, a small island, near the middle of the Forth; which, small as it is, has a spring of fresh water, and now affords pasture to some sheep.

Or h of the wn gua

By the overthrow of James IV. at the battle of Flowden, the city of Edinburgh was overwhelmed with grief and confusion, that monarch having been attended in his unfortunate expedition by the earl of Angus, then provost, with the rest of the magistrates, and a number of the principal inhabitants, most of whom perished in the battle. After this disaster, the inhabitants being alarmed for the safety of their city, it was enacted that every fourth man should keep watch at night; the fortifications of the town were renewed, the wall being also extended in such a manner as to enclose the Grassmarket, and the field on which Heriot's Hospital, the Grey Friars Church, and Charity Workhouse, stand. On the east side it was made to enclose the College, Infirmary, and High School; after which, turning to the north, it met the old wall at the Netherbow port. After this alarm was over, the inhabitants were gradually relieved from the trouble of watching at night, and a certain number of militia appointed to prevent disturbances; who continue to this day, and are known by the name of the *Town Guard*. Before these new enclosures, most of the principal people lived in the Cowgate without the wall; and the burying place was situated where the Parliament Close now is. In our days of peace, when no alarm of an enemy is at all probable, great part of the walls, with all the gates, have been taken down, and the city laid quite open, in order to afford more ready passage to the great concourse of people with whom the street is daily filled. But at the period we speak of, not only were the inhabitants much less numerous by reason of the small extent of the city, but it was depopulated by a dreadful plague; so that, to stop if possible the progress of the infection, all houses and shops were shut up for 14 days, and some where infected persons had died were pulled down altogether.

8
Erection of wooden houses.

In 1504, the tract of ground called the *Burrough Muir* was totally overgrown with wood, though now it affords not the smallest vestige of having been in such a state. So great was the quantity at that time, however, that it was enacted by the town council, that whoever inclined to purchase as much wood as was sufficient to make a new front for their house, might extend it seven feet into the street. Thus the city was in a short time filled with houses of wood instead of stone; by which, besides the inconvenience of having the street narrowed 14 feet, and the beauty of the whole entirely marred, it became much more liable to accidents by fire: but almost all these are now pulled down; and in doing this a singular taste in the masonry which supported them is said to have been discovered.

9
Edinburgh destroyed by the English

In 1542, a war with England having commenced through the treachery of Cardinal Beaton, an English fleet of 200 sail entered the Forth; and having landed their forces, quickly made themselves masters of the towns of Leith and Edinburgh. They next attacked the castle, but were repulsed from it with loss; and by this they were so enraged, that they not only destroyed the towns of Edinburgh and Leith, but laid waste the country for a great way round.—These towns, however, speedily recovered from their ruinous state; and, in 1547, Leith was again burned by the English after the battle of Pinkey, but Edinburgh was spared.

10
Siege of the castle in Queen Elizabeth's time.

Several disturbances happened in this capital at the time of the Reformation, of which an account is given under the article SCOTLAND; but none of these greatly affected the city till the year 1570, at which time there was a civil war on account of Q. Mary's forced resignation. The regent, who was one of the contending parties, bought the castle from the perfidious governor (Balfour) for 5000l. and the priory of Pittenweem. He did not, however, long enjoy the fruits of this infamous bargain. Sir William Kirkaldy, the new governor, a man of great integrity and bravery, declared for the queen. The city in the mean time was sometimes in the hands of one party and sometimes of another; during which contentions, the inhabitants, as may easily be imagined, suffered extremely. In the year 1570 above mentioned, Queen Elizabeth sent a body of 1000 foot and 300 horse, under the command of Sir William Drury, to assist the king's party. The castle was summoned to surrender; and several skirmishes happened during the space of two years, in which a kind of predatory war was carried on. At last a truce was agreed on till the month of January 1573; and this opportunity the earl of Morton, now regent,

regent, made use of to build two bulwarks across the high street, nearly opposite to the tolbooth, to defend the city from the fire of the castle.

On the first of January, early in the morning, the governor began to cannonade the city. Some of the cannon were pointed against the fish-market, then held on the high street; and the bullets falling among the fishes, scattered them about in a surprising manner, and even drove them up so high in the air, that they fell down upon the tops of the houses. This unusual spectacle having brought a number of people out of their houses, some of them were killed, and others dangerously wounded. Some little time afterwards, several houses were set on fire by shot from the castle, and burned to the ground, which greatly enraged the people against the governor. A treaty was at last concluded between the leaders of the opposite factions; but Kirkaldy refused to be comprehended in it. The regent therefore solicited the assistance of Queen Elizabeth, and Sir William Drury was again sent into Scotland with 1500 foot and a train of artillery. The castle was now besieged in form, and batteries raised against it in different places. The governor defended himself with great bravery for 33 days; but finding most of the fortifications demolished, the well choked up with rubbish, and all supplies of water cut off, he was obliged to surrender. The English general, in the name of his mistress, promised him honourable treatment; but the queen of England shamefully gave him up to the regent, by whom he was hanged.

11
The city incurs the displeasure of James VI.

Soon after this, the spirit of fanaticism, which succeeded the Reformation, produced violent commotions, not only in Edinburgh, but through the whole kingdom. The foundation of these disturbances, and indeed of most others which have ever happened in Christendom on account of religion, was that pernicious maxim of Popery, that the church is independent of the state. It is not to be supposed that this maxim was at all agreeable to the sovereign; but such was the attachment of the people to the doctrines of the clergy, that King James found himself obliged to compound matters with them. This, however, answered the purpose but very indifferently; and at last a violent uproar was excited. The king was then sitting in the court of session, which was held in the tolbooth, when a petition was presented to him by six persons, lamenting the dangers which threatened religion; and being treated with very little respect by one Bruce, a minister, his majesty asked who they were that dared to convene against his proclamation? He was answered by Lord Lindsay, that they dared to do more, and would not suffer religion to be overthrown. On this the king perceiving a number of people crowding into the room, withdrew into another without making any reply, ordering the door to be shut. By this the petitioners were so much enraged, that on their return to the church the most furious resolutions were taken; and had it not been for the activity of Sir Alexander Home the provost, and Mr Watt the deacon convener, who assembled the crafts in his majesty's behalf, it is more than probable that the door would have been forced, and an end put to his life. This affront was so much resented by the king, that he thought proper to declare Edinburgh an unfit place of residence for the court or the administration of justice. In consequence of this declaration, he commanded the college of justice, the inferior judges, and the nobility and barons, to retire from Edinburgh, and not to return without express license. This unexpected declaration threw the whole town into consternation, and brought back the magistrates and principal inhabitants to a sense of their duty. With the clergy it was far otherwise. They railed against the king in the most furious manner, and endeavouring to persuade the people to take up arms, the magistrates were ordered to imprison them; but they escaped by a timely flight. A deputation of the most respectable burgesses was then sent to the king at Linlithgow, with a view to mitigate his resentment. But he refused to be pacified; and on the last day of December 1596 entered the town between two rows of his soldiers who lined the streets, while the citizens were commanded to keep within their houses. A convention of the estates was held in the tolbooth, before whom the magistrates made the most abject submissions, but in vain. The convention declared one of the late tumults, in which an attack had been made upon the king's person, to be high treason; and ordained, that if the magistrates did not find out the authors, the city itself should be subjected to all the penalties due to that crime. It was even proposed to raze the town to the foundation, and erect a pillar on the spot where it had stood, as a monument of its crimes. The inhabitants were now reduced to the utmost despair; but Queen Elizabeth interposing in behalf of the city, the king thought proper to abate somewhat of his rigour. A criminal prosecution, however, was commenced, and the town council were commanded to appear at Perth by the first of February. On their petition, the time for their appearance was prolonged to the first of March; and the attendance of 13 of the common council was declared sufficient, provided they had a proper commission from the rest. The trial commenced on the 5th day of the month; and one of the number having failed in his attendance, the cause was immediately decided against the council; they were declared rebels, and their revenues forfeited.

12
Is again ceived in favour.

For 15 days the city continued in the utmost confusion; but, at last, on their earnest supplication, and offering to submit entirely to the king's mercy, the community were restored on the following conditions, which they had formerly proffered: That they should continue to make a most diligent search for the authors of the tumult in order to bring them to condign punishment; that none of the seditious ministers should be allowed to return to their charges, and no others admitted without his majesty's consent; and that in the election of their magistrates they should present a list of the candidates to the king and his lords of council and session, whom his majesty and their lordships might approve or reject at pleasure. To these conditions the king now added some others; viz. that the houses which had been possessed by the ministers should be delivered up to the king; and that the clergymen should afterwards live dispersed through the town, every one in his own parish: That the town council house should be appointed for accommodating the court of exchequer: and that the town should become bound for the safety of the lords of session from any attempts of the burgesses, under a penalty of 40,000 merks; and, lastly, that

that the town should immediately pay 20,000 merks to his majesty.

Upon these terms a reconciliation took place; which appears to have been very complete, as the king not only allowed the degraded ministers to be replaced, but in 1610 conferred a mark of his favour on the town, by allowing the provost to have a sword of state carried before him, and the magistrates to wear gowns on public occasions. In 1618 he paid his last visit to this city, when he was received with the most extravagant pomp and magnificence. See SCOTLAND.

Proceed-
ngs of the
ma
trates, &c.

The events which, during this period, regard the internal police of the city, were principally the following. After the unfortunate battle at Pinkey, the magistrates, probably apprehending that now their power was enlarged by reason of the present calamity, proceeded in some respects in a very arbitrary manner; forcing the inhabitants to furnish materials for the public works; enjoining merchants to bring home silver to be coined at the mint; and ordering lanterns to be hung out at proper places to burn till nine at night, &c. Another invasion from England being apprehended in 1558, the city raised 1450 men for its defence, among whom there are said to have been 200 tailors, so that their profession seems to have been in a very flourishing state at that time. During the disturbances which happened at the Reformation, and of which a particular account is given under the article SCOTLAND, it was enacted, that the figure of St Giles should be cut out of the town standard, and that of a thistle inserted in its place. It was likewise enacted, that none but those who professed the reformed religion should serve in any office whatever; and the better to preserve the extraordinary appearance of sanctity which was affected, a pillar was erected in the North Loch, for the purpose of ducking fornicators.

In 1595, the boys of the High School rose against their masters; and such was the barbarism of those days, that one of these striplings shot a magistrate with a pistol, who had come along with the rest to reduce them to obedience. The reason of the uproar was, that they were in that year refused two vacations, which had been customary in former times: however, they were at last obliged to submit, and ever since have been allowed one for about six weeks in the autumn. The same year the house of one of the bailies was assaulted by the tradesmen's sons, assisted by journeymen who had not received the freedom of the town; he escaped with his life, but the offenders were banished the city for ever.

ist an-
es i he
me
har I.

In the beginning of the reign of Charles I. a perfect harmony seems to have subsisted between the court and the city of Edinburgh; for in 1627 King Charles I. presented the city with a new sword and gown to be worn by the provost at the times appointed by his father James VI. Next year he paid a visit to this capital, and was received by the magistrates in a most pompous manner; but soon after this the disturbances arose which were not terminated but by the death of that unfortunate monarch. These commenced on an attempt of Charles to introduce Episcopacy into the kingdom; and the first step towards this was the erection of the three Lothians and part of Berwick into a diocese, Edinburgh being the episcopal seat, and the church of St Giles the cathedral. An account of the disturbance occasioned by the first attempt to read the prayer book there, is given under the article BRITAIN; but though the attempt was given over, the minds of the people were not to be quieted. Next winter they resorted to town in such multitudes, that the privy-council thought proper to publish two acts; by one of which the people were commanded, under severe penalties, to leave the town in 24 hours; and by the other, the court of session was removed to Linlithgow. The populace and their leaders were so much enraged by the latter, that Lord Traquair and some of the bishops narrowly escaped with their lives; and next year (1638)matters became still more serious. For now, the king having provoked his subjects throughout all Scotland with the innovations he attempted in religion, Edinburgh was made the general place of rendezvous, and the most formidable associations took place; an account of which has already been given under the article BRITAIN. Each of the towns in Scotland had a copy; and that which belonged to Edinburgh, crowded with 5000 names, is still preserved among the records of the city. Notwithstanding this disagreement, however, the king once more visited Edinburgh in 1641, and was entertained by the magistrates at an expence of 12,000l. Scots. It does not appear that after this the city was in any way particularly concerned with the disturbances which followed either throughout the remainder of the reign of Charles I. the commonwealth, or the reign of Charles II. In 1680 the duke of York with his duchess, the princess Anne, and the whole court of Scotland, were entertained by the city in the Parliament House, at the expence of 15,000l. Scots. At this time it is said that the scheme of building the bridge over the North Loch was first projected by the duke.

15
Regulations made by the magistrates.

From the time that King James VI. paid his last visit to Edinburgh in 1618, till the time of the union in 1707, a considerable number of private regulations were made by the magistrates; some of them evidently calculated for the good of the city, others strongly characteristic of that violent spirit of fanaticism which prevailed so much in the last century. Among the former was an act passed in 1621, that the houses, instead of being covered with straw or boards, should have their roofs constructed of slate, tiles, or lead. This act was renewed in 1667; and in 1668 an act was passed regulating their height also. By this they were restrained to five stories, and the thickness of the wall determined to be three feet at bottom. In 1684 a lantern with a candle was ordered to be hung out on the first floor of every house, in order to light the streets at night; and there were two coaches with four horses each ordered to be bought for the use of the magistrates; but it does not appear how long they continued to be used. In 1681 the court of session discontinued its sittings in summer: but as this was found to be attended with inconvenience, an act was passed for their restoration, which has continued ever since. During the time of the civil war in 1649, the city was visited by the plague, which is the last time that dreadful distemper hath made its appearance in this country. The infection was so violent, that the city was almost depopulated, the prisoners were discharged from the tolbooth, and an act was made for giving one Dr Joannes Politius a salary of 80l. Scots per month, for visiting those who were infected with the disease. In 1677 the first coffee-houses were allowed to be opened, but none without a license: and the same year the town council regulated the price of penny weddings; ordaining the men to pay no more than two shillings, and the women 18 pence; very extravagant prices having been exacted before.

In contradistinction to these salutary acts, we may state those which show an extravagant desire of preserving the appearance of virtue in the female sex, as if it had been possible for others to inspire them with virtuous notions if they had not imbibed them of themselves. In 1633 an act of council was passed, by which women were forbidden to wear plaids over their faces, under penalty of five pounds and the forfeiture of the plaid for the first fault. Banishment was the punishment of the third. The reason assigned for this act was, that matrons were not known from strumpets and loose women, while the plaid continued to be worn over the face. This act was renewed in 1637 and 1638. Succeeding town councils continued to show the same regard to these matters; for in 1695 they enacted, that no innkeeper, vintner, or aleseller, should for the future employ women as waiters or servants, under the penalty of five shillings sterling for each.

The following anecdote may perhaps make the virtues of these legislators themselves wear a suspicious aspect. In 1649 the city having borrowed 40,000l. Scots, in order to raise their quota of men for his majesty, the payment of it was absolutely refused by the town-council when a demand was made for that purpose. That they might not, however, depend entirely upon their own opinion in a matter of such importance, they took that of the General Assembly upon the subject; and it was determined by these reverend divines, that they were not in conscience bound to pay for an unlawful engagement which their predecessors had entered into. But in 1652, Cromwell's parliament, who pretended to no less sanctity than they, declared themselves of a very different opinion; and on the application of one of the creditors, forced them to repay the sum.

16 Infamous treatment of the marquis of Montrose.

The treatment which the brave marquis of Montrose met with, likewise fixes an indelible stigma both upon the magistrates and clergy at that time. Having been put under sentence of excommunication, no person was allowed to speak to him or to do him the least office of friendship. Being met without the city by the magistrates and town guard, he was by them conducted in a kind of gloomy procession through the streets bareheaded, and in an elevated cart made for the purpose; the other prisoners walking two and two before him. At the time of his execution he was attended by one of the ministers, who, according to his own account, did not choose to return till *he had seen him casten over the ladder*.

17 Loyalty of the city 1715 an 1725.

The union in 1707 had almost produced a war between the two kingdoms which it was designed to unite; and on that occasion Edinburgh became a scene of the most violent disturbances, of which a particular account is given under the article Britain. During the time the act was passing, it was found absolutely necessary for the guards and four regiments of foot to do duty in the city. The disturbances were augmented by the disagreement of the two members of parliament; and notwithstanding the victory gained at that time by the court party, Sir Patrick Johnston the provost, who voted for the union, was obliged afterwards to leave the country. In 1715 the city remained faithful to the royal cause, and proper measures were taken for its defence. A committee of safety was appointed, the city guard increased, and 400 men raised at the expence of the town. The trained bands likewise were ordered out, 100 of whom mounted guard every night: by which precautions the rebels were prevented from attempting the city: they, however, made themselves masters of the citadel of Leith; but fearing an attack from the duke of Argyll, they abandoned it in the night time. A scheme was even laid for becoming masters of the castle of Edinburgh; for which purpose they bribed a serjeant to place their scaling ladders. Thus some of the rebels got up to the top of the walls before any alarm was given; but in the mean time the plot being discovered by the serjeant's wife, her husband was hanged over the place where he had attempted to introduce the rebels. The expence of the armament which the city had been at on this occasion amounted to about 1700l. which was repaid by government in the year 1721.

The loyalty of this city was still farther remarkable in the year 1725, when disturbances were excited in all parts of the kingdom, particularly in the city of Glasgow, concerning the excise bill; for all remained quiet in Edinburgh, nothwithstanding the violent outcries that were made elsewhere; and so remarkable was the tranquillity in the metropolis, that government afterwards returned thanks to the magistrates for it. In 1736, however, the city had again the misfortune to fall under the royal dipleasure, on the following account. Two smugglers having been detected in stealing their own goods out of a customhouse, were condemned to be hanged. The crime was looked upon as trivial; and therefore a general murmur prevailed among the populace, which was no doubt heightened by the following accident. At that time it had been customary for persons condemned to die to be carried each Sunday to the church, called from that circumstance the *Tolbooth church*. The two prisoners just mentioned were conducted in the usual way, guarded by three soldiers, to prevent their making their escape: but having once gone thither a little before the congregation met, one of the prisoners seized one of the guards in each hand, and the other in his teeth, calling out to his companion to run; which he immediately did with such speed, that he soon got out of sight, and was never heard of afterwards. The person who had thus procured the life of his companion without regard to his own, would no doubt become a general object of compassion; and of course, when led to the place of execution, the guard were severely pelted by the mob, and some of them, according to the testimony of the witnesses who were sworn on the occasion, pretty much wounded. By this Captain Porteous, who commanded the guard, was so much provoked, that he gave orders to fire, by which six people were killed and eleven wounded. The evidence, however, even of the fact that the orders to fire were given, appears not to have been altogether unexceptionable; nevertheless, on this he was tried and condemned to be executed. At that time the king was absent in Hanover, having

18 Captai Porteou execute by a m

having left the regency in the hands of the queen; and the case of the unfortunate Porteous having been represented to her, she was pleased to grant him a reprieve: but such was the inveteracy of the people against him, that they determined not to allow him to avail himself of the royal clemency. On the night previous to the day that had been appointed for his execution, therefore, a number of people assembled, shut the gates of the city, and burnt the door of the prison, the same which the mob would formerly have broken open in order to murder King James. They then took out Porteous, whom it was found impossible to rescue out of their hands, though every method that the magistrates could take for that purpose in such a confusion was made use of. It was even proved that the member of parliament went to the commander in chief, and requested that he would send a party of soldiers to quell the disturbance, but was absolutely denied this request, because he could not produce a written order from the provost to this purport; which, in the confusion then existing in the city, could neither have been expected to be given by the provost, nor would it have been safe for any person to have carried it about him. Thus the unhappy victim was left in the hands of his executioners; and being dragged by them to the place destined for receiving his fate, was hanged on a dyer's sign post. As they had not brought a rope along with them, they broke open a shop where they knew they were to be had; and having taken out what they wanted, left the money upon the table, and retired without committing any other disorder.

Such an atrocious insult on government could not but be highly resented. A royal proclamation was issued, offering a pardon to any accomplice, and a reward of 200l. to any person who would discover one of those concerned. The proclamation was ordered to be read from every pulpit in Scotland the first Sunday of every month for a twelvemonth: but so divided were the people in their opinions about this matter, that many of the clergy hesitated exceedingly about complying with the royal order, by which they were brought in danger of being turned out of their livings; while those who complied were rendered so unpopular, that their situation was rendered still worse than the others. All the efforts of government, however, were insufficient to produce any discovery; by which, no doubt, the court was still more exasperated; and it was now determined to execute vengeance on the magistrates and city at large. Alexander Wilson, the provost at that time, was imprisoned three weeks before he could be admitted to bail; after which, he and the four bailies, with the lords of justiciary, were ordered to attend the house of peers at London. On their arrival there a debate ensued, whether the lords should attend in their robes or not? but at last it was agreed that they should attend in their robes at the bar. This, however, was refused by their lordships, who insisted that they should be examined within the bar; upon which the affair of their examination was dropped altogether. A bill at last passed both houses, by which it was enacted that the city of Edinburgh should be fined 2000l. for the benefit of Porteous's widow (though she was prevailed upon to accept of 1500l. for the whole); and the provost was declared incapable of ever serving government again in any capacity whatever. To prevent such catastrophes in time coming, the town council enacted, that, on the first appearance of an insurrection, the chief officers in the different societies and corporations should repair to the council to receive the orders of the magistrates for the quelling of the tumult, under the penalty of 8l. 6s. 8d. for each omission.

20 The city taken by the rebels in 1745.

In 1745, the city was invested by the Pretender's army; and on the 17th of September, the Netherbow gate being opened to let a coach pass, a party of Highlanders, who had reached the gate undiscovered, rushed in, and took possession of the city. The inhabitants were commanded to deliver up their arms at the palace of Holyroodhouse; a certain quantity of military stores was required from the city, under pain of military execution; and an assessment of 2s. 6d. upon the pound was imposed upon the *real* rents within the city and liberties for defraying that expence.

The pretender's army guarded all the avenues to the castle; but no signs of hostilities ensued till the 25th of the month, when the garrison being alarmed from some unknown cause, a number of cannon were discharged at the guard placed at the West Port, but with very little effect. This gave occasion to an order to the guard at the Weigh-house, to prevent all intercourse between the city and castle; and then the governor acquainted the provost by letter, that unless the communication was preserved, he would be obliged to dislodge the guard by means of artillery. A deputation was next sent to the Pretender, acquainting him with the danger the city was in, and entreating him to withdraw the guard. With this he refused to comply; and the Highland centinels firing at some people who were carrying provisions into the castle, a pretty smart cannonading ensued, which set on fire several houses, killed some people, and did other damage. The Pretender then consented to dismiss the guard, and the cannonading ceased. After the battle of Culloden, the provost of Edinburgh was obliged to stand a very long and severe trial, first at London and then at Edinburgh, for not defending the city against the rebels; which, from the situation and extent of the walls, every one must have seen to be impossible.

During this trial a very uncommon circumstance happened; the jury having sat two days, insisted that they could sit no longer, and prayed for a short respite. As the urgency of the case was apparent, and both parties agreed, the court, after long reasoning, adjourned till the day following, taking the jury bound under a penalty of 500l. each; when the court continued sitting two days longer, and the jury were one day enclosed. The event was, that the provost was exculpated.

21 Government of the city restored.

After the battle of Culloden the duke of Cumberland caused fourteen of the rebel standards to be burned at the cross; that of the Pretender was carried by the common executioner, the others by chimney-sweepers; the heralds proclaiming the names of the commanders to whom they belonged as they were thrown into the fire. At this time the city of Edinburgh felt a temporary inconvenience from the election of their magistrates not having taken place at the usual time; so that it became necessary to apply to his majesty for the restoration of the government of the city. This was readily granted, the burgesses being allowed a poll tax; after which an entire new set of magistrates was returned,

returned, all of them friends to the house of Hanover; and soon after the freedom of the city in a gold box was presented to the duke of Cumberland.

With these transactions all interferences betwixt government and the metropolis of Scotland were ended; the rest of its history therefore only consists of internal occurences, the regulations made by its own magistrates for the benefit of the city, their applications to government for leave to improve it, or the execution of these improvements; of which we shall now give a brief detail.

22
Salary bestowed on the provost.

In the year 1716, the city first bestowed a settled salary on the provost, in order to enable him to support the dignity of the first magistrate. This was at first 100l.; was afterwards augmented to 500l. and now we believe is a larger sum. In 1718 it was recommended to the magistrates to distinguish themselves by wearing coats of black velvet, for which they were allowed 10l. but this act being abrogated in 1754, gold chains were assigned as badges of their office, which they continue to wear. Provost Kincaid happened to die in office in the year 1777; which being a rare occurrence, perhaps the only one at that time of the kind to be met with in the records of Edinburgh, he was buried with great solemnity. A similar funeral procession took place at the death of Mr Coulter in 1809.

23
Account of tumults.

Tumults have been frequent in Edinburgh, chiefly on account of the dearness of provisions. In 1740 Bell's mills were first attacked by the populace, and afterwards Leith mills; nor could the rioters be dispersed till the military had fired among them and wounded three, of whom one died; and it was found necessary to order some dragoons into the city in order to preserve tranquillity. In 1742, another violent tumult took place, owing to a custom of stealing dead bodies from their graves for anatomical purposes, which had then become common. The populace beat to arms, threatened destruction to the surgeons; and, in spite of the efforts of the magistrates, demolished the house of the beadle at St Cuthbert's. In 1756 new disturbances, which required the assistance of the military, took place: the cause at this time was the impressing of men for the war which was then commencing. A disturbance was likewise excited in 1760. This was occasioned by the footmen, who till then were allowed to follow their masters into the playhouse, and now took upon them to disturb the entertainment of the company; the consequence of which was, that they were turned out, and have ever since been obliged to wait for their masters. In 1763 and 1765, the tumults on account of the price of provisions were renewed; many of the mealmongers had their houses broken open and their shops destroyed. The magistrates, as usual, were obliged to call in a party of dragoons to quell the disturbance; but at the same time, to put an effectual stop, as far as was in their power, to these proceedings for the future, they gave security, that people who brought grain or provision into the market should be secured in their property. Since that time there have been no tumults directly on the account of provisions; though in 1784 a terrible riot and attack of a distillery at Canonmills took place, on a supposition that the distillers enhanced the price of meal by using unmalted grain. The attack was repelled by the servants of the distillery; but the mob could not be quelled until the sheriff called the soldiers quartered in the castle to his assistance. The same night a party of rioters set out for Ford, a place ten miles to the southward, where there was likewise a large distillery; which, as there was none to make any opposition, they soon destroyed. One man was killed in this riot at Edinburgh by the fire of a servant of the distillery, and several of the rioters were afterwards secured and punished.

In the years 1778 and 1779 two very alarming disturbances happened, which threatened a great deal of bloodshed, though happily they were terminated without any. The first was a mutiny of the earl of Seaforth's Highland regiment, who were at this time quartered in the castle. These having been ordered to embark, for some reason or other unanimously refused, and posted themselves on the top of Arthur's seat, where they continued for two days. Troops were collected to prevent their escape, and the inhabitants were ordered to keep within doors at the first toll of the great bell, which was to be a signal of violence about to take place; but fortunately all the fears, naturally arising from the expectation of this event, were dissipated by an accommodation. The other happened on account of the attempt to repeal the penal laws against the Papists; and was much more alarming than the other, as being the effect of a premeditated scheme and determined resolution to oppose government. On the second of February 1779 a mob assembled in the evening, burned a Popish chapel, and plundered another. Next day they renewed their depredations; destroying and carrying off the books, furniture, &c. of several Popish priests and others of that persuasion. The riot continued all that day, though the assistance of the military was called in; but happily no lives were lost, nor was there any firing. The city was afterwards obliged to make good the damage sustained by the Catholics on this occasion, which was estimated at 1500l. This year also an unlucky accident happened at Leith. About 50 Highland recruits having refused to embark, a party of the South Fencibles was sent to take them prisoners. Unexpectedly, however, the Highlanders stood upon their defence; when, after some words, a firing commenced on both sides, and about one half of the Highlanders were killed and wounded, the remainder being taken prisoners and carried to the castle. Captain Mansfield and two or three privates were killed in this affray.

24
General history the improveme

We shall close this history of Edinburgh with a general account of the improvements which have lately taken place in it, and of which a particular description will afterwards be given. These began in the year 1753, when the foundation-stone of the Exchange was laid, at which time there was a grand procession, and the greatest concourse of people ever known in Edinburgh. A triumphal arch was erected for the purpose, through which the procession passed, and medals were scattered among the populace. In 1756 the high street was cleared by the removal of the cross; though many regretted this, on account of its being a very ancient and elegant building. In the middle it had an unicorn placed on the top of a pillar 20 feet high; but this fine ornament was broken to pieces by the giving way of the tackle by which it was attempted to remove it. It is now again erected at Drum, a seat formerly belonging to Lord Somerville, about four miles

miles from Edinburgh. In 1763 the first stone of the North bridge was laid by Provost Drummond; and in 1767 an act of parliament was obtained for extending the royalty of the city over the fields to the northward, where the New Town is now situated. About the same time a spot of ground upon the south side of the town was purchased by a private person for 1200l. which being feued out for building, gave rise to the increase of the town in that quarter; and this proceeded the more rapidly, as the houses built there were free from the duties imposed upon others subject to the royalty. In 1774 the foundation of the Register Office was laid. In 1784 the project for rendering the access to the town equally easy on both sides was begun to be put in execution by laying the foundation of the South bridge. At the same time a great improvement was made by reducing the height of the street several feet all the way from the place where the cross stood to the Netherbow; by which means the ascent is rendered more easy, not only for carriages, but also for persons who walk on foot. At the same time, the street was farther cleared by the removal of the town guard house, which had long been complained of as an encumbrance. The taking down of the Luckenbooths in 1802-3, removed a still greater encumbrance. The old jail at the west end, and the land over Mr Creech's shop at the east end, however, still remained to disfigure the street till 1817, when both were pulled down, and the street laid completely open. By the removal of these buildings, and of the old council chamber, the cathedral of Saint Giles is now exposed to view on all sides. As several of its parts are much decayed, and the whole has rather a dilapidated appearance, it is in contemplation to case it over with new stone, preserving the original plan and style of building. The last improvement which requires to be mentioned, is the magnificent new road over the Calton hill, which was begun in 1816, and opened in 1820. It is connected with Prince's street by the Regent bridge, a single arch of 50 feet span, but finished in the upper part in a very handsome style, and adorned with two fine ranges of buildings. This new road, with the Regent bridge, forms a very fine approach to the city on the east, and is admired by all travellers for its singular appearance, and the picturesque views it affords of the town.

Having thus given a concise history of the city from its earliest foundation, we shall now proceed to describe it in its most improved state.

Description of Ed- urgh.

Edinburgh is situated upon a steep hill, rising from east to west, and terminating in a high and inaccessible rock, upon which the castle stands. At the east end or lower extremity of this hill stands the abbey of Holyroodhouse, or king's palace, distant from the castle upwards of a mile; and betwixt which, along the top of the ridge, and almost in a straight line, runs the High street. On each side, and parallel to this ridge or hill, is another ridge of ground lower than that in the middle, and which does not extend so far to the east: that on the south being intercepted by Salisbury rocks and Arthur's seat, a hill of about 800 feet of perpendicular height; and that on the north by the Calton hill, considerably lower than Arthur's seat; so that the situation of this city is most singular and romantic; the east or lower part of the town lying between two hills; and the west or higher part rising up towards a third hill, little inferior in height to the highest of the other two, upon which, as has been observed, the castle is built, and overlooks the town.

The buildings of the town terminate at the distance of about 200 yards from the castle gate; which space affords a most delightful as well as convenient and healthful walk to the inhabitants. The prospect from this spot is perhaps the finest anywhere to be met with, for extent, beauty, and variety.

In the valley or hollow betwixt the mid and the south ridges, and nearly parallel to the High street, is another street called the Cowgate; and the town has now extended itself over most part of that south ridge also. Betwixt the mid and the north ridges was a loch, which, till of very late, terminated the town on that side. From the High street towards the loch on the north, and Cowgate on the south, run narrow cross streets or lanes, called *wynds* and *closes*, which grow steeper and steeper the farther west or nearer the castle; so that, were it not for the closeness and great height of the buildings, this city, from its situation and plan, might naturally be expected to be the best aired, as well as the cleanest, in Europe. The former, notwithstanding these disadvantages, it enjoys in an eminent degree; but we cannot compliment it upon the latter, notwithstanding every possible means has been used by the magistrates for that purpose.

26 Account of the gradual increase of Edinburgh.

The gradual increase of the city of Edinburgh may in some degree be understood from the traces of its ancient walls that still remain. James II. in 1450, first bestowed on the community the privilege of fortifying the city with a wall, and empowered them to levy a tax upon the inhabitants for defraying the expence. When the city was first fortified, the wall reached no farther than the present water-house, or reservoir, on the Castle hill: from thence to the head of Halkerston's wynd, just below the new bridge, the city was defended by the North Loch; an inconsiderable morass, which, being formerly overflowed, formed a small lake that has since been drained. From this place to the foot of Leith wynd, it does not appear how the city was fortified: but from the foot of Leith wynd to the Nether-bow port it was defended only by a range of houses; and when these had become ruinous, a wall was built in their place. The original wall of Edinburgh, therefore, began at the foot of the north-east rock of the castle. Here it was strengthened by a small fortress, the ruins of which are still to be seen, and are called the *Well-house tower*, from their having a spring in their neighbourhood. When the wall came opposite to the reservoir, it was carried quite across the hill, having a gate on the top for making a communication between the town and castle. In going down the hill, it went slanting in an oblique direction to the first angle in going down the West-bow, where was a gate named the *Upper-bow Port*, one of the hooks of which still remains. Thence it proceeded eastward in such a manner, as would have cut off not only all the Cowgate, but some part of the Parliament house; and being continued as far as the Mint close, it turned to the north-east, and connected itself with the buildings on the north side of the High street, where was the original

Nether-bow Port, about 50 yards west from that which afterwards went by the same name.

Soon after the building of this wall, a new street was formed on the outside of it, named the *Cowgate*, which in the 16th century became the residence of the nobility, the senators of the college of justice, and other persons of the first distinction. After the fatal battle of Flowden, however, the inhabitants of the Cowgate became very anxious to have themselves defended by a wall as well as the rest. The wall of the city was therefore extended to its present limits. This new wall begins on the south-east side of the rock on which the castle is built, and to which the town wall comes quite close. From thence it descends obliquely to the West Port; then ascends part of a hill on the other side, called the *High Riggs;* after which, it runs eastward with but little alteration in its course, to the Bristo and Potter-row ports, and from thence to the Pleasance. Here it takes a northerly direction, which it keeps from thence to the Cowgate port; after which the enclosure is completed to the Nether-bow by the houses of St Mary's wynd. The original Nether-bow port, being found not well adapted for defence, was pulled down, and a new one built in 1571 by the adherents of Queen Mary. In 1606, the late handsome building was erected about 50 yards below the place where the former stood. It was two stories high, and had an elegant spire in the middle; but being thought to encumber the street, and the whole building being in a crazy situation, it was pulled down by order of the magistrates in 1764.

In the original wall of Edinburgh there was, as has been already observed, a port on the Castle-hill. On the extension of the wall, after building the houses in the Cowgate, this gate was pulled down. That in the upper or West-bow stood for a much longer time, and was pulled down within the memory of some persons lately or perhaps still living. Besides these, there was a third, about 50 yards above the head of the Canongate; but whether there were any more, is uncertain. The ports or gates of the new walls were, 1. The *West Port*, situated at the extremity of the Grass Market; beyond which lies a suburb of the town and a borough of regality, called *Portsburgh.* Next to this is a wicket, struck out of the town wall in 1744, for the purpose of making an easier communication between the town and the public walks in the meadows, than by Bristo port. The next to this was *Bristo Port*, built in 1515; beyond which lies a suburb called *Bristo Street.* At a small distance from Bristo was the *Potter-row Port*, which took this name from a manufactory of earthen ware in the neighbourhood. Formerly it was called *Kirk of Field Port.* Between this and the Cowgate port stood another, called *St Mary's Wynd Port*, which extended from east to west across the foot of the Pleasance, and which was demolished only since the middle of the last century. Close to the middle of this stood the *Cowgate Port;* which opened a communication between the Cowgate and St Mary's wynd, and the Pleasance. The *Nether-bow Port* has been already spoken of. At the foot of Leith wynd was another gate, known by the name of *Leith Wynd Port;* and within it was a wicket giving access to the church of Trinity College, and which still remains. At the foot of Halkerston's wynd was another, which, as well as the former, was built about the year 1560. Both of these were pulled down some years ago, and all the rest in 1785. Another still remains at the foot of the Canongate, known by the name of the *Water-gate.*

For 250 years the city of Edinburgh occupied the same space of ground, and it is but very lately that its limits have been so considerably enlarged. In the middle of the 16th century, it is described as extending in length about an Italian mile, and about half as much in breadth; which answers very nearly to its present limits, the late enlargements only excepted. This space of ground, however, was not at that time occupied in the manner it is at present. The houses were neither so high nor so crowded upon each other as they are now. This was a consequence of the number of inhabitants increasing, which has occasioned the raising of the houses to such a height as is perhaps not to be paralleled in any other part of the world. Till the time of the Reformation, the burying ground of the city extended over all the space occupied by the Parliament square, and from thence to the Cowgate. The lands lying to the southward of the Cowgate were chiefly laid out in gardens belonging to the convent of Black friars, and the church of St Mary in the Field. These extended almost from the Pleasance to the Potterrow port. From the Bristo to the West port the ground was laid out in gardens belonging to the Gray friars. The magistrates, on their application to Queen Mary, obtained a grant of the Gray friars gardens for a burying place; for which it was given as a reason, that they were somewhat distant from the town. Here, however, it must be understood, that these gardens were distant from the houses, and not without the walls; for they had been enclosed by them long before. In the time of James I. the houses within the walls, seem to have been in general, if not universally, covered with thatch or broom; and not above 20 feet high. Even in the year 1621, these roofs were so common, that they were prohibited by act of parliament, in order to prevent accidents from fire. In the middle of the 17th century, there were neither courts nor squares in Edinburgh. The Parliament close or square is the oldest of this kind in the city. Miln's square, James's court, &c. were built long after; and Argyle's and Brown's squares about the years 1750 or 1760. 27

New To

The *New Town* was projected in the year 1752; but as the magistrates could not then procure an extension of the royalty, the execution of the design was suspended for some time. In 1767, an act was obtained, by which the royalty was extended over the fields to the northward of the city; upon which advertisements were published by the magistrates, desiring proper plans to be given in. Plans were given in accordingly, and that designed by Mr James Craig architect was adopted. Immediately afterwards, people were invited to purchase lots from the town council; and such as purchased became bound to conform to the rules of the plan. In the mean time, however, the town council had secretly reserved to themselves a privilege of departing from their own plan; which they afterwards made use of in such a manner as produced a law-suit. According to the plan held forth to the purchasers, a canal was to be made through that place

place where the North Loch had been, and the bank on the north side of it laid out in terraces: but instead of this, by an act of council, liberty was reserved to the town to build upon this spot; and therefore, when many gentlemen had built genteel houses in the new town on faith of the plan, they were surprised to find the spot appointed for terraces and a canal, beginning to be covered with mean irregular buildings, and work houses for tradesmen. This deviation was immediately complained of; but as the magistrates showed no inclination to grant any redress, a prosecution was commenced against them before the Lords of Session. In that court the cause was given against the pursuers, who thereupon appealed to the House of Lords. Here the sentence of the Court of Session was reversed, and the cause remitted to the consideration of their Lordships. At last, after an expensive contest, matters were accommodated. The principal term of accommodation was, that some part of the ground was to be laid out in terraces and a canal; but the time of disposing it in that manner, was referred to the Lord President of the Court of Session and the Lord Chief Baron of the Exchequer. The fall of part of the bridge, hereafter mentioned, proved a very considerable disadvantage to the New Town; as it necessarily induced a suspicion that the passage, by means of the bridge, could never be rendered safe. An oversight of the magistrates proved of more essential detriment. A piece of ground lay to the southward of the Old Town, in a situation very proper for building. This the magistrates had an opportunity of purchasing for 1200l.; which, however, they neglected, and it was bought by a private person, who immediately feued it out in lots for building, as has been already mentioned. The magistrates then began to see the consequence, namely, that this spot being free from the duties to which the royalty of Edinburgh is subject, people would choose to reside there rather than in the New Town. Upon this they offered the purchaser 2000l. for the ground for which he had paid 1200l.; but as he demanded 20,000l. the bargain did not take place. Notwithstanding these discouragements, the New Town is now almost finished; and from the advantages of its situation, and its being built according to a regular plan, it has undoubtedly a superiority over any city in Britain. By its situation, however, it is remarkably exposed to storms of wind, which at Edinburgh sometimes rage with uncommon violence.

It has three streets, almost a mile in length, running from east to west, intersected with cross streets at proper distances. Queen's street, the most northerly, till lately that Heriot row and Great King street were built, is 100 feet broad, and commands an extensive prospect of the Forth, the county of Fife, and the shipping in the river. That called *George's Street*, which is in the middle, is no less than 115 feet wide. It is terminated at each end by two very elegant and extensive squares; that on the east end is called *St Andrew's Square;* the other, which is not yet finished, is called *Charlotte's Square.* Prince's street is the most southerly; and extends from the northern extremity of the bridge, quite to the west end of the town. It was only finished in 1805. From the west end of Prince's street, a spacious street (Maitland street) has been opened to join the two roads to Glasgow by Airdrie and Whitburn. This has greatly improved the approach to the town from the west. The northern part of the New Town, which is now in progress, is distinguished from the older part, by the superior style of the architecture. Heriot row, with its continuation Abercromby place, and Great King street now building, are peculiarly beautiful in their design and decorations.

The most remarkable public buildings in Edinburgh are—

28
Public buildings described.

1. *The Castle.* This stands on a high rock, accessible only on the east side. On all others it is very steep, and in some places perpendicular. It is about 300 feet high from its base: so that, before the invention of artillery, it might well have been deemed impregnable; though the event showed that it was not. The entry to this fortress is defended by an outer barrier of pallisadoes; within this is a dry ditch, draw-bridge, and gate, defended by two batteries which flank it; and the whole is commanded by a half moon mounted with brass cannon, carrying balls of 12 pounds. Beyond these are two gate-ways, the first of which is very strong, and has two portcullises. Immediately beyond the second gateway, on the right hand, is a battery mounted with brass cannon, carrying balls of 12 and 18 pounds weight. On the north side are a mortar and some gun batteries. The upper part of the castle contains a half-moon battery, a chapel, a parade for exercise, and a number of houses in the form of a square, which are laid out in barracks for the officers. Besides these, there are other barracks sufficient to contain 1000 men; a powder magazine, bomb proof; a grand arsenal, capable of containing 8000 stand of arms; and other apartments for the same use, which can contain 22,000 more: so that 30,000 stand of arms may be conveniently lodged in this castle. On the east side of the square above mentioned, were formerly royal apartments; in one of which King James VI. was born, and which is still shown to those who visit the castle. In another, the regalia of Scotland were deposited on the 26th of March 1707; but as they were never shown to any body, a suspicion had arisen that they were carried to London. This has however been removed. Commissioners, with the necessary powers, opened a large oaken chest in February 1818, in which were found the Scottish crown, sceptre, and sword of state, of elegant workmanship, and in perfect preservation.

The governor of the castle is generally a nobleman, whose place is worth about 1000l. a-year; and that of deputy governor, 500l. This last resides in the house appointed for the governor, as the former never inhabits it. There is also a fort-major, a store-keeper, master-gunner, and chaplain; but as this last does not reside in the castle, worship is seldom performed in the chapel. The parliament house was formerly included in the great square on the top, and the royal gardens were in the marsh afterwards called the *North Loch;* the king's stables being on the south side, where the houses still retain the name, and the place where the barns were still retains the name of Castlebarns.

The castle is defended by a company of invalids, and four or five hundred men belonging to some marching regiment, though it can accommodate 1000, as above mentioned; and this number has been sometimes kept in it. It could not, in all probability, withstand, even for a few hours, a well directed bombardment: for no part but the powder magazine is capable of resisting these destructive machines; and the splinters from the rock on which the castle is built, could not fail to render them still more formidable. Besides, the water of the well, which is very bad, and drawn up from a depth of 100 feet, is apt to subside on the continued discharge of artillery, which produces a concussion in the rock.

2. *The Palace of Holyroodhouse.* This, though much neglected, is the only royal habitation in Scotland that is not entirely in ruins. It had a handsome square of 230 feet in the inside, surrounded with piazzas. The front, facing the west, consists of two double towers joined by a beautiful low building, adorned with a double balustrade above. The gate-way in the middle is decorated with double stone columns, supporting a cupola in the middle, representing an imperial crown, with a clock underneath. On the right hand is the great staircase which leads to the council chamber and the royal apartments. These are large and spacious, but unfurnished: in one of them the Scotch peers meet to elect 16 of their number to represent them in parliament. The gallery is on the left hand, and measures 150 feet by 27½. It is adorned with the supposed portraits of all the kings of Scotland. In the apartments of the duke of Hamilton, which he possesses as hereditary keeper of the palace, Queen Mary's bed of crimson damask, bordered with green fringes and tassels, is still to be seen, but almost reduced to rags. Here also strangers are shown a piece of wainscot, hung upon hinges, which opens to a trap stair communicating with the apartments below. Through this passage Darnley and the other conspirators rushed in to murder the unhappy Rizzio. Towards the outward door of these apartments are large dusky spots on the floor, said to be occasioned by Rizzio's blood, which could never be washed out. In the lodgings assigned to Lord Dunmore is a picture by Van Dyke, esteemed a masterly performance, of King Charles I. and his queen going a-hunting. There are likewise the portraits of their present majesties at full length by Ramsay. The lodgings above the royal apartments are occupied by the duke of Argyle as heritable master of the household.

The front of this palace is two stories high; the roof flat; but at each end the front projects, and is ornamented with circular towers at the angles. Here the building is much higher, and the rest of the palace is three stories in height. The north-west towers were built by James V. for his own residence: his name is still to be seen below a niche in one of these towers. During the minority of Queen Mary, this palace was burned by the English; but soon after repaired and enlarged beyond its present size. At that time it consisted of five courts, the most westerly of which was the largest. It was bounded on the east by the front of the palace, which occupied the same space it does at present; but the building itself extended further to the south. At the north-west corner was a strong gate with Gothic pillars, arches, and towers, part of which was not long ago pulled down. Great part of the palace was burnt by Cromwell's soldiers; but it was repaired and altered into the present form after the Restoration. The fabric was planned by Sir William Bruce a celebrated architect, and executed by Robert Mylne mason. The environs of the palace afford an asylum for insolvent debtors; and adjoining to it is an extensive park, all of which is a sanctuary.

The abbey church was formerly called the *monastery of Holyroodhouse*, and built by King David I. in 1128. He gave it the name of *Holyroodhouse*, in memory, as is said, of his deliverance from an enraged hart, by the miraculous interposition of a cross from heaven. This monastery he gave to the canons regular of St Augustine: on whom also he bestowed the church of Edinburgh castle, with those of St Cuthbert's, Corstorphin, and Libberton, in the shire of Mid Lothian, and of Airth in Stirlingshire; the priories of St Mary's Isle in Galloway, of Blantyre in Clydesdale, of Rowadill in Ross, and three others in the Western Isles. To them he also granted the privilege of erecting a borough between the town of Edinburgh and the church of Holyroodhouse. From these canons it had the name of the *Canongate*, which it still retains. In this new borough they had a right to hold markets. They had also portions of land in different parts, with a most extensive jurisdiction, and right of trial by duel, and fire and water ordeal. They had also certain revenues payable out of the exchequer and other funds, with fishings, and the privilege of erecting mills on the water of Leith, which still retain the name of *Canon mills*. Other grants and privileges were bestowed by succeeding sovereigns; so that it was deemed the richest religious foundation in Scotland. At the Reformation, its annual revenues were 442 bolls of wheat, 640 bolls of bear, 560 bolls of oats, 500 capons, two dozen of hens, as many salmon, 12 loads of salt; besides a great number of swine, and about 250l. sterling in money. At the Reformation, the superiority of North Leith, part of the Pleasance, the barony of Broughton, and the Canongate, were vested in the earl of Roxburgh; and were purchased from him by the town council of Edinburgh in 1636. In 1544, the church suffered considerably by the invasion of the English; but was speedily repaired. At the Restoration, King Charles II. ordered the church to be set apart as a chapel royal, and prohibited its use as a common parish church for the future. It was then fitted up in a very elegant manner. A throne was erected for the sovereign, and 12 stalls for the knights of the order of the Thistle: but as mass had been celebrated in it in the reign of James VII. and it had an organ, with a spire, and a fine chime of bells on the west side, the Presbyterians at the Revolution entirely destroyed its ornaments, and left nothing but the bare walls.—Through time, the roof of the church became ruinous; on which the duke of Hamilton represented its condition to the barons of exchequer, and craved that it might be repaired. This request was complied with: but the architect and mason who were employed, covered the roof with thick flag stones, which soon impaired the fabric; and on the 2d of December 1768, the roof fell in. Since that time, no attempt has been made to repair it, and it is now entirely fallen to ruin.

The ruins of this church, however, are still sufficient to discover the excellency of the workmanship. Here some of the kings of Scotland are interred; and an odd kind of curiosity has been the occasion of exposing some bones said to be those of Lord Darnley and a countess of Roxburgh who died several hundred years ago. Those said to belong to the former were very large, and the latter had some flesh dried upon them. The chapel was fitted up in the elegant manner above mentioned by James VII. but such was the enthusiasm of the mob, that they not only destroyed the ornaments, but tore up even the pavement, which was of marble.

To the eastward of the palace is the bowling green, now entirely in disorder; and behind it is a field called *St Ann's Yards*. Beyond this is a piece of ground called *the King's Park;* which undoubtedly was formerly overgrown with wood, though now there is not a single tree in it. It is about three miles in circumference; and was first enclosed by James V. It contains the rocky hills of *ARTHUR's Seat* and Salisbury Craigs, which last afford an inexhaustible stone quarry; and upon the north side of the hill stands an old ruinous chapel, dedicated to St Anthony. The stones are used in building, as well as for paving the streets and highways. The park was mortgaged to the family of Haddington for a debt due to them. A good number of sheep and some black cattle are fed upon it. A footpath, completed in 1820, along the north-west side of Salisbury Craig, affords one of the most beautiful and romantic walks in existence.

3. *St Giles's Church* is a venerable Gothic building, measuring in length 206 feet. At the west end, its breadth is 110; in the middle, 129; and at the east end, 76 feet. It has a very elevated situation, and is adorned with a lofty square tower; from the sides and corners of which arise arches of figured stone work: these meeting with each other in the middle, complete the figure of an imperial crown, the top of which terminates in a pointed spire. The whole height of this tower is 161 feet.

This is the most ancient church in Edinburgh. From a passage in an old author called *Simeon Dunelmensis*, some conjecture it to have been built before the year 854; but we do not find express mention made of it before 1359. The tutelar saint of this church, and of Edinburgh, was St Giles, a native of Greece. He lived in the sixth century, and was descended of an illustrious family. On the death of his parents, he gave all his estate to the poor; and travelled into France, where he retired into a wilderness near the conflux of the Rhone with the sea, and continued there three years. Having obtained the reputation of extraordinary sanctity, various miracles were attributed to him; and he founded a monastery in Languedoc, known long after by the name of *St Giles's*.—In the reign of James II. Mr Preston of Gorton, a gentleman whose descendants still possess an estate in the county of Edinburgh, got possession of an arm of this saint; which relick he bequeathed to the church of Edinburgh. In gratitude for this donation, the magistrates granted a charter in favour of Mr Preston's heirs, by which the nearest heir of the name of Preston was entitled to carry it in all processions. At the same time, the magistrates obliged themselves to found an altar in the church of St Giles's, and appoint a chaplain for celebrating an annual mass for the soul of Mr Preston; and likewise, that a tablet, containing his arms, and an account of his pious donation, should be put up in the chapel.—St Giles's was first simply a parish church, of which the bishop of Lindisfarn or Holy Island, in the county of Northumberland, was patron. He was succeeded in the patronage by the abbot and canons of Dunfermline, and they by the magistrates of Edinburgh. In 1466, it was erected into a collegiate church by James III. At the Reformation, the church was, for the greater convenience, divided into several parts. The four principal ones are appropriated to divine worship, the lesser ones to other purposes. At the same time the religious utensils belonging to this church were seized by the magistrates. They were,—St Giles's arm, enshrined in silver, weighing five pounds three ounces and a half; a silver chalice, or communion cup, weighing 23 ounces; the great *eucharist* or communion cup, with *golden weike and stones;* two cruets of 25 ounces; a golden bell, with a heart, of four ounces and a half; a golden unicorn; a golden pix, to keep the host; a small golden heart, with two pearls; a diamond ring; a silver chalice, patine, and spoon, of 32 ounces and a half: a communion table cloth of gold brocade; *St Giles's coat*, with a little piece of red velvet which hung at his feet; a round silver *eucharist;* two silver censers, of three pounds fifteen ounces; a silver ship for incense; a large silver cross, with its base, weighing sixteen pounds thirteen ounces and a half; a triangular silver lamp; two silver candlesticks, of seven pounds three ounces; other two, of eight pounds thirteen ounces; a silver chalice gilt, of 20½ ounces; a silver chalice and cross, of 75 ounces; besides the priests robes, and other vestments, of gold brocade, crimson velvet embroidered with gold, and green damask.—These were all sold, and part of the money applied to the repairs of the church; the rest was added to the funds of the corporation.

In the steeple of St Giles's church are three large bells brought from Holland in 1621; the largest weighing 2000lb. the second 700, and the third 500. There are also a set of music bells, which play every day between one and two o'clock, or at any time in the case of rejoicings. The cathedral is divided by partition walls; and the principal apartments are used as four separate churches, which are distinguished by the names of the *New* or *High Church*, the *Old Church*, the *Tolbooth Church*, which is contiguous to the prison, and the *Little Church*, or *Haddow's Hole Church*, which derives its latter name from a gentleman who had been confined in it. The principal division is called the *High Church*, which has been elegantly repaired and new seated. There is a very elegant and finely ornamented seat for his majesty, with a canopy supported by four Corinthian pillars decorated in high taste. This seat is used by the king's commissioner during the time the General Assembly sits. On the right hand is a seat for the lord high constable of Scotland, whose office it is to keep the peace within doors in his majesty's presence; it being the duty of the earl marshal to do the same without. The seats belonging to the lords of council and session are on the right of the lord high constable; and on the left of the throne was a seat for the lord high chancellor of Scotland; but that office being now abolished, the seat is occupied by others. On the left of this sit the barons of exchequer; and, to the left of them, the lord provost, magistrates, and town council. The pulpit, king's seat, and galleries, are covered with crimson velvet with gold and silk fringes.

The aisle of St Giles's church is fitted up with seats for the general assembly, who meet here; and there is a throne for his majesty's commissioner, with a canopy of crimson silk damask, having the king's arms embroidered with gold, presented by the late Lord Cathcart to his successor in office. In this church is a monument dedicated to the memory of Lord Napier, baron of Merchiston, well known as the inventor of logarithms; a second, to the earl of Murray, regent of Scotland during the minority of James VI.; and a third, to the great marquis of Montrose.

4. *The Parliament House*, in the great hall of which the Scottish parliament used to assemble, is a magnificent building. The hall is 123 feet long and 42 broad, with a fine arched roof of oak, painted and gilded. In this the lawyers and agents now attend the courts, and single judges sit to determine causes in the first instance, or to prepare them for the whole court, who sit in an inner room formerly appropriated to the privy council. Since the division of the court into two bodies in 1808, an additional chamber has been built for the second division, on the west side of the large hall. The statue of President Forbes is now placed in this room. The statue of President Blair was placed in the chamber of the first division in 1818; and in the same year a marble statue of Lord Melville was erected in the outer or large hall. Two smaller apartments were built for the use of the judge ordinaries, at the south end of the large hall in 1820. In this hall, there are also full-length portraits of King William III. Queen Mary his consort, and Queen Anne, all done by Sir Godfrey Kneller; also of George I. John duke of Argyle, and Archibald duke of Argyle, by Mr Aikman of Cairney.

The Scottish Court of Exchequer occupies the new apartments above and to the east of the Parliament house, on the second floor. The valuable library of the Faculty of Advocates, occupies the ground floor of the Parliament house; but a splendid new room above that of the writers to the signet is preparing. Besides 30,000 printed volumes, it contains many scarce and valuable manuscripts, medals, and coins: here is also an entire mummy in its original chest, presented to the faculty (at the expence of 300l.) by the earl of Morton, late president to the Royal Society. As these rooms are immediately below the hall where the parliament sat, they are subject to a search by the lord high constable of Scotland ever since the gunpowder plot; and this is specified in the gift from the city to the faculty. This library was founded in the year 1682, by Sir George Mackenzie lord advocate. Among other privileges, it is entitled to a copy of every book entered in Stationers hall. Before the great door is a noble equestrian statue of Charles II. the proportions of which are reckoned exceedingly just. Over the entrance are the arms of Scotland, with Mercy and Truth on each side for supporters.

5. *The Tolbooth* was erected in 1561, not for the purposes merely of a prison, but likewise for the accommodation of the parliament and other courts; but it has since become so very unfit for any of these purposes, that it is now proposed to pull it down, and rebuild it in some other place, especially as it is very inconvenient in its present situation on account of its encumbering the streets. The provost is captain of the tolbooth, with a gaoler under him: and the latter has a monopoly of all the provisions for the prisoners; a circumstance which must certainly be considered as a grievous oppression, those who are least able to purchase them being thus obliged to do so at the highest price. There is a chaplain who has a salary of 30l. a year.

6. *Bridewell.* "On the Calton-hill, to be seen from the North Bridge, is a correction-house or *Bridewell*, built within these few years. It is a strong stone fabric. The principal part of the building is in the form of the letter D, with a house for the governor at some distance opposite to the northern or rectilineal part of it. The whole is surrounded by lofty walls, betwixt which and the house is an area laid out as a garden.

"This is said to be one of the most complete buildings of the kind in Britain. It consists of five stories; the uppermost of which is used as an hospital for sick prisoners and for store-rooms, &c. The other four stories are laid out in the following manner: A passage goes along the middle of the semicircular part of the building, with apartments on each hand. The apartments on the outward side of the curvature are smaller than those on the inner side, They are double the number, and are used as separate bed-chambers for each of the persons confined. The apartments on the inner side of the semicircle, of which there are thirteen in each story, are allotted for labour. They have a grate in front, and look into the inner court. Opposite to them, in the flat side of the building, is a dark apartment with narrow windows, from which, without being seen, the governor can see how the prisoners in the apartments for work are employed. The court, or space in the middle between the flat and semicircular part of the building, is roofed in at the top; and a great part of it is covered with glass, so as to light the whole. On the floor of the area is a stove, which during winter heats the whole apartments allotted to labour. There is also a pulpit, from which a chaplain preaches on Sundays; and the prisoners come into the front apartments to attend the service.

"The bed-chambers, looking outwards to the country, are lighted by a long narrow windows in each. The window is glazed. The frame in which the glass is fixed is of iron. It turns on pivots fixed at the top and bottom, so as to be opened and shut at pleasure. Each bed-chamber, which is about eight feet long by seven broad, is furnished with a bed and a bible. The frame of the bed is of iron, the bed consists of a straw mattress of the best quality. The whole floors and partitions of the building are of stone. No wood is used excepting for the doors of the apartments. There are cells, however, for solitary confinement for male criminals, in which the frames of the beds are of wood, lest, by breaking them, tools or weapons of a dangerous nature should be obtained. Large cisterns, supplied with water from the city's reservoir, are placed at the top of the house, from which the water is distributed to the different stories, and to a kitchen, washing house, and baths, on the ground floor.

"The institution is managed with great care. Besides being superintended by the magistrates of Edinburgh, the

the sheriff of the county once each month visits every corner of it. It is kept in a state of the most perfect cleanness. The prisoners, when first received, are clothed in a uniform belonging to the place; and their own clothes, after being cleaned, are preserved for them till their dismission. They remain during the day in the apartments allotted to labour, from which they are always dismissed as soon as it becomes dark to their bedchambers. The women spin, and the men pick oakum. Their food consists of oatmeal porridge with small beer, for breakfast and supper; and for dinner, of broth made of fat and vegetables, resembling what in Scotland is called *shearer's kail* (reaper's broth). Those that exert any tolerable industry are allowed bread to their broth, and also a larger portion of porridge. Only one death has occurred in the house during the last four years; and in that case the individual who died had come into Bridewell under a complication of diseases. In truth, the food, clothing, good air, and comfortable lodging, which are enjoyed in this place, are far superior to what the greater number of inhabitants can expect to obtain on their return to the world at large. To reside here, therefore, is a punishment from moral and not from physical causes; that is to say, because it is attended with the loss of freedom and of society, and because it is a place of infamy."

B ties of Sc and, vo . p. 4.

7. The society of Writers to the Signet have a very fine hall, 136 feet long, and adorned with a double row of Corinthian columns. It is in the new buildings at the north end of the Parliament House. The office of keeper of the signet is very lucrative, and he is allowed a depute and clerks under him. Before any one enters into this society he must attend the college for two years, and serve five years as an apprentice to one of the society. There is a very excellent library belonging to this hall, which is rapidly increasing. Each member of this society pays 100l. of apprentice fee, and 100l. when he enters.

8. *The Exchange* is a large and elegant building, with a court of about 90 feet square in the middle. On the north side are piazzas where people can walk under cover, the other three sides being laid out in shops; but the merchants have never made use of it to meet in, still standing in the street as formerly. The back part of the building formerly used for the general customhouse of Scotland, where the commissioners met to transact business, is now occupied by the offices for the city business, including the apartments of the town council. There are above 20 rooms for the different departments, to which the access is by a hanging stair 60 feet in height. In looking over the window before he ascends this stair, a stranger is surprised to find himself already 40 feet from the ground, which is owing to the declivity on which the Exchange is built. The fine mansion of Bellevue, north of the New Town, is now converted into apartments for the customhouse.

The Trustees Office for the improvement of fisheries and manufactures in Scotland is in the south-west corner of the Exchange; the fund under their management being part of the equivalent money given to Scotland at the Union. This is distributed in premiums amongst those who appear to have made any considerable improvement in the arts.

9. *The North Bridge*, which forms the main passage of communication betwixt the Old and New Towns, was founded, as has already been observed, in 1763, by Provost Drummond; but the contract for building it was not signed till August 21. 1764. The architect was Mr William Mylne, who agreed with the town council of Edinburgh to finish the work for 10,140l. and to uphold it for 10 years. It was also to be finished before Martinmas 1769: but on the 3d of August that year, when the work was nearly completed, the vaults and side walls on the south fell down, and five people were buried in the ruins. This misfortune was occasioned by the foundation having been laid, not upon the solid earth, but upon the rubbish of the houses which had long before been built on the north side of the High street, and which had been thrown out into the hollow to the northward. Of this rubbish there were no less than eight feet between the foundation of the bridge and the solid earth. Besides this deficiency in the foundation, an immense load of earth which had been laid over the vaults and arches in order to raise the bridge to a proper level, had no doubt contributed to produce the catastrophe above mentioned.—The bridge was repaired, by pulling down some parts of the side walls, and afterwards rebuilding them; strengthening them in others, with chain bars; removing the quantity of earth laid upon the vaults, and supplying its place with hollow arches, &c. The whole was supported at the south end by very strong buttresses and counterforts on each side; but on the north it has only a single support.—The whole length of the bridge, from the High street in the Old Town to Prince's street in the New, is 1125 feet; the total length of the piers and arches is 310 feet. The width of the three great arches is 72 feet each: of the piers, 13½ feet; and of the small arches, each 20 feet. The height of the great arches from the top of the parapet to the base, is 68 feet; the breadth of the bridge within the wall over the arches is 40 feet, and the breadth at each end 50 feet.—On the southern extremity of this bridge stands the General Post Office for Scotland; a neat plain building, with a proper number of apartments for the business, and a house for the secretary.

The communication betwixt the two towns by means of this bridge, though very complete and convenient for such as lived in certain parts of either, was yet found insufficient for those who inhabit the western districts. Another bridge being therefore necessary, it was proposed to fill up the valley occasionally with the rubbish dug out in making the foundations of houses in the New Town; and so great was the quantity, that this was accomplished so as to be fit for the passage of carriages in little more than four years and a half.

10. *The South Bridge*, is directly opposite to the other, so as to make but one street, crossing that called the *High Street* almost at right angles. It consists of 19 arches of different sizes: but only one of them is visible, viz. the large one over the Cowgate; and even this is small in comparison with those of the North Bridge, being no more than 30 feet wide and 31 feet high. On the south it terminates at the University on one hand, and the Royal Infirmary on the other. The Tron Church, properly called *Christ Church*, stands at the northern extremity, facing the High Street, and in the middle of what is now called *Hunter's Square*, in memory of the worthy chief magistrate who planned those improvements, but did not live to see them executed.

executed. On the west side of this square the Merchant Company have built a very handsome hall for the occasional meetings of their members. This bridge was erected with a design to give an easy access to the great number of streets and squares on the south side, as well as to the country on that quarter from whence the city is supplied with coals. The street on the top is supposed to be as regular as any in Europe; every house being of the same dimensions, excepting that between every two of the ordinary construction there is one with a pediment on the top, in order to prevent that sameness of appearance which would otherwise take place. So great was the rage for purchasing ground on each side of this bridge for building, that the areas sold by public auction at 50l. per foot in front. By this the community will undoubtedly be considerable gainers; and the proprietors hope to indemnify themselves for their extraordinary expence by the vast sale of goods supposed to attend the shops in that part of the town; though this seems somewhat more dubious than the former.

11. The *Concert Hall*, called also *St Cecilia's Hall*, stands in Niddery's street; and was built in 1762, after the model of the great opera theatre in Parma. The plan was drawn by Sir Robert Mylne, architect of Blackfriars bridge. The musical room is of an oval form, the ceiling being a concave elliptical dome, lighted from the top by a lanthorn. The society for which this hall was built has gradually fallen into neglect, and the tenement, after being occupied by a congregation of Baptists for some time, was sold to the grand lodge in 1812, and now bears the name of *Freemasons Hall.*

The Musical Society was first instituted in the year 1728. Before that time, several gentleman had formed a weekly club at a tavern kept by one Steil, a great lover of music, and a good singer of Scots songs. Here the common entertainment consisted in playing on the harpsichord and violin the concertos and sonatas of Handel, just then published. The meeting, however, soon becoming numerous, they instituted, in the year above mentioned, a society of 70 members, for the purpose of holding a weekly concert. The affairs of the society were regulated by a governor, deputy-governor, treasurer, and five directors, who were annually chosen by the members. The meetings were continued ever since that time on much the same footing as at first, and the number of members increased to 200. The weekly concerts were on Friday; the tickets being given gratis by the directors, and attention paid in the first place to strangers. Oratorios were occasionally performed throughout the year; and the principal performers had also benefit concerts. The band were excellent in their several departments; and several of the members being also good performers, took their part in the orchestra. There were always many applications on the occasion of a vacancy; and such was generally the number of candidates, that it was no easy matter to be admitted. This society, however, as already stated, has been long neglected, and the hall disposed of for other purposes.

12. *The University.* In the year 1581, a grant was obtained from King James VI. for founding a college or university within the city of Edinburgh; and the citizens, aided by various donations from well disposed persons, purchased a situation for the intended new college, consisting of part of the areas, chambers, and church of the collegiate provostry and prebends of the Kirk-a-field, otherwise called *Templum et Præfectura Sanctæ Mariæ in campis*, lying on the south side of the city. Next year, a charter of confirmation and erection was obtained also from King James VI. from which the college to be built did afterwards derive all the privileges of an university.

In 1583, the provost, magistrates, and council, the patrons of this new institution, prepared the place in the best manner they could for the reception of teachers and students; and in the month of October the same year, Robert Rollock, whom they had invited from a professorship in St Salvator's College in the university of St Andrew's, began to teach in the new college of Edinburgh. Other professors were soon after elected; and in the year 1586, Rollock was appointed principal of the college, and the following year also professor of divinity, immediately after he had confered the degree of M. A. on the students who had been under his tuition for four years. The offices of principal and professor of divinity remained united till the year 1620.

In the 1617, King James VI. having visited Scotland after his accession to the crown of England, commanded the principal and regents of the college of Edinburgh to attend him in Stirling castle; and after they had there held a solemn philosophical disputation in the royal presence, his majesty was so much satisfied with their appearance, that he desired their college for the future might be called *The College of King James*, which name it still bears in all its diplomas or public deeds.

For several years the college consisted only of a principal, who was also professor of divinity, with four regents or professors of philosophy. Each of these regents instructed one class of students for four years, in Latin, Greek, school logic, mathematics, ethics, and physics, and graduated them at the conclusion of the fourth course. A professor of humanity or Latin was afterwards appointed, who prepared the students for entering under the tuition of the regents; also a professor of mathematics, and a professor of Hebrew or oriental languages. It was not till about the year 1710 that the four regents began to be confined each to a particular profession; since which time they have been commonly styled *Professors of Greek, Logic, Moral Philosophy, and Natural Philosophy.*—The first medical professors instituted at Edinburgh, were Sir Robert Sibbald and Doctor Archibald Pitcairn, in the year 1685[*]. These, however, were only titular professors; and for 30 years afterwards, a summer lecture on the officinal plants, and the dissection of a human body once in two or three years, completed the whole course of medical education at Edinburgh. In 1720, an attempt was made to teach the different branches of physic regularly; which succeeded so well, that ever since, the reputation of the university as a school for medicine hath been constantly increasing, both in the island of Britain, and even among distant nations.

The college is endowed with a very fine library, founded in 1580 by Mr Clement Little advocate, who bequeathed it to the town council. They ordered a house to be built for it in the neighbourhood of St Giles's church, where it was for some time kept

under

---

[*] See C lege of P sicians.

under the care of the eldest minister of Edinburgh, but was afterwards removed to the college. This collection is enriched, as well as others of a similar kind, by receiving a copy of every book entered in Stationers hall, according to the statute for the encouragement of authors. Besides this, the only fund it has is the money paid by all the students at the university, except those of divinity, upon their being matriculated; and a sum of 5l. given by each professor at his admission. The amount of these sums is uncertain, but has been estimated at about 150l. annually. The students of divinity, who pay nothing to this library, have one belonging to their own particular department.

Here are shown two skulls, one almost as thin as paper, pretended to be that of the celebrated George Buchanan; and, by way of contrast, another said to have been that of an idiot, and which is excessively thick. Here also are preserved the original protest against the council of Constance for burning John Huss and Jerome of Prague in 1417; the original contract of Queen Mary with the dauphin of France, and some valuable coins and medals. There are also several portraits; particularly of Robert Rollock the first principal of the university, King James VI. John Napier the inventor of logarithms, John Knox, Principal Carstairs, Mr Thomson the author of the Seasons, &c. The museum contains a good collection of natural curiosities, the number of which is daily increasing. The anatomical preparations are worth notice, as are also those belonging to the professor of midwifery.

The celebrity of this college has been greatly owing to the uniform attention of the magistracy in filling up the vacant chairs with men of known abilities in their respective departments.

The university of Edinburgh "having been instituted after the Reformation, among a frugal people that had no love for ecclesiastical dignities, it differs greatly from the wealthy foundations which receive the name of *universities* and *colleges* in England, or in the catholic countries of the continent of Europe. The university of Edinburgh consists of a single college, which enjoys the privilege of conferring degrees. It consists of a principal, with a salary of 111l. 2s. 0$\frac{2}{3}$d. whose office is in a great measure nominal, and of a professor in each of the following departments:

Faculty of Theology.

	Salaries.		
Divinity	L.161	2	0$\frac{2}{3}$
Church history	100	0	0
Oriental languages	119	12	8

Faculty of Law.

Law of Nature and Nations.—Salary variable, but always above	300	0	0
Civil Law	100	0	0
Scots Law	100	0	0
Civil History and Antiquities	100	0	0

Faculty of Medicine.

	Salaries.		
Anatomy and Surgery	50	0	0
Practice of Medicine		—	—
Botany	77	15	6$\frac{2}{3}$
Materia Medica		—	—
Chemistry		—	—
Theory of Medicine		—	—
Midwifery		—	—
Clinical Surgery	100	0	0
Military Surgery	100	0	0
Medical Jurisprudence	100	0	0
Natural History	70	0	0

Faculty of Arts.

Moral Philosophy	102	4	5$\frac{1}{3}$
Rhetoric and Belles Lettres	70	0	0
Greek	52	4	5$\frac{1}{3}$
Latin	52	10	0
Natural Philosophy	52	4	5$\frac{2}{3}$
Mathematics	113	6	8
Practical Astronomy	100	0	0
Logic	52	4	5$\frac{1}{3}$
Agriculture	50	0	0

"Of these, the professors of church history and natural history, botany, clinical and military surgery, medical jurisprudence, astronomy, law of nature and nations, and rhetoric, are in the gift of the crown. The professor of agriculture was nominated by Sir William Pultney, founder of the institution. The remaining chairs are in the gift of the town-council of Edinburgh. Besides these classes here enumerated, the medical professors alternately give clinical lectures upon the cases of the patients in the royal infirmary of Edinburgh."

Beauties of Scotland, I. 45.

The university is now attended by not less than 2000 students in the different departments of science and literature.

The old buildings being very mean, and unfit for the reception of so many professors and students, and quite unsuitable to the dignity of such a flourishing university, as well as inconsistent with the improved state of the city, the Lord Provost, Magistrates, and Council, set on foot a subscription for erecting a new structure, according to a design of Robert Adam, Esq. architect. Part of the old fabric has in consequence been pulled down, and the new building is already in considerable forwardness. The foundation stone was laid on Monday the 16th of November, with great solemnity, by the Right Hon. Francis Lord Napier, grand master mason of Scotland, in the presence of the Right Hon. the Lord Provost, Magistrates, and Town Council of the city of Edinburgh, with the principal, professors, and students of the university of Edinburgh, a number of nobility and gentry, and the masters, officers, and brethren of all the lodges of free masons in the city and neighbourhood, who marched in procession from the Parliament House down the High street. After the different masonic ceremonials were performed, two crystal bottles, cast on purpose at the glass house of Leith, were deposited in the foundation stone. In one of these were put different coins of the present reign, each of them being previously enveloped in crystal, in such an ingenious manner, that the legend on the coins could be distinctly read without breaking the crystal. In the other bottle were deposited seven rolls of vellum, containing a short account of the original foundation and present state of the university, together with several other papers, in particular the different newspapers, containing advertisements relative to the college, &c. and a list of the names of the principal and professors, also of the present lord provost and magistrates, and officers of the

the grand lodge of Scotland. The bottles being carefully sealed up, were covered with a plate of copper wrapt in block tin; and upon the under side of the copper were engraved the arms of the city of Edinburgh and the university; likewise the arms of the Right Hon. Lord Napier, grand master mason of Scotland. Upon the upper side, a Latin inscription, of which the following is a copy:

ANNUENTE DEO OPT. MAX.
REGNANTE GEORGIO III. PRINCIPE
MUNIFICENTISSIMO;
ACADEMIÆ EDINBURGENSIS
ÆDIBUS,
INITIO QUIDEM HUMILLIMIS,
ET JAM, POST DUO SECULA, PENE RUINOSIS;
NOVI HUJUS ÆDIFICII,
UBI COMMODITATI SIMUL ET ELEGANTIÆ,
TANTO DOCTRINARUM DOMICILIO
DIGNÆ,
CONSULERETUR,
PRIMUM LAPIDEM POSUIT,
PLAUDENTE INGENTI OMNIUM ORDINUM
FREQUENTIA,
VIR NOBILISSIMUS
FRANCISCUS DOMINUS NAPIER,
REIPUB. ARCHITECTONICÆ APUD SCOTOS
CURIO MAXIMUS:
XVI. KAL. DECEMB.
ANNO SALUTIS HUMANÆ MDCCLXXXIX.
ÆRÆ ARCHITECTONICÆ IↃↃIↃↃCCLXXXIX.
CONSULE THOMA ELDER,
ACADEMIÆ PRÆFECTO GULIELMO
ROBERTSON,
ARCHITECTO ROBERTO ADAM.
Q. F. F. Q. S.

The building went on rapidly for some time; but the funds being far from sufficient for the extent of the plan, it was necessarily stopped, and remained for many years a useless pile resembling a ruin. At length in 1815, by the exertions of Sir John Marjoribanks, member for the city, a grant of 10,000l. per annum for seven years was obtained from parliament, to be expended under the direction of commissioners appointed in the bill. With this aid the western side of the building has been entirely finished, and great progress is making with the other parts. The east and west fronts extend 255 feet, and the south and north 358. A new plan was adopted, designed by Mr Playfair, and modifying in some degree that of Mr Adams. The library, occupying the south side of the square, is to be divided into two floors, the lower of which is separated into five compartments. The upper floor will form one magnificent saloon. The museum of natural history, which occupies the west side of the area, and is now finished, consists of two floors 90 feet long, and fitted in the most tasteful and beautiful style. The fine collection it contains is in excellent order, and admirably arranged.

The botanical garden belonging to the university is situated at the distance of about a mile, on the road between Edinburgh and Leith. It consists of about five acres of ground; and is furnished with a great variety of plants, many of them brought from the most distant quarters of the globe. The professor is botanist to the king, and receives a salary of 120l. annually for the support of the garden. A monument to the memory of the celebrated botanist Linnæus, was erected here by the late Dr Hope, who first planned the garden, and brought it to perfection.

The university of Edinburgh, like the others in this kingdom, sends one member to the General Assembly of the church of Scotland; and the widows of the professors have a right to the funds of those of ministers, the professors being trustees on that fund along with the presbytery of Edinburgh.

"In the year 1772, the Board of Trustees for the encouragement of Manufactures, &c. in Scotland, appointed Mr Alexander Runciman, painter, to teach 20 boys or girls drawing, allowing him a yearly salary of 120l. He was succeeded in this office by Mr Allan; to whom followed Mr Graham, who was succeeded by Mr A. Wilson in 1818. This institution being appropriated for the use of manufactures, is not properly a school of painting. In this last art, however, very eminent teachers are to be found in Edinburgh, but no public establishment exists for its encouragement.

"Near the University there is also a *Riding School*, called the *Royal Academy for teaching Exercises*. The teacher of this academy receives a salary of 200l. a-year from the crown, and is accommodated with a riding school of 120 feet in length by 40 in breadth, and stables to a considerable extent.

"In Edinburgh there is established, in imitation of that in London, a *Royal Society*, which has published some volumes of transactions. It contains a number of members of great respectability; but in Edinburgh men of letters are apt to be extremely jealous and unsociable with regard to each other. This illiberality of temper prevents the Royal Society from being of much value. Great numbers of the most accomplished and active men of letters are unconnected with it; while it contains others who have been introduced to it merely by their rank in the world, or the circumstance of having attained to distinguished literary situations by the patronage of men in power, who of late years have, in this country, displayed little of that anxiety to discriminate and bring into notice men of literary talents, which once formed the most honourable characteristic of the nobles and statesmen of Scotland." Beau of Scotl I. 59.

13. *The Royal Infirmary* was first thought of by the College of Physicians in 1725. A fishing company happening to be dissolved at that time, the partners contributed some of their stock towards the establishment of the Infirmary. A subscription was also set on foot, and application made to the General Assembly to recommend the same throughout their jurisdiction. This was readily complied with, and the assembly passed an act for that purpose; but very little regard was paid to it by the clergy. Notwithstanding this, however 2000l. being procured, a small house was opened for the reception of the sick poor in August 1729. In 1736, the contributors towards the Infirmary were erected into a body corporate by royal statute; and after this the contributions increased very considerably: by which means the managers were enabled to enlarge their scheme from time to time; and at last to undertake the present magnificent structure, the foundation of which was laid in 1738. During 25 years, when this institution was in its infancy, Lord Hopetoun bestowed upon it an annuity of 400l. In 1750, Doctor Archibald Ker bequeathed to this incorportion 200l. a-year in the island of Jamaica. In 1755, the lords

lords of the treasury made a donation to it of 8000l. which had been appointed for the support of invalids. In return for this, the managers of the Infirmary constantly keep 60 beds in readiness for the reception of sick soldiers. This year also sick servants began to be admitted into the Infirmary, and a ward was fitted up for their reception.

This institution, however, was more indebted to George Drummond, Esq. than to any other person. He was seven times chosen lord provost of Edinburgh; and always directed his attention to the improvement of the city, particularly to that of the Royal Infirmary. So sensible were the managers of their obligations to him, that, in their hall, they erected a bust of him with this inscription, "George Drummond, to whom this country is indebted for all the benefit which it derives from the Royal Infirmary."—In 1748, the stock of the Infirmary amounted to 5000l.; in 1755, to 7076l. besides the estate left by Doctor Ker; in 1764, to 23,426.; and in 1778, to 27,074l.

The Royal Infirmary is attended by two physicians chosen by the managers, who visit their patients daily in presence of the students. All the members of the College of Surgeons were obliged to attend in rotation, according to seniority. If any surgeon declined attendance, he was not allowed to appoint a depute; and the patients were committed to the care of one of four assistant surgeons, chosen annually by the managers: this was formerly the mode of attendance, but the managers have in consequence of a decision of the high court of judicature assumed to themselves the sole right of electing the surgeons.—From the year 1762 to 1769, there were admitted 6261 patients; which number added to 109 who were in the hospital at the commencement of the year 1762, made, in all, 6370. Of these, 4395 were cured; 358 died: the rest were either relieved, dismissed incurable, for irregularities, or by their own desire, or remained in the hospital.—From 1770 to 1775, the patients annually admitted into the Infirmary were, at an average, 1567; of whom 63 died. In 1766, there were admitted 1668, of whom 57 died; and in 1777, the number admitted was 1593, and of deaths 52. In the year 1786, there were admitted 1822 patients: Of these 1354 were cured; 166 relieved; 84 died. In 1818 there were in the Infirmary and in the Fever Hospital at Queensberry House, 3453 patients, of whom 189 only died.

The building consists of a body and two wings, each of them three stories high, with an attic story and garret, and a very elegant front. The body is 210 feet long, and 36 broad in the middle, but at the ends only 24 feet broad. There is a bust of King George II. in a Roman dress, above the great door. The wings are 70 feet long, and 25 broad. In the centre is a large staircase, so wide that sedan chairs may be carried up. In the different wards, 228 patients may be accommodated, each in a different bed. There are cold and hot baths for the patients, and also for the citizens; and to these last the patients are never admitted.

Besides the apartments necessary for the sick, there are others for the officers and servants belonging to the house. There are likewise rooms for the managers, a consulting room for the physicians and surgeons, a waiting room for the students, and a theatre that will hold upwards of 200 people, for performing chirurgical operations. There is a military ward, supported by the interest of the 8000l. already mentioned; and in consequence of which a small guard is always kept at the Infirmary. The wards for sick servants are supported by collections at the church doors. Besides the surgical attendance already mentioned, there are two physicians belonging to the house, who are elected by the managers, and have a salary: there is likewise a house surgeon and apothecary. Students who attend the Infirmary, paid formerly 3l. 3s. which is increased to 5l. 5s. annually, which brings in a considerable revenue towards defraying the expence of the house. Two wards are set apart for the patients whose cases are supposed to be most interesting; and the medical professors in the university give clinical lectures upon them by rotation. In 1818, when typhus fever was very prevalent, Queensberry House was set apart as a fever hospital, and it is still in use for this purpose.

14. *The Public Dispensary* was founded by Dr Duncan in 1776, for the poor whose diseases are of such a nature as to render their admission into the Infirmary either unnecessary or improper. Here the patients receive advice gratis four days in a week; a register is kept of the diseases of each, and of the effects produced by the medicines employed. All patients not improper for dispensary treatment are admitted on the recommendation of the elder or church warden of the parish where they reside. The physicians officiate and give lectures gratis; so that the apothecary who lodges in the house, and the medicines, are the only expences attending this useful institution. The expence of the whole is defrayed by public contributions, and from a small annual fee paid by the students who attend the lectures. It is under the direction of a president, two vice-presidents and 20 directors elected annually from among the contributors. One guinea entitles a contributor to recommend patients and be a governor for two years, and five guineas gives the same privilege for life. Under the same management there is an institution for the gratuitous inoculation for the cowpox.

15. *The High School.* The earliest institution of a grammar school in Edinburgh seems to have been about the year 1519. The whole expence bestowed upon the first building of this kind amounted only to about 40l. sterling. Another building, which had been erected for the accommodation of the scholars in 1578, continued, notwithstanding the great increase of their number, to be used for that purpose till 1777. The foundation of the present new building was laid on the 24th of June that year by Sir William Forbes, Grand Master of the Free Masons. The total length of this building is 120 feet from south to north; the breadth in the middle 36, at each end 38 feet. The great hall where the boys meet for prayers, is 68 feet by 30. At each end of the hall is a room of 32 feet by 20, intended for libraries. The building is two stories high, the one 18, the other 17, feet in height. The expence of the whole was reckoned at 4000l.

There is a rector and four masters, who teach about 800 scholars annually. The salaries are trifling, and the fees depend upon the reputation they have obtained for teaching. There is a janitor, whose place is supposed to be worth about 70l. a-year. His business is to take care of the boys on the play ground; and there is a woman who lives on the spot as under-janitor, whose place may be worth about 25l. annually. There is a library, but not large, as each of the boys pays only one shilling annually to its support.

There are four established English schools in Edinburgh, the masters of which receive a small salary, upon express condition that they shall not take above a limited sum per quarter from any of their scholars. There are likewise many other private schools in Edinburgh for all languages; and, in general, every kind of education is to be had here in great perfection and at a very cheap rate.

16. *The Mint* is kept up by the articles of Union, with all the offices belonging to it, though no money is ever struck here. It stands in the Cowgate, a little to the west of the English church, but is in a ruinous state, though still inhabited by the different officers, who have free houses; and the bellman enjoys his salary by regularly ringing the bell. This place, as well as the abbey of Holyroodhouse, is an asylum for debtors.

17. *The English Chapel* stands near the Cowgate Port, and was founded on the 3d of April 1771. The foundation stone was laid by General Oughton. It is a plain handsome building, neatly fitted up in the inside, and somewhat resembling the church of St Martin's in the Fields, London. It is 90 feet long, 75 broad, and ornamented with an elegant spire of considerable height. This building was sold to a congregation of dissenters in 1817, when the Episcopalian congregation removed to their new chapel in York Place.

18. *St Paul's Chapel* in York Place was founded in 1816, and completed in 1818. It is built in the Gothic style as it prevailed in the reign of Henry VI. It consists of a nave with four octagon towers at the angles. The outside length is 122 feet, and breadth 73. The ceiling of the nave is a flat Gothic arch, covered with ornamented tracery mouldings, as are also the ceilings under the side aisles. The great eastern window is fitted up with painted glass.

19. *St John's Chapel* stands at the west end of Prince's Street, on the south side. The architecture is of the florid Gothic. It is 113 feet long by 62 in breadth. The height of the great eastern window, which is finished with stained glass, is 30 feet. The wall is supported by buttresses, and adorned at top by minarets and niches with tracery work. It has a square tower at the west end 120 feet high. Around it is a terrace, covering arched burial vaults. There is no gallery, but two rows of very light Gothic columns support the roof. This chapel was begun in 1816, and finished in 1819, at an expence exceeding 15,000l. sterling.

20. *St George's Chapel*, which stands in York Place, is small, but finished in a very neat style.

21. *The Roman Catholic Chapel* stands at the eastern termination of York Place, close by the Pantheon. The body of the building is plain, but it is ornamented with a very handsome Gothic façade.

22. *Heriot's Hospital* owes its foundation to George Heriot, goldsmith to James VI. who acquired by his business a large fortune. At his death, he left the magistrates of Edinburgh 23,625l. 10s. "for the maintenance, relief, and bringing up of so many poor and fatherless boys, freemen's sons of the town of Edinburgh," as the above sum should be sufficient for. This hospital is finely situated on the west end of the south ridge, almost opposite to the castle, and is the most magnificent building of the kind in Edinburgh. It was founded in July 1628, according to a plan (as is reported) of Inigo Jones; but the work being interrupted by the civil wars, it was not finished till the year 1650. The expence of the building is said to have been upwards of 30,000l. (A): and the hospital is now possessed of an income of about 5000l. a-year; though this cannot be absolutely ascertained, as the rents are paid in grain, and of course must be fluctuating.

It stands on a rising ground to the south-west of the city, and is a square of 162 feet without, having a court 94 feet square in the inside, with piazzas on three of the sides. There is a spire with a clock over the gateway, and each corner of the building is ornamented with turrets; but notwithstanding the magnificent appearance of the outside, the inner part is far from being convenient. There is a statue of the founder over the gateway, in the dress of the times, and a very good painting of him in the governors room, with a picture of the late treasurer Mr Carmichael. There is a chapel 61 feet long and 22 broad, which is now repairing in such a manner as will make it worthy of notice. When Cromwell took possession of Edinburgh after the battle of Dunbar, he quartered his sick and wounded soldiers in this hospital. It was applied to the same purpose till the year 1658, when General Monk, at the request of the governors, removed the soldiers; and on the 11th of April 1659, it was opened for the reception of boys, 30 of whom were admitted into it. The August after, they were increased to 40; and in 1661, to 52. In 1753 the number was raised to 130, and in 1763, to 140. In 1819 the number was 180.—In this hospital the boys are instructed in reading, writing, arithmetic, and a knowledge of the Latin tongue. With such as choose to follow any kind of trade, an apprentice fee of 30l. is given when they leave the hospital; and those who choose an academical education, have an annuity of 10l. a-year bestowed on them for four years. The whole is under the oversight of the treasurer, who has under him a house governor, housekeeper, and schoolmasters.

(A) It is to be observed, that money then bore 10 per cent. interest.—The above sums are taken from Mr Arnot's History of Edinburgh, who subjoins the following note. "Where Maitland had collected his most erroneous account of George Heriots effects we do not know. He makes the sum received, out of Heriot's effects, by the governors of the hospital, to be 43,608l. 11s. 3d. being almost double of what they really got. This blunder has been the cause of many unjust murmurings against the magistrates of Edinburgh, and even the means of spiriting up lawsuits against them."

23. *Watson's Hospital* has its name from the founder George Watson, who was at first clerk to Sir William Dick provost of Edinburgh in 1676, then accountant of the bank of Scotland; after that he became receiver of the city's impost on ale, treasurer to the Merchants Maiden Hospital, and to the Society for propagating Christian knowledge. Dying a bachelor in 1723, he left 12,000l. for the maintenance and education of the children and grandchildren of decayed members of the merchant company of Edinburgh. The scheme, however, was not put into execution till the year 1738, when the sum originally left had accumulated to 20,000l. The present building was then erected, in which 70 boys are maintained and educated (1819). It is much less magnificent than Heriot's Hospital, but the building is far from being despicable. It stands to the southward of the city at a small distance from Heriot's Hospital, and was erected at the expence of 5000l.: its present revenue is about 1700l. It is under the management of the master, assistants, and treasurer of the Merchant Company, four old bailies, the old dean of guild, and the two ministers of the Old church. The boys are genteelly clothed and liberally educated. Such as choose an university education are allowed 10l. per annum for five years: those who go to trades have 20l. allowed them for their apprentic fee, and at the age of 25 years, if they have behaved properly, and not contracted marriage without consent of the governors, they receive a bounty of 50l. The boys are under the immediate inspection of the treasurer, schoolmaster, and housekeeper.

24. *The Merchants Maiden Hospital* was established by voluntary contribution about the end of the last century, for the maintenance of young girls, daughters of the merchants burgesses of Edinburgh. The governors were erected into a body corporate, by act of parliament, in 1707. The annual revenue amounts to 3000l. Eighty girls are maintained in it; who, upon leaving the house, receive 9l. 6s. 8d. The old building in Bristo street having become inadequate, a new one was erected in Lauriston lane, and was finished in 1819. It is 180 feet in length, by 60 in depth, and is in the Grecian style.

25. *The Trades Maiden Hospital* was founded in the year 1704 by the incorporations of Edinburgh, for the maintenance of the daughters of decayed members, on a plan similar to that of the Merchants hospital. To this, as well as to the former, one Mrs Mary Erskine, a widow gentlewoman, contributed so liberally, that she was by the governors styled *joint foundress* of the hospital. Fifty girls are maintained in the house, who pay of entry money 1l. 13s. 4d.; and, when they leave it, receive a bounty of 5l. 11s. $1\frac{1}{2}$d. The revenues are estimated at 600l. a-year.

26. *The Orphan Hospital* was planned in 1732, by Andrew Gairdner merchant, and other inhabitants. It was promoted by the society for propagating Christian knowledge, by other societies, by voluntary subscriptions, and a collection at the church doors.—In 1733, the managers hired a house, took in 30 orphans, maintained them, gave them instructions in reading and writing, and taught them the weaving business. In 1735, they were erected into a body corporate by the town of Edinburgh: and, in 1742, they obtained a charter of erection from his late majesty, appointing most of the great officers of state in Scotland, and the heads of the different societies in Edinburgh, members of this corporation; with powers to them to hold real property to the amount of 1000l. a-year. The revenue is inconsiderable; but the institution is supported by the contributions of charitable persons. Into this hospital orphans are received from any part of the kingdom. None are admitted under seven, nor continued in it after 14 years of age.

The orphan hospital is situated to the east of the North bridge; and is a handsome building, consisting of a body and two wings, with a neat spire, furnished with a clock and two bells. The late worthy Mr Howard admits, that this institution is one of the most useful charities in Europe, and is a pattern for all institutions of the kind. The funds have been considerably increased, and the building greatly improved, through the attention and exertions of Mr Thomas Tod formerly treasurer.

27. *The Trinity Hospital.* This was originally founded and amply endowed by King James II.'s queen. At the Reformation it was stripped of its revenues; but the regent afterwards bestowed them on the provost of Edinburgh, who gave them to the citizens for the use of the poor. In 1585, the town council purchased from Robert Pont, at that time provost of Trinity college, his interest in these subjects; and the transaction was afterwards ratified by James VI. The hospital was then repaired, and appointed for the reception of poor old burgesses, their wives and unmarried children, not under 50 years of age. In the year 1700, this hospital maintained 54 persons; but, since that time, the number has decreased.—The revenue consists in a real estate of lands and houses, the gross rents of which are 762l. a year, and 5500l. lent out in bonds at 4 per cent.

This hospital is situated at the foot of Leith wynd, The inmates are supplied with roast or boiled meat every day for dinner, have money allowed them for clothes, and likewise a small sum for pocket money. There is a small library for their amusement, and they have a chaplain to say prayers. The funds are under the management of the town council. The number of persons on the establishment in 1819 was 80 men, and 30 women, besides 93 out-pensioners who receive each 6l. per annum. None are received under fifty years of age.

28. *The Charity Workhouse* was erected in 1743 by voluntary contribution. It is a large plain building, on the south side of the city. Here the poor are employed, and are allowed twopence out of every shilling they earn. The income of the house for the year ending 1st July 1818, including 2000l. of borrowed money, amounted to 10,309l. 14s. 7d. while the expenditure for the same period was 10,857l. 4s. 7d. The number of persons in the house in 1818 was 890, but considerable sums are paid to out-pensioners. The average expence of maintaining each person in the house is 8l. 8s. 6d. The only permanent fund for defraying this expence is a tax of five per cent. on the valued rents of the city. The rest is derived from collections at the church doors and voluntary contributions; but as these always fall short of what is requisite, recourse must frequently be had to extraordinary collections. The sum arising from the rents of the city, however, is

constantly increasing; but the members of the college of justice are exempted from the tax.

29. "To the south-west of the castle, near a suburb called the *Wrights Houses*, on the site of a very ancient building, which was demolished to make way for it, *Gillespie's Hospital* has lately been erected. Its appellation is derived from the founder, an eminent manufacturer of snuff in Edinburgh. It is intended for the support of aged persons; and those bearing the name of the founder are preferred. It is a neat stone building, executed in a style of moderate expence, with a small tower in the centre and a parapet, and Gothic turrets at suitable distances around the roof.

"Besides these there are to be found in Edinburgh several charitable establishments, which, though not furnished with costly buildings, are not of a less benevolent or valuable nature. Of these, one of the most distinguished is the Hospital or Workhouse, or *Asylum*, as it is called, *for the Industrious Blind*; which is supported by the contributions of charitable persons, and by the price of the articles manufactured in it. Here the blind are taught such trades as may enable them to earn a subsistence, or at least aid them in contributing to their own support. They manufacture baskets, matts, &c.; and some of them have been taught to act as weavers, for which purpose they use the fly-shuttle.

"The *Magdalene Asylum* also deserves notice; in which a most laudable attempt has of late years been made, by a benevolent society, to reclaim, from vice and misery, women who have degraded themselves by public prostitution, but who think fit to retire thither with the view of abandoning their mode of life, and of supporting themselves by industry. This institution is managed with a degree of care and delicacy which does the highest credit to its patrons. The objects of this charity are kept concealed: they reap the fruits of their own labour; and every effort is made to procure employment for them. In particular, needle-work of all sorts is executed in it in the neatest manner; and linen is washed, at moderate prices, for such persons in the city as think fit to transmit these articles to the society.

"Besides all these charities, there is an hospital in the city for *Lying-in Women*, under the care of the professor of midwifery: which is an institution analogous to that of the Royal Infirmary.—There is a *Society for the Relief of the Destitute Sick*, which has received considerable public countenance, though it has no appropriate building or local establishment.—An institution of a peculiar nature, not unconnected with the present subject, called the *Repository*, ought not to pass unnoticed. It is a shop or ware-room on South Bridge Street, to which ladies in straitened circumstances have an opportunity of sending for sale curious, beautiful, or useful articles of needle-work, with the price affixed. When a purchaser has been found for the goods, the proceeds are transmitted in such a manner as to prevent its being known to the public by whom the articles were prepared. This institution has been promoted by the duchess of Buccleugh and many other persons of rank."

Beauties of Scotland, i. 69.

There are two other charity workhouses in the suburbs, much on the same plan with that now described: one in the Canongate, and the other in St Cuthbert's or West kirk parish.

To this account of the charitable establishments in Edinburgh, we shall add that of some others; which, though not calculated to decorate the city by any public building, are perhaps no less deserving of praise than any we have mentioned. The first is that of Captain William Horn; who left 3500l. in trust to the magistrates, the annual profits to be divided on Christmas day to poor out-day labourers, who must at that season of the year be destitute of employment; five pounds to be given to those who have large families, and one half to those who have smaller.

Another charity is that of Robert Johnston, LL.D. of London, who in 1640 left 3000l. to the poor of this city; 1000l. to be employed in setting them to work, another 1000l. to clothe the boys in Heriot's Hospital, and the third 1000l. to bursars at the university.

About the beginning of this century John Strachan left his estate of Craigcrook, now upwards of 300l. a-year in trust to the presbytery of Edinburgh, to be by them disposed of in small annual sums to poor old people not under 65 years of age, and to orphans not above 12.

There is besides a society for the support of the industrious poor, another for the indigent sick, and there are also many charity schools.

Having thus given an account of the most remarkable edifices belonging to Old Edinburgh, we shall now proceed to those of the New Town. This is terminated on the east side by the Calton hill, round which there is a pleasant walk, and which affords one of the finest prospects that can be imagined, varying remarkably almost at every step. On this hill is a burying ground, which contains a fine monument to the memory of David Hume the historian.—On the top is an observatory, the scheme for building which was first adopted in the year 1736; but the disturbance occasioned by the Porteous mob prevented any thing from being done towards the execution of it at that time. The earl of Morton afterwards gave 100l. for the purpose of building an observatory, and appointed Mr M'Laurin professor of mathematics, together with the principal and some professors of the university, trustees for managing the sum. Mr M'Laurin added to the money above mentioned the profits arising from a course of lectures which he read on experimental philosophy; which, with some other small sums, amounted in all to 300l.; but Mr M'Laurin dying, the design was dropped.—Afterwards the money was put into the hands of two persons who became bankrupt; but a considerable dividend being obtained out of their effects, the principal and interest, about the year 1776, amounted to 400l. A plan of the building was made out by Mr Craig architect; and the foundation stone was laid by Mr Stodart, lord provost of Edinburgh, on the 25th of August 1776. About this time, however, Mr Adam architect happening to come to Edinburgh, conceived the idea of giving the whole the appearance of a fortification, for which its situation on the top of the Calton hill was very much adapted. Accordingly a line was marked out for enclosing the limits of the observatory with a wall constructed

structed with buttresses and embrasures, and having Gothic towers at the angles. Thus the money designed for the work was totally exhausted, and the observatory still remains unfinished; nor is there any appearance of its being soon completed either by voluntary subscription or any other way.

30. Proceeding to the westward, the first remarkable building is the *Theatre*, which stands opposite to the Register Office, in the middle of Shakespeare Square. The building is plain on the outside, but elegantly fitted up within, and is generally open three days in the week, and when full will draw about 150l. a-night; so that the manager generally finds himself well rewarded when he can procure good actors.

Entertainments of the dramatic kind came very early into fashion in this country. They were at first only representations of religious subjects, and peculiarly designed to advance the interests of religion; the clergy being the composers, and Sunday the principal time of exhibition. In the 16th century, the number of playhouses was so great, that it was complained of as a nuisance, not only in Edinburgh, but throughout the kingdom. They soon degenerated from their original institution; and the plays, instead of being calculated to inspire devotion, became filled with all manner of buffoonery and indecency.—After the Reformation, the Presbyterian clergy complained of these indecencies; and being actuated by a spirit of violent zeal, anathematised every kind of theatrical representation whatever. King James VI. compelled them to pass from their censures against the stage; but in the time of Charles I. when fanaticism was carried to the utmost length at which perhaps it was possible for it to arrive, it cannot be supposed that stage plays would be tolerated.—It seems, however, that amusements of this kind were again introduced at Edinburgh about the year 1684, when the duke of York kept his court there. His residence at Edinburgh drew off one half of the London company, and plays were acted in Edinburgh for some little time. The misfortunes attending the duke of York, however, and the establishment of the Presbyterian religion (the genius of which is unfavourable to amusements of this kind), soon put a stop to the progress of the stage, and no theatrical exhibition was heard of in Edinburgh till after the year 1715. The first adventurer was Signora Violante, an Italian, remarkable for feats of strength, tumbling, &c. In this way she first exhibited in a house at the foot of Carruber's close, which has since been employed by different sectaries for religious purposes. Meeting with good success, she soon invited a company of comedians from London; and these being also well received, Edinburgh continued for some years to be entertained with the performances of a strolling company, who visited it annually. Becoming at last, however, obnoxious to the clergy, they were in 1727 prohibited by the magistrates from acting within their jurisdiction. But this interdict was suspended by the court of session, and the players continued to perform as usual.

Still, however, theatrical amusements were but rare. The town was visited by itinerant companies only once in two or three years. They performed in the Taylor's Hall in the Canongate; which, when the house was full, would have drawn (at the rate of 2s. 6d. for pit and boxes, and 1s. 6d. for the gallery) 40l. or 45l. a night. About this time an act of parliament was passed, prohibiting the exhibition of plays, except in a house licensed by the king. Of this the presbytery of Edinburgh immediately laid hold; and at their own expence brought an action on the statute against the players. The cause was by the court of session decided against the players; who thereupon applied to parliament for a bill to enable his majesty to license a theatre in Edinburgh. Against this bill petitions were presented in 1739 to the house of commons by the magistrates and town council, the principal and professors of the university, and the dean of guild and his council; in consequence of which, the affair was dropped. All this opposition, however, contributed in reality to the success of the players; for the spirit of party being excited, a way of evading the act was easily found out, and the house was frequented more than usual, insomuch that Taylor's Hall was found insufficient to contain the number of spectators.

The comedians now fell out among themselves, and a new playhouse was erected in the Canongate in the year 1746. The consequence of this was, that the old one in Taylor's Hall became entirely deserted, and through bad conduct the managers of the new theatre soon found themselves greatly involved. At last, a riot ensuing through dissensions among the performers, the playhouse was totally demolished.—When the extension of the royalty over the spot where the New Town is built was obtained, a clause was likewise added to the bill, enabling his majesty to license a theatre in Edinburgh. This was obtained, and thus the opposition of the clergy for ever silenced. Mr Jackson's patent having expired in 1809, it was renewed in the name of trustees as formerly, and acquired by Mr Henry Siddons. Mr Siddons on his becoming manager, fitted up Corri's rooms as a theatre, in which performances were continued for two seasons. Mr Siddons then acquired the property of the old theatre, on becoming bound to pay 2000l. annually, for 21 years from the date of the patent.

Not far from this building, an amphitheatre was opened in 1790, on the road to Leith, for equestrian exhibitions, pantomime entertainments, dancing, and tumbling. The circus was 60 feet in diameter; and in the forenoon ladies and gentlemen were taught to ride. The house held about 1500 people. The building has been since converted into a concert room, and applied to various other uses.

31. *The Register Office.* This work was first suggested by the late earl of Morton, lord register of Scotland, with a view to prevent the danger which attended the usual method of keeping the public records. In former times, indeed, these suffered from a variety of accidents. Edward I. carried off or destroyed most of them, in order to prevent any marks of the former independence of the nation from remaining to posterity. Afterwards Cromwell spoiled this nation of its records, most of which were sent to the Tower of London. At the time of the Restoration many of them were sent down again by sea; but one of the vessels was shipwrecked, and the records brought by the other have ever since been left in the greatest confusion.—The earl of Morton taking this into consideration, obtained from his majesty a grant of 12,000l. out of the forfeited estates, for the purpose of building a register office,

office, or house for keeping the records, and disposing them in proper order. The foundation was laid on the 27th of June 1774, by Lord Frederick Campbell lord-register, Mr Montgomery of Stanhope lord advocate, and Mr Millar of Barskimming lord justice clerk; three of the trustees appointed by his majesty for executing the work. The ceremony was performed under a discharge of artillery, in presence of the judges of the courts of session and exchequer, and in the sight of a multitude of spectators. A brass plate was put into the foundation stone with the following inscription: CONSERVANDIS TABULIS PUBLICIS POSITUM EST, ANNO M.DCC.LXXIV, MUNIFICENTIA OPTIMI ET PIETISSIMI PRINCIPIS GEORGII TERTII. In a glass vase hermetically sealed, which is also placed in the foundation stone, are deposited specimens of the different coins of his present majesty.

The front of the building directly faces the bridge, extends from east to west 100 feet, and is 40 feet back from the line of Prince's street. In the middle of the front is a small projection of three windows in breadth. Here is a pediment, having in its centre the arms of Great Britain, and the whole is supported by four Corinthian pilasters. At each end is a tower projecting beyond the rest of the building, having a Venetian window in front, and a cupola on the top. The front is ornamented from end to end with a beautiful Corinthian entablature. In the centre of the building is a dome of wooden work covered with lead. The inside forms a saloon 50 feet diameter and 80 high, lighted at top by a copper window 15 feet in diameter. Round the whole is a hanging gallery of stone, with an iron ballustrade, which affords conveniency for presses in the walls for keeping the records. The whole number of apartments is 97; all of which are vaulted beneath, and warmed with fire-places. This building, which is the most beautiful of Mr Adam's designs, was executed in a substantial manner, in about 16 years, at the expence of near 40,000l. and is one of the principal ornaments of the city. A serjeant's guard is placed here from the castle, for the further protection of the records.

32. On the east side of St Andrew's square stands the *General Excise Office*, built by the late Sir Lawrence Dundas for his own residence, but sold by his son for the above purpose. It is a very handsome building, with a pediment in front ornamented with the king's arms, and supported by four Corinthian pilasters; and, in conjunction with the two corner houses, has a fine effect.

33. *St Andrew's Church* stands on the north side of George's street. It is of an oval form; and has a very neat spire of 186 feet in height, with a chime of eight bells, the first and only one of the kind in Scotland. It has also a handsome portico in front.

34. *St George's Church* stands on the west side of St Andrew's square, so as to close the perspective of George street, It was founded in 1811, and finished in 1814, at an expence of 33,000l. The front to the square is 112 feet, and consists of a portico or vestibule, with four columns, and two pilasters of the Ionic order, 35 feet high. Behind the portico rises a dome to the height of 150 feet, upon a basement of 40 feet square. The extreme breadth of the building is 128 feet.

35. Opposite to St Andrew's church is the *Physicians Hall*, designed for the meetings of the faculty, and which has a portico resembling that of the church.

36. Farther to the westward, on the south side, stand the *Assembly Rooms*, which though a heavy looking building on the outside, are nevertheless extremely elegant and commodious within. The largest is 100 feet long and 40 broad, being exceeded in its dimensions by none in the island, the large one at Bath excepted. Weekly assemblies are held here for dancing, and card-playing, under the direction of a master of ceremonies; admission tickets five shillings each.

There are four Banking Companies in Edinburgh established by statute, or by royal charters. These are the Bank of Scotland, commonly called the Old Bank, the Royal Bank of Scotland, the British Linen Company, and the Commercial Bank.

37. The *Bank of Scotland*, commonly called the *Old Bank*, was erected by act of parliament, A. D. 1695. By the statute of erection, the company was empowered to raise a joint stock of 1,200,000l. Scots, or 100,000l. sterling, for the purpose of carrying on a public bank. The smallest share which any person could hold in the bank was declared to be 1000l. Scots; and the largest sum for which any one was allowed to subscribe was 20,000l. of the same money. Eight thousand are declared to be the qualification necessary to entitle any one to be elected governor; 6000l. deputy-governor; and 3000l. for each director. The management of the affairs of the company was vested in a governor, deputy-governor, and twenty-four directors; and in choosing these managers, each proprietor was declared to have a vote for every 1000l. of stock held by him.

The office of this company was held in a house down a narrow lane at the south side of that part of the High street called the Lawn-market; but, at a great expence, they erected for their accommodation a building which is situated at the foot of Bank street, to the northward of the High street, in full view of Prince's street. This is at once a magnificent and beautiful fabric. The back of the building is towards Prince's street; and here, while erecting, it had the disadvantage, from its vast height, of having somewhat the aspect of a tower. This effect, however, is now removed by restoring the earth for the purpose of covering up the lower part of it, and by a wall of considerable height in the nature of a curtain, which has been added to augment its apparent breadth. It forms, upon the whole, a beautiful and most superb fabric. As a work of magnitude, it is seen to most advantage from the mound of earth which connects the Old and the New Town, at that part of the mound which is in the direction of the north-west angle of the building. Here the eye is filled by the full view of two sides of the fabric, and by a display of its great height. The result of which is, that as a magnificent and stupendous structure, it seems to have no rival in this country.

"This banking company has established branches in every considerable town in Scotland, excepting Glasgow, which, in consequence of an amicable adjustment to avoid rivalship, is left to the Royal Bank. By agreement, the latter has a branch in Glasgow, and no branch in any other town in Scotland.

38. "The *Royal Bank* was established in the following manner: By the articles of union, Scotland was declared to be liable to the same duties which were levied by way of customs or excise in England. As these duties had, in the latter of these nations, been appropriated for the discharge of debts contracted by England before the union, it was found reasonable to give Scotland an equivalent for this additional burthen. The sum, given by way of equivalent, was ordained to be paid for certain purposes, and to certain persons or bodies corporate, mentioned in the articles of union and in posterior statutes. The proprietors of these sums, to the extent of 248,550l. sterling, were erected into a body corporate, under the name of the *Equivalent Company*; and the said sum of 248,550l. was declared to be the joint stock of the company. Upon application by this company, they obtained a royal charter, empowering such of them as inclined to subscribe their shares in the joint stock for that purpose, to carry on the business of banking. By this charter the subscribers to this banking business were, in A. D. 1727, erected into a body corporate, to be called, "*The Royal Bank of Scotland*." They were vested with the requisite powers, and the management of the company's affairs declared to be in a governor, deputy-governor, nine ordinary and nine extraordinary directors. The qualifications of these managers were declared to be, that of the governor to hold stock to the extent of 2000l.; of the deputy-governor, of 1500l.; of the ordinary directors, of 1000l.; and of the extraordinary directors, of 500l. The sum originally subscribed was 111,000l.; but by a charter passed in favour of the Royal Bank, A. D. 1738, explaining the privileges formerly bestowed upon them, and enabling them to increase their capital, they were empowered to raise their stock to a sum not exceeding in whole, when joined to their original funds, 150,000l. By the charter of erection of this company, a share of 300l. entitles a proprietor to one vote, one of 600l. to two, of 1200l. to three, and of 2000l. to four; and no proprietor can have more than four votes.

39. "The *British Linen Company*, with a capital of 100,000l. was incorporated by royal charter in 1746, with a view to encourage the manufacture of linen in Scotland. By the constitution of this company, its affairs are declared to be under the management of a governor, deputy-governor, and five directors. It is declared a necessary qualification in the governor to be possessed of a share in the company's stock to the amount of 1000l.; of the deputy governor, 500l.; and of each director, of 300l. A share of 200l. entitles a proprietor to vote in the choice of these managers, of 500l. to two votes, and of 1000l. to four votes; but it is declared that no proprietor shall possess more than four votes.

"This company carries on the business of banking, and issues promissory notes like the two former companies; but the banking business is carried on separately from the linen trade. The Linen Hall remains in the Canongate; but the apartments of the bank are removed to a large house in St Andrew's square, next to the Excise Office.

40. The *Commercial Bank* was established in 1810, with a capital of three millions. It is managed by ordinary and extraordinary directors like the other banks. It occupies a building erected by themselves in the Old Assembly close, High street. All these banks issue promissory notes for various sums not under one pound sterling.

"Besides these there are several private banking houses of great reputation in Edinburgh, which do not issue promissory notes for small sums payable on demand, but which carry on the other branches of the banking trade, by transmitting money, discounting bills, and accommodating individuals with cash accounts."

Beauties of Scotland, I. 91.

29
Religious establishments.

It now remains only to speak something of the religious and civil establishments of this metropolis. The highest of the former is the General Assembly of the church of Scotland, who meet there annually in the month of May, in an aisle of the church of St Giles fitted up on purpose for them. The throne is filled by a commissioner from his majesty, but he neither debates nor votes. He calls them together, and dissolves them at the appointed time in the name of the king; but they call and dissolve themselves in the name of the Lord Jesus Christ. This assembly consists of 350 members chosen out of the various presbyteries throughout the kingdom; and the debates are often very interesting and eloquent. This is the supreme ecclesiastical court in Scotland, to which appeals lie from the inferior ones.

The ecclesiastical court next in dignity to the Assembly is the Synod of Lothian and Tweeddale, who meet in the same place in April and November; and next to them is the Presbytery of Edinburgh. These meet on the last Wednesday of every month, and are trustees on the fund for ministers widows. They have a hall in Scott's close, where there is a good picture of Dr Webster by Martin, which was put up at the expence of the trustees, out of gratitude for the trouble he took in planning and fully establishing the fund.

The Society for propagating Christian Knowledge in the Highlands and Islands of Scotland, was established a body corporate by Queen Anne in the year 1709, for the purpose of erecting schools to instruct poor children in the principles of Christianity, as well as in reading and writing. The society have a hall in Warriston's close, where their business is transacted. From time to time they have received large contributions, which have always been very properly applied; and for much the same purpose his majesty gives 1000l. annually to the generally assembly of the church of Scotland, which is employed by a committee of their number for instructing the poor Highlanders in the principles of the Christian religion.

The Erse church at Edinburgh was built about 30 years ago by subscriptions for the same laudable purpose. Great numbers of people resort to the metropolis from the Highlands, who understand no other language but their own, and consequently have no opportunity of instruction without it; and a most remarkable proof of the benefit they have received from it is, that though the church is capable of holding 1000 people, yet it is not large enough for those who apply for seats. The minister has 100l. per annum arising from the seat rents, and holds communion with the church of Scotland. A larger church for their accommodation has since been built at the head of the Horse wynd.

30
Political constitution.

With regard to the political constitution of Edinburgh, the town council have the direction of all public

lic affairs. The *ordinary* council consists only of 25 persons; but the *council ordinary and extraordinary*, of 33. The whole is composed of merchants and tradesmen, whose respective powers and interests are so interwoven, that a balance is preserved between the two bodies. The members of the town council are partly elected by the members of the 14 incorporations, and they partly choose their own successors. The election is made in the following manner: First, a list or *leet* of six persons is made out by each incorporation; from which number, the deacon belonging to the incorporation must be chosen. These lists are then laid before the ordinary council of 25, who "shorten the *leets*," by expunging one half of the names from each; and from the three remaining ones the deacon is to be chosen. When this election is over, the new deacons are presented to the ordinary council, who choose six of them to be members of their body, and the six deacons of last year then walk off. The council of 25 next proceed to the election of the three merchant and two trades counsellors. The members of council, who now amount to 33 in number, then make out *leets*, from which the lord provost, dean of guild, treasurer, and bailies, must be chosen. The candidates for each of these offices are three in number; and the election is made by the 30 members of council already mentioned, joined to the eight *extraordinary* council deacons.

The lord provost of Edinburgh, who is styled *right honourable*, is high sheriff, coroner, and admiral, within the city and liberties, and the town, harbour, and road of Leith. He has also a jurisdiction in matters of life and death. He is preses of the convention of royal boroughs, colonel of the train bands, commander of the city guard and of Edinburgh jail. In the city he has the precedency of all the great officers of state and of the nobility; walking on the right hand of the king or of his majesty's commissioner; and has the privilege of having a sword and mace carried before him. Under him are four magistrates called *bailies*, whose office is much the same with that of aldermen in London. There is also a dean of guild, who has the charge of the public buildings, and without whose warrant no house nor building can be erected within the city. He has a council to consult with, a nominal treasurer, who formerly had the keeping of the town's money, which is now given to the chamberlain. These seven are elected annually; who with the seven of the former year, three merchants and two trades counsellors, and 14 deacons or preses of incorporated trades, making in all 33, form the council of the city, and have the sole management and disposal of the city revenues; by which means they have the disposal of places to the amount of 20,000l. annually. Formerly the provost was also an officer in the Scots parliament. The magistrates are sheriffs depute and justices of the peace; and the town council are also patrons for all the churches in Edinburgh, patrons of the university, and electors of the city's representative in parliament. They have besides a very ample jurisdiction both civil and criminal. They are superiors of the Canongate, Portsburgh, and Leith; and appoint over these certain of their own number, who are called *baron bailies*: but the person who presides over Leith has the title of *admiral*, because he hath there a jurisdiction over maritime affairs. The baron bailies appoint one or two of the inhabitants of their respective districts to be their substitutes, and these are called *resident bailies*. They hold courts in absence of the baron bailies, for petty offences and discussing civil causes of little moment.

31 Town guard

No city in the world affords greater security to the inhabitants in their persons and properties than Edinburgh. Robberies are here very rare, and street murder hardly known in the memory of man; so that a person may walk the streets at any hour of the night in perfect security. Formerly this was attributed to the *town guard*. This institution originated from the consternation into which the citizens were thrown after the battle at Flowden. At that time, the town council commanded the inhabitants to assemble in defence of the city, and every fourth man to be on duty each night. This introduced a kind of personal duty for the defence of the town, called *watching and warding*; by which the trading part of the inhabitants were obliged in person to watch alternately, in order to prevent or suppress occasional disturbances. This, however, becoming in time extremely inconvenient, the town council, in 1648, appointed a body of 60 men to be raised, the captain of which was to have a monthly pay of 11l. 2s. 3d. two lieutenants of 2l. each, two serjeants of 1l. 5s. and the private men of 15s. each. No regular fund was established for defraying this expence: the consequence of which was, that the old method of watching and warding was resumed; but the people on whom this service devolved were now become so relaxed in their discipline, that the magistrates were threatened with having the king's troops quartered in the city if they did not appoint a sufficient guard. On this 40 men were raised in 1679, and in 1682 the number was increased to 108. After the Revolution, the town council complained of the guard as a grievance, and requested parliament that it might be removed. Their request was immediately granted, and the old method of watching and warding was renewed. This, however, was now so intolerable, that the very next year they applied to parliament for leave to raise 126 men for the defence of the city, and to tax the citizens for their payment. This being granted, the corps was raised and continued under the name of the *town guard*, till the establishment of the present police. The establishment consisted of three officers and about 90 men, who mounted guard by turns. The officers had a lieutenant's pay; the serjeants, corporals, drummers, and common soldiers, the same with those of the army. Their arms were the same with those of the king's forces: but when called upon to quell mobs, they used Lochaber axes, a part of the ancient Scottish armour only in use among themselves.

32 Militia or trained bands.

The militia or trained band of the city consist of 16 companies of 100 men each. They were in use to turn out every king's birth day; but only the officers now remain, who are chosen annually. They consist of 16 captains and as many lieutenants and ensigns; the provost, as has already been mentioned, being the colonel.

The town guard were paid chiefly by a tax on the trading people; these being the only persons formerly subject to watching and warding. The tax, however, amounted only to 1250l.; and as the expence of

the

the guard amounted to 1400l. the magistrates were obliged to defray the additional charge by other means.

But in the year 1805, in consequence of a new system of police being established, the city guard was reduced to one lieutenant, two serjeants, two corporals, two drummers, and thirty men, the lord provost for the time being to be captain, without pay, and the company to be armed and clothed at the expence of the city, but their pay to be defrayed out of the general fund raised under the new police act; and the duty of this company is to attend upon his majesty's commissioner to the general assembly of the church of Scotland, the magistrates and town council, the supreme courts of justice, and to act in general for the support of the new system of police.

33 S em of pe e.

The system of police above alluded to, was established in 1805 by act of parliament, under the authority of which the city and suburbs were divided into six districts or wards for the more convenient execution of the purposes to which the act extended. The regulations included under this system of police relate to cleansing and lighting the streets and passages in the city and suburbs, apprehending and punishing vagrants and disorderly persons, suppressing common begging, preventing nuisances and obstructions, and for other purposes connected with the preservation of peace and good order. The management of the whole affairs under this system of police was entrusted to the general and resident commissioners. The general commissioners appointed by the act, were, the lord provost and magistrates of the city of Edinburgh, with the lord president of the court of session, the lord justice clerk, the lord chief baron of the court of exchequer, the law officers of the crown, and several other public characters, in conjunction with the whole resident commissioners in the different wards. There were to be seven resident commissioners in each ward, the two highest in the list to go out, and two others to be elected in their stead annually; the commissioners to be occupiers of houses valued at twenty pounds sterling of free rent yearly, excepting in two wards, where occupying a house of twelve pounds rent is a sufficient qualification. In each ward there were to be elected by the resident commissioners, with the approbation of the general commissioners, an inspector, and such a number of officers of police and watchmen as might be necessary, the officers of police and watchmen upon duty having the authority and possessing the powers given by the law of Scotland to the office of constable.

The general commissioners had the power of choosing a superintendant or master of police for the whole city and suburbs included in the act, and to appoint a clerk who shall do the duty of clerk to the general meetings, as well as to the court of police to be held by the superintendant. The general commissioners also were authorized to fix the number of officers and watchmen to be employed in the different wards. The superintendant of police having been appointed by the commissioners, was to receive from the sheriff depute of the county of Edinburgh the authority of a sheriff substitute, as well as a commission of sheriff depute within the city and liberties from the lord provost, who was principal sheriff within these bounds, that the superintendant acting as master or judge of police may have the full powers of a magistrate in the execution of his duty. By the powers with which the superintendant was invested, he might commit offenders to the tolbooth or to bridewell for a period not exceeding 60 days, and impose fines for offences not exceeding 40 shillings sterling, and give judgment in damages for any sum not exceeding three pounds sterling with the expences in either case. From the sentences of the superintendant there was no appeal to the sheriff depute of the county, or to the lord provost as sheriff principal within the city. The superintendant of police was also the billet-master within his bounds, and the inspectors of wards were billet-masters within their several wards. The inspectors also had the powers of procurator fiscals with respect to all prosecutions for offences committed within their bounds.

The expences necessary to carry the above act into execution, were to be defrayed from a fund raised by assessment on the inhabitants, of three per cent. on the free rent of houses, shops, or warehouses; and for the expences of clothing and alimenting the persons committed to bridewell a farther assessment, not exceeding $\frac{1}{4}$ per cent. of the free rent of such houses, &c. For the purpose of ascertaining rents, surveyors were appointed; and if the rent fixed by them should be overrated, an appeal might be made to a committee of the general commissioners specially appointed.

After a trial of seven years this bill was found objectionable in many points; and therefore in 1812 a new bill was procured, which abolished the office of judge of police, divided the city into 26 wards, with three resident commissioners for each. The sheriff of the county, and magistrates of Edinburgh, were appointed judges. A superintendant, with a salary of 500l. a-year, was appointed, assisted by a clerk with 200l. and three lieutenants at 80l. each. The total expence of the establishment in 1817 was 18,482l.

34 Number of inhabitants.

The number of inhabitants in the city of Edinburgh is somewhat uncertain, and has been very variously calculated. By a survey made in the year 1775, it appears that the number of families in the city, Canongate, and other suburbs, and the town of Leith, amounted to 13,806. The difficulty therefore is to fix the number of persons in a family. Dr Price fixes this number at 4$\frac{1}{10}$; Mr Maitland, at 5$\frac{1}{2}$; and Mr Arnot, at 6; so that, according to this last gentleman, the whole number of inhabitants is 82,836; to which he thinks 1400 more may be added for those in the garrisons, hospitals, &c.

The following table exhibits a comparative view of the population of the city of Edinburgh with Leith and suburbs taken in different years. The enumeration made in 1801 by act of parliament is supposed to be considerably defective in the real amount of the inhabitants, as an alarm was industriously spread that it was done with a view to the imposition of new taxes.

1678	35,500
1722	40,420
1755	57,195
1775	70,430
1791	84,886
1801	82,560
1811	102,987

According to this last enumeration the males were 43,982, the females 59,005, a most surprising difference, if correct. The number of families was 23,104.

There are in Edinburgh 14 incorporations, capable of choosing their own deacons, viz. The royal college of surgeons; the corporations of goldsmiths, skinners, furriers, hammermen, wrights and masons, taylors, bakers, butchers, shoemakers, weavers, waukers, bonnet-makers, and merchant company.

The markets of Edinburgh are plentifully supplied with all sorts of provisions. Fresh butcher meat, as well as fowl and fish, if the weather permit, may be had every day; and no city can be better supplied with garden stuffs. The Edinburgh strawberries particularly are remarkably large and fine. A striking instance of the plenty of provisions with which Edinburgh is supplied was observed in the year 1779, when several large fleets, all of them in want of necessaries, arrived in the Forth, to the amount of about 500 sail, and having on board at least 20,000 men; yet the increased consumption of provisions, which certainly ensued upon the arrival of so many strangers, made not the least increase in the rate of the markets, insomuch that several victualling ships sent down by the navy board returned without opening their hatches. The city mills are let to the corporation of bakers in Edinburgh: and the bread made in the city is remarkable for its good quality.

Edinburgh is supplied with water brought for some miles in pipes, and lodged in two reservoirs, from whence it is distributed through the city both to public wells and private families. A revenue accrues to the town from the latter, which must undoubtedly increase in proportion as the city extends in magnitude.

There are but few merchants in Edinburgh, most of them residing at the port of Leith: so that the support of the city depends on the consumption of the necessaries as well as the superfluities of life. There are five different sorts of people on whom the shopkeepers, publicans, and different trades depend: 1. The people of the law, who are a very respectable body in the city. 2. The number of young people of both sexes who come to town for their education, many of the parents of whom come along with them. 3. The country gentlemen, gentlemen of the army and navy, and people who have made their fortunes abroad, &c. all of whom come to attend the public diversions, or to spend their time in such a manner as is most agreeable to them. 4. The vast concourse of travellers from all parts. 5. Most of the money drawn for the rents of country gentlemen is circulated among the bankers or other agents. See EDINBURGH, SUPPLEMENT.

EDINBURGHSHIRE, or MIDLOTHIAN, is bounded on the north by the frith of Forth, and the river Amond, which divides it from Westlothian or Linlithgow; on the east by Haddingtonshire; on the south by the counties of Lanark, Peebles, and Berwick; and at the west corner by part of the county of Linlithgow. It extends about 30 miles in length, and its breadth varies from 16 to 20: containing in all about 354 square miles, or 226,560 English acres. The surface of the country is pleasant, having much level ground, interspersed with some hills, watered with many agreeable streams, and sheltered and decorated with woods. The arable land, which may be calculated about one third of the whole, is in a state of high cultivation, and affords excellent crops. The two great ridges of hills which pass through the county, called the *Moorfoot* and the *Pentland* hills, afford pasture; the former is far superior in quality to the latter:-in these hills it is generally remarked that the north side of the hill is the finest and best pasture, contrary to what we should be apt, *à priori*, to imagine. Like the other parts of the country, this district experiences the consequences of an insulated situation; being subject to that instability and uncertainty, that the climate in one day exhibits the weather of every season of the year; the cold east winds in the spring are exceedingly detrimental to fruit, and in autumn the *haars* or mists from the sea, are apt to whiten and wither the corns before they are ripe. The immediate vicinity of many of the farms to the metropolis affords the opportunity of procuring street dung easily, and has been of material advantage in improving the land; it has this disadvantage, however, that by long continuance the fields become very full of weeds, particularly the *scaller*, or wild mustard; it is imagined that this would be obviated by throwing the field out in pasture for a few years, and afterwards liming it well before ploughing. The chief rivers of the county of Edinburgh, are the *North* and *South Esks*, which, uniting, fall into the frith of Forth at the town of Musselburgh; the *Amond*, which falls into the same frith at the village of Cramond, and the water of *Leith*, which forms the harbour of that town; all of these abound with trout. The islands of Inchkeith and Cramond, and of Inchmickery, also belong to this county. Few districts of Scotland afford more minerals than the county of Edinburgh; it abounds everywhere with coal, limestone, and freestone of superior quality; and iron ore of different species is very abundant; compound stone, called *petuntse*, is found in great quantity in the Pentland hills, and has been successfully employed in the manufacture of British porcelain. In the parish of Ratho is found a fine species of whetstone or hone; and in the parish of Duddingstone, at Brickfield, is found clay, fit for making earthen ware. The hills are composed of *porphyry* and *basalt* or *whinstone*, which in many places, particularly Arthur's Seat and Craig-Lockhart, exhibit regular forms. Near Glencross, and in the Braid-hills, are found great veins of the heavy spar, or barytes, which is often an attendant on metallic veins, especially of lead and copper. All the hills contain specimens of zeolites, jaspers, spars, &c. From the vicinity to the metropolis, numerous seats of nobility and gentry are everywhere to be seen. Besides the city of Edinburgh and its suburbs, in which we may include the town of Leith, this county contains several large towns and villages, as Dalkeith, Musselburgh, Liberton, Lasswade, and Gilmerton, and is divided into 31 parishes, of which the following is the population at two different periods.

burgh-
ire
||
om.

	Parishes.	Population in 1755.	Population 1790—1798.
1	Borthwick	910	858
	Calder, West	1294	1289
	Canongate	4500	6200
	Carrington	555	329
5	Cockpen	640	1123
	Colingtown	792	1395
	Corstorphine	995	1037
	Cramond	1455	1485
	Cranstoun	725	839
10	Crichton	611	900
	Currie	1227	1300
	Dalkeith	3110	4366
	Duddingston	989	910
	Edinburgh	31,122	31,898
15	Fala	312	372
	Glencross	557	385
	Heriot	209	300
	Inveresk	4645	5392
	Kirknewton	1157	812
20	Lasswade	2190	3000
	Leith, North	2205	2409
	Leith, South	7200	11,432
	Libbertoun	2793	3457
	Midcalder	1369	1251
25	Newbottle	1439	1295
	Newton	1199	1135
	Pennycuick	890	1721
	Ratho	930	825
	St Cuthberts	12,193	32,947
30	Stow	1294	1400
31	Temple	905	593
		90,412	122,655
	Population in 1811	148,607	

See EDINBURGHSHIRE, SUPPLEMENT.

Editor
||
Edrisi.

EDITOR, a person of learning, who has the care of an impression of any work, particularly that of an ancient author: thus, Erasmus was a great editor; the Louvain doctors, Scaliger, Petavius, F. Sirmond, Bishop Walton, Mr Hearne, Mr Ruddiman, &c. are likewise famous editors.

EDOM, or ESAU, the son of Isaac and brother of Jacob. The name of Edom, which signifies *red*, was given him, either because he sold his birthright to Jacob for a mess of red pottage, or by reason of the colour of his hair and complexion. Idumæa derives its name from Edom, and is often called in Scripture the land of Edom. See the next article.

EDOM, or IDUMÆA, in *Ancient Geography*, a district of Arabia Petræa; a great part also of the south of Judæa was called *Idumæa*, because occupied by the Idumæans, upon the Jewish captivity, quite to Hebron. But the proper Edom or Idumæa appears not to have been very extensive, from the march of the Israelites, in which they compassed it on the south eastwards, till they came to the country of the Moabites. Within this compass lies Mount Hor, where Aaron died; marching from which the Israelites fought with King Arad the Canaanite, who came down the wilderness against them (Moses.) And this is the extent of the *Idumæa Propria* lying to the south of the Dead sea; but in Solomon's time extending to the Red sea, (1 Kings ix. 26.).

EDMUND I. and II. See (*History of*) ENGLAND.

EDRISI, an eminent Arabian geographer. See SUPPLEMENT.

EDUCATION.

Ed tion.

Def ion.

EDUCATION may be defined that series of means by which the human understanding is gradually enlightened, and the dispositions of the human heart are formed and called forth, between earliest infancy and the period when we consider ourselves as qualified to take a part in active life, and, ceasing to direct our views solely to the acquisition of new knowledge or the formation of new habits, are content to act upon the principles which we have already acquired.

Part lars
com
end un-
er de-
nit .

This comprehends the circumstances of the child in regard to local situation, and the manner in which the necessaries and conveniences of life are supplied to him; the degree of care and tenderness with which he is nursed in infancy; the examples set before him by parents, preceptors, and companions; the degree of restraint or licentiousness to which he is accustomed; the various bodily exercises, languages, arts, and sciences, which are taught him, and the method and order in which they are communicated; the moral and religious principles which are instilled into his mind; and even the state of health which he enjoys during that period of life.

lan

1st, In this article we propose to give an account of some of the most remarkable institutions for the education of youth which have been legally established or have accidentally prevailed among various nations and in various periods of society. 2dly, An account of the most judicious and the most fanciful plans which have been proposed by those authors who have written on the subject of education. And, lastly, To offer the result of our own observations and recollections on this important head.

Education.

4
Education in a savage state.

In the infancy of society, very little attention can be paid to the education of youth. Before men have risen above a savage state, they are almost entirely the creatures of appetite and instinct. The impulse of appetite hurries them to propagate their species. The power of instinctive affection is often, though not always, so strong as to compel them to preserve and nurse the fruit of their embraces. But even when their wants are not so urgent, nor their hearts so destitute of feeling as to prompt them to abandon their new-born infants to the ferocity of wild beasts or the severity of the elements, yet still their uncomfortable and precarious situation, their ignorance of the laws of nature, their deficiency of moral and religious principles, and their want of dexterity or skill in any of the arts of life; all these together must render them unable to regulate the education of their children with much attention and sagacity. They may relate to them the wild inconsistent tales, in which all their notions concerning superior beings, and all their knowledge of the circumstances and transactions of their ancestors, are contained; they may teach them to bend the bow, to point their arrows, to hollow the trunk of a tree into a canoe, and to trace the almost imperceptible path of an enemy or a wild beast over dreary mountains or through intricate forests: but they cannot impress their minds with just ideas concerning their social relations, or concerning their obligations to a Supreme Being, the framer and upholder of nature; they teach them not to repress their irregular appetites, nor to restrain the sallies of passion when they exceed just bounds or are improperly directed; nor can they inform their understandings with very accurate or extensive views of the phenomena of nature. Besides, they know not how far implicit obedience to his parents commands is to be acquired of the boy, nor how far he ought to be left to the guidance of his own reason.

5 Among savages the influence of parental authority soon expires, nor is the parent solicitous to maintain it. As the eagle expels his young from his lofty nest as soon as they become able to support themselves in the air; so the savage generally ceases to care for his child, or assume any power over him, as soon as he becomes capable of procuring the means necessary for his own subsistence. Savages being scarce connected by any social ties, being unacquainted with the restraint of civil laws, and being unable to contribute in any great degree to the maintenance or protection of one another; each individual among them, as soon as he attains that degree of strength and dexterity which may enable him to procure the necessaries of life, stands single and alone, independent on others, and scorning to submit to their commands. The parent, conscious of his inability to confer any important benefits on his child, after he has advanced even a very short way towards manhood, no longer endeavours to controul his actions; and the child proud of his independence, scarce submits to ask his parents advice. And even before his reaching this period of independence, so few are the benefits which parents can bestow (being confined to supplying the necessaries of life, and communicating the knowledge of a very few of the rudest simplest arts), that children regard them with little deference, nor do *they* always insist on implicit submission. Want of natural affection, and consciousness of superior strength, often prompt the parent to abuse the weakness of his child. Yet though small the skill with which the savage can cultivate the understanding or form the dispositions of his child, though few the arts which he can teach him, and though not very respectful or submissive the obedience or deferences which he requires; yet there is one quality of mind which the savage is more careful to inspire than those parents who are directed in educating their children by all the lights of civilized society. That quality indeed is absolutely necessary to fit the savage for his situation; without it, the day on which he ceased to enjoy the protection of his parents would most probably be the last day of his life: That quality is Fortitude. We may perhaps think, that the hardships to which the young savage is from the period of his birth unavoidably exposed, might be enough to inspire him with fortitude; but as if these were insufficient, other means are applied to inspire him with what the Stoics have regarded as the first of virtues. He is compelled to submit to many hardships, unnecessary but from a view to this. Children are there called to emulate each other in bearing the severest torments. Charlevoix relates, that he has seen a boy and girl bind their arms together, place a burning coal between them, and try who could longest endure without shrinking the pain to which they thus exposed themselves.

6 The sa indebte chiefly nature a circums ces for educati

Still, however, the young savages owes his education rather to nature, and to the circumstances in which he is placed and the accidents which befal him, than to the kindness or prudence of his parents. Nature has endowed him with certain powers of understanding, sentiments, sensations, and bodily organs; he has been placed in certain circumstances, and is exposed to a certain train of events; and by these means chiefly, not by the watchful industry of instructors, does he become such as he appears when he has reached the years of maturity.

7 Educati in an im proved state of ciety.

But man was not designed by his wise and beneficent Creator to remain long in a savage state; the principles of his nature incline him to social life. Reason, distinguishing the superior advantages to be enjoyed in society, concurs with the social principle in his breast, in prompting him to seek the company and conversation of others of the human race. When men enter into society, they always unite their powers and talents, in a certain degree, for the common advantage of the social body. In consequence of this, laws come in time to be instituted; new arts are invented; progress is made in the knowledge of nature; moral duties are better understood and defined; juster ideas are gradually acquired of all our social relations; friendship, love, filial, parental, and conjugal affection, all are heightened and refined. All these advantages do not instantly result from men's entering into a social state; the improvement of the human mind, and the civilization of society, are gradual and progressive: But as it is natural for men to unite in a social state, so it is no less natural for society to be gradually improved and civilized till it attain a high degree of perfection and refinement.

8 Attentio to the e cation o youth a tural co sequenc civilization

When men have attained to such knowledge and improvement as to be entitled to a more honourable appellation than that of savages, one part of their improvements generally consists in their becoming more judicious and attentive in directing the education of their youth. They have now acquired ideas of dependence and subordination; they have arts to teach and knowledge to communicate; they have moral principles to instil; and have formed notions of their relations and obligations to superior powers, which they are desirous that their children should also entertain. Their affection to their offspring is now also more tender and constant. We observe at present in that state of society in which we live, that the poor who can scarce earn for themselves and their children the necessaries of life, are generally less susceptible of parental affection, in all its anxious tenderness, than the rich, or those whom Providence hath placed in easy circumstances; and we may make use of this fact in reasoning concerning the different degrees of the same affection felt by the savage and the member of a civilized society.

ty. The savage may be considered as the poor man, who with difficulty procures the necessaries of life even for himself; the other, as the man in affluent circumstances, who is more at leisure to listen to the voice of tender and generous affection.

In this improved state of society, the education of youth is viewed as an object of higher importance. The child is dearer to his parent; and the parent is now more capable of cultivating the understanding and rectifying the dispositions of his child. His knowledge of nature, and his dexterity in the arts of life, give him more authority over a child than what the savage can possess. Obedience is now enforced, and a system of education is adopted; by means of which the parent attempts to form his child for acting a part in social life. Perhaps the legislature interferes; the education of the youth is regarded as highly worthy of public concern: it is considered that the foolish fondness or the unnatural caprice of parents may, in the rising generation, blast the hopes of the state.

9
Pu[illegible] e-[illegible]sh-[illegible] for education am[illegible] the an[illegible]ts.

In reviewing ancient history, we find that this actually took place in several of the most celebrated governments of antiquity. The Persians, the Cretans, and the Lacedæmonians, were all of them too anxious to form their youth for discharging the duties of citizens to entrust the education of the children solely to the parents. Public establishments were formed among those nations, and a series of institutions enacted, for carrying on and regulating the education of their youths: Not such as our European universities, in which literary knowledge being the sole object of pursuit, the student is maintained solely at his parents expence, and attends only if his parents think proper to send him; but of a very different nature, and on a much more enlarged plan.

[illegible]
Am[illegible] the [illegible]t Per[illegible]s.

The Persians, according to the elegant and accurate account delivered by Xenophon in the beginning of his Cyropædia, divided the whole body of their citizens into four orders; the boys, the youth, the full-grown men, and those who were advanced beyond that period of life during which military service was required. For each of these orders particular halls were appropriated. Each of them was subjected to the inspection of twelve rulers. The adults and the superannuated were required to employ themselves in the performance of particular duties, suitable to their age, their abilities and their experience; while the boys and the youth were engaged in such a course of education as seemed likely to render them worthy and useful citizens.

The boys were not employed in their places of instruction, in acquiring literary accomplishments; for to such the Persians were strangers. They went thither to learn justice, temperance, modesty; to shoot the bow, and to launch the javelin. The virtues and the bodily exercises were what the Persians laboured to teach their children. These were the direct, and not subordinate, purposes of their system of education. The masters used to spend the greatest part of the day in dispensing justice to their scholars; who carried before them actions for thefts, robberies, frauds, and other such grounds of complaint against one another.—Such were the means by which the Persians endeavoured to instil, even in early youth, a regard for the laws of natural equity, and for the institutions of their country. Till the age of 16 or 17, the boys were busied in acquiring those parts of education. At that period they ceased to be considered as boys, and were raised to the order of the youths. After they entered this order, the same views were still attended to in the carrying on of their education. They were still inured to bodily labour. They were to attend the magistrates, and to be always ready to execute their commands. They were led out frequently to the chase; and on such expeditions they were always headed by the king, as in time of war. Here they were taught to expose themselves fearlessly to danger; to suffer, without repining or complaint, hunger, thirst, and fatigue; and to content themselves with the coarsest, simplest fare, for relieving the necessities of nature. In short, whether at home or out on some hunting expedition, they were constantly employed in acquiring new skill and dexterity in military exercises, new vigour of mind and body, and confirmed habits of temperance, fortitude, abstinence, patience, patriotism, and noble integrity. After spending ten years in this manner, their course of education was completed; they were admitted into the class of the adults, and were esteemed qualified for public offices. It must not escape our notice, that the citizens were not compelled to send their children to pass through this course of education in the public halls; but none except such as passed through this course of education were capable of civil power, or admitted to participate in public offices or public honours.

Such are the outlines of that system of education which Xenophon represents as publicly established among the Persians. Were we able to preserve in a translation all the manly and graceful simplicity of that enchanting author, we would have offered to the perusal of our readers the passage in which he has described it: but conscious of being inadequate to that task, we have presumed only to extract the information which it contains.

11
Remarks on Xenophon's account of Persian education.

Perhaps, however, this system of education did not subsist precisely as the eloquent disciple of Socrates describes it among that rude and simple people. On other occasions he has commemorated such instances of their barbarity, as would tempt us to think them incapable of so much order and so much wisdom. Perhaps, as the discoverers of the new world have sometimes conferred on the inhabitants of that hemisphere, in the accounts of them with which they entertained their friends in Europe, amazing degrees of moral and political wisdom, of skill and dexterity in the arts, of industry and valour, which those uncivilized children of nature were afterwards found not to possess; so the Athenian philosopher has also ascribed to the Persians prudence and attention in regulating the education of their youth beyond what people in so rude a state can possibly exert.

But if we examine into the principles on which this system of education proceeds, without concerning ourselves whether it once actually prevailed among the Persians, or is the production of the fine imagination of Xenophon, we will find it peculiarly suitable for a nation just emerging from the rudeness and ignorance of barbarity to a knowledge of social and civil relations, and of the duties connected with such relations. They have sacrificed their independence to obtain the comfort and security of a social state. They now glory in the appellation of citizens, and are desirous to discharge the duties incumbent on a citizen. They must inform their children in the nature of their social relations, and impress them with habits of discharging their social duties; otherwise the society will soon be dissolved, and their posterity will fall back into the same wild miserable state from which they have emerged. But perhaps the circumstances, or abilities, or dispositions of individuals, render them unequal to this weighty task. It becomes therefore naturally an object of public care. The whole social body find it necessary to deliberate on the most proper means for discharging it aright. A plan of education is then formed; the great object of which is, to fit the youth for discharging the duties of citizens. Arts and sciences are hitherto almost wholly unknown: and all that can be communicated to the youth is only a skill in such exercises as are necessary for their procuring subsistence, or defending themselves against human enemies or beasts of prey; and habits of performing those duties, the neglect of which must be fatal to the society or the individual.

Such is the system of education which we have surveyed as established among the Persians; and perhaps we may now be less suspicious than before of Xenophon's veracity. It appears natural for a people who have reached that degree of civilization in which they are described, and have not yet advanced farther, to institute such an establishment. Some such establishment also appears necessary to prevent the society from falling back into their former barbarity. It will prevent their virtue and valour from decaying, though it may perhaps at the same time prevent them from making any very rapid progress in civilization and refinement. Yet the industry, the valour, the integrity, and the patriotism which it inspires, must necessarily produce some favourable change in their circumstances; and that change in their circumstances will be followed by a change in their system of education.

12
Among the Cretans.

The Cretans, too, the wisdom of whose laws is so much celebrated in the records of antiquity, had a public establishment for the education of their youth. Minos, whom they revered as their great legislator, was also the founder of that establishment. Its tendency was similar to that of the course of education pursued among the Persians,—to form the soldier and the citizen. We cannot present our readers with a very particular or accurate account of it; but such as we have been able to procure from the best authorities we think it our duty to lay before them.

The Cretans were divided into three classes; the boys, the youth, and the adults. Between seven and seventeen years of age, the boy was employed in learning to shoot the bow, and in acquiring the knowledge of his duties as a man and a citizen, by listening to the conversation of the old men in the public halls, and observing their conduct. At the age of seven, he was conducted to the public halls to enter on this course of education. He was taught to expose himself boldly to danger and fatigue; to aspire after skill and dexterity in the use of arms and in the gymnastic exercises; to repeat the laws and hymns in honour of the gods. At the age of seventeen he was enrolled among the youth. Here his education was still continued on the same plan. He was to exercise himself among his equals in hunting, wrestling, and the military exercises; and while thus engaged, his spirits were roused and animated by strains of martial music played on such instruments as were then in use among the inhabitants of Crete. One part of the education of the Cretan youth, in which they were particularly desirous to excel, was the Pyrrhic dance; which was the invention of a Cretan, and consisted of various military evolutions performed to the sound of instruments.

Such were the principles and arts in which the Cretan legislature directed the youth to be instructed. This course of education could not be directed or superintended by the parent. It was public, and carried on with a view to fit the boy for discharging the duties of a citizen when he should attain to manhood.

It is easy to see, that such a system of education must have been instituted in the infancy of society, before many arts had been invented, or the distinctions of rank had arisen; at a time when men subsisted in a considerable degree by hunting, and when the intercourse of nations was on such a footing, that war, instead of being occasional, was the great business of life. Such a system of life would then naturally take place, even though no sage legislator had arisen to regulate and enforce it.

Lycurgus, the celebrated lawgiver of Lacedæmon, thought it necessary to direct the education of youth in a particular manner, in order to prepare them for paying a strict obedience to his laws. He regarded children as belonging more properly to the state than to their parents, and wished that patriotism should be still more carefully cherished in their breasts than filial affection. The spirit of his system of education was pretty similar to that of those which we have just viewed as subsisting among the Persians and the Cretans.

As soon as a boy was born, he was submitted to the inspection of the elders of that tribe to which his parents belonged. If he was well shaped, strong, and vigorous, they directed him to be brought up, and assigned a certain portion of land for his maintenance. If he was deformed, weak, and sickly, they condemned him to be exposed, as not being likely ever to become an useful citizen. If the boy appeared worthy of being brought up, he was intrusted to the care of his parents till he attained the age of seven years; but his parents were strictly charged not to spoil either his mind or his bodily constitution by foolish tenderness. Probably, too, the state of their manners was at that time such as not to render the injunction peculiarly necessary,

At the age of seven, however, he was introduced to a public class, consisting of all the boys of the same age. Their education was committed to masters appointed by the state; and what was chiefly inculcated on them in the course of it, was submissive obedience and respect to their superiors; quickness and brevity in their conversation, and replies to such questions as were put to them; dexterity and address in performing what was commanded them, and firmness and patience in bearing every pain or hardship to which they might be exposed. One of the means used to form them to habits of activity and address, was to permit, nay,

nay, to direct them to commit little acts of theft; which, if they performed them so dexterously as to avoid detection, they might afterwards boast of as noble exploits: but if detected in such enterprises, the awkward artless boy was exposed both to punishment and disgrace. To avoid the punishment and disgrace incurred by being discovered in an act of theft, the Spartan boy would often suffer with unshrinking fortitude the severest torments. It is related of one of them, that rather than be detected with a young fox under his cloak, which he had stolen, he suffered the little animal to tear open his bowels. Not cóntent with beholding the children suffer by submitting voluntarily to such hardships, the Spartans also endeavoured to form them to fortitude, by whipping them on their religious festivals, sometimes with such severity that they expired under the lash. The Lacedæmonian youth were also taught such bodily exercises, and the use of such warlike weapons, as were necessary to render them expert and skilful soldiers.

5 Remarks.

They too, as well as the Cretans and Persians, among whom we have seen similar modes of education adopted, were to be citizens and soldiers, not husbandmen, mechanics, artists, merchants, &c. Their mode of education, therefore, was simple and uniform. Its aim was, to make them acquainted with the nature of their social duties, and to form them to such vigour of body and such firmness of mind as might render them fit for the station in which they were to be placed, and adequate to the part which they were to act. This establishment for education was perfectly consistent with the other parts of that legislature which was instituted by Lycurgus. Youth educated among the Lacedæmonians could hardly fail to become worthy members of that singular republic. Let us not, however, regard the Spartans as singularly inhumane in their treatment of youth. Let us reascend, in imagination, to that period in the progress of society from rudeness to refinement, which they had reached when Lycurgus arose among them. What were then their circumstances, their arts and manners, their moral principles, and military discipline? Not very different from those which the laws of Lycurgus rendered so long stationary among them. He, no doubt, rectified some abuses, and introduced greater order and equality. But man is not to be so easily metamorphosed into a new form. As you cannot, at once, raise an acorn to a venerable oak; so neither will you be able to change the savage, at once, into the citizen. All the art or wisdom of Lycurgus, even though assisted by all the influence of the prophetic Apollo, could never have established his laws among his countrymen, had not their character and circumstances previously disposed them to receive them. But, grant this, and you must, of consequence, allow, that, what to us may appear cruel and inhumane, must have affected their feelings in a different manner. The change introduced in the treatment of youth by the establishment of this system of education, was probably recommended by its being more humane than what before prevailed. Corrupted as are our manners, and effeminate our modes of education; yet we would not perhaps act wisely in laying them aside, to adopt in their stead those of ancient Sparta. But the Spartan education was peculiarly well fitted to form citizens for the republic of Lycurgus; it was happily adapted to the state of society in which it was introduced. And, if we should inquire by what means Lycurgus was enabled to fix the arts, the manners, and in short the civilization of his country, for so long a period, in a stationary state; we would perhaps find reason to ascribe that effect to the public establishment which he instituted for the education of youth; to his confining the Spartan citizens to the profession of arms, and assigning all servile offices to the Helots; and to his prohibiting the use of gold and silver. Among these however his establishment for education occupies the chief place. Never was any state adorned with more patriotic citizens than those of Sparta: With them every private affection seemed to be swallowed up by the *amor patriæ:* the love of their country was at least their ruling passion. Pœdaretes being rejected when he offered himself a candidate for a seat among the council of three hundred, returned home, rejoicing that there were in Sparta no fewer than three hundred whom his countrymen found reason to regard as better citizens than himself. This was not a seeming joy, assumed to conceal the pain which he suffered from the disappointment; it was heartfelt and sincere. Such were the effects of their system of education.

16 Education among the other nations of antiquity.

When we turn our eyes from the Persians, the Cretans, and the Spartans, to the other nations of antiquity; we nowhere behold so regular a system of public education. Among the Athenians and the Romans, the laws did not descend to regulate in so particular a manner the management of the youth. These nations gradually emerged from a state of the rudest barbarity, to that polished, enlightened, and civilized state, which rendered them the glory and the wonder of the heathen world: but in no part of their progress from the one state to the other do we find any such establishment subsisting among them. So various, however, are the circumstances which form and diversify the character of nations, that we cannot reasonably conclude, because no such establishments existed among the Athenians and Romans, that therefore their existence was unnatural among those nations who possessed them. But though the education of youth was managed in a different manner among these and most other nations in the ancient world, than by public establishments, which detached children from the care of their parents; yet still it was everywhere regarded as an object of the highest importance. As the manners of mankind gradually improved to a state of refinement; as the invention of arts, and the discovery of science gradually introduced opulence and luxury; connubial, parental, and filial affection gradually acquired greater strength and tenderness. Of consequence, children experienced more of their parents care; and that care was directed to form them for acting a becoming part in life. According to the circumstances of each nation, the arts which they cultivated, and the form of government under which they lived; the knowledge which they sought to communicate to their children, and the habits which they endeavoured to impress upon them, were different from those of other nations: And again, according to the different circumstances, tempers, abilities, and dispositions of parents, even the children of each family were brought up in a manner different from that

that in which those of other families were managed. The Athenians, the Romans, the Carthaginians, conducted each of them the education of their youth in a different manner, because they had each different objects in view. But having considered the most singular establishments for education which prevailed in the ancient world, it seems unnecessary for us to descend to a particular account of the manner which every nation, or fantastic individual, thought proper to pursue in bringing up their youth. It will probably be more useful and entertaining to our readers, if we next present them with a view of some of the most judicious or fanciful plans of education which have been proposed by the writers on that subject.

17 Quinctilian.

One of the most respectable writers on education among the ancients is the celebrated Quinctilian. He taught rhetoric in Rome during the reign of Domitian, and under several of the other emperors. When he retired from the exercise of his employment as a teacher of rhetoric, he spent his leisure in the composition of a treatise, not merely on rhetoric, but on the most proper means for educating a boy so as to render him both an eloquent orator and a good man.

In that valuable treatise, he enters into a minute detail of all that appears to him most likely to conduce to those important ends.

As soon as the boy enters the world, he would have the greatest care to be used in selecting those who are to be placed about him. Let his nurse have no impediment of speech. It will be happy for him, if his parents be persons of sense and learning. Let his tutor, at least, possess these qualifications. As soon as he attains the distinct use of his organs of speech, let him be initiated in the first elements of literature. For as he is capable of distinguishing and remembering at a very early age; so his faculties cannot possibly be employed in a more advantageous manner. And even at this early period of life, let maxims of prudence and the first principles of morals be inculcated upon his mind by the books which are put into his hands, and even by the lines which he copies in learning the art of writing. The Greek language was to the Romans in the days of Quinctilian, what the Latin and Greek and French are to us at present, an acquisition held indispensably necessary to those who aspired to a liberal education; and Quinctilian judges it proper that the boy should begin his application to letters with the Greek language in preference to his mother tongue.

This judicious writer next examines a question which has been often agitated. Whether a domestic or a public education is liable to the fewest inconveniences, and likely to be attended with the greatest advantages? And he is of opinion, that in a domestic education the boy is in danger of being corrupted by injudicious fondness and evil example; is not roused by the spur of emulation; and is deprived of proper opportunities for acquiring a just idea of his own power, or that activity and dexterity which he will afterwards find so necessary when he comes to act a part in life: While in a public education, which was preferred by some of the most renowned nations of antiquity, the morals are not greatly exposed to corruption, emulation is roused, friendships are formed, all the powers of the mind are called forth to act with new vigour, and the youth is prepared for performing his part on the great theatre of the world. Quinctilian, therefore, wishes that parents would place their children in public seminaries of education.

When a boy is committed to a master's care, the master's attention must be first directed to discover his dispositions and the extent of his capacity. Of his capacity he will form a favourable judgment, not from his sprightliness, nor even from his quickness of apprehension, but from his modesty, docility, and virtuous dispositions. If the boy possess these last qualifications, the master will rejoice in him, as likely to give him satisfaction and do him honour. According to his temper and dispositions, let the boy be treated with mildness or severity; but never let severity extend to blows. Let the boy be allured and led, by the most artful and insinuating treatment, to do his duty; there will then be no occasion to punish him for neglecting it.

As Quinctilian's professed object was, not merely to give general directions for forming the heart and cultivating the understanding, but to form a particular character in life, the scholar and the orator; he finds it necessary to enter into minute details concerning the manner in which the boy is to be instructed in speaking, writing, grammar, and composition; of which it does not appear necessary for us take particular notice in this place. Music and geometry, he thinks, ought to make a part of the young orator's studies; as being useful to render him accurate in reasoning, and capable of relishing the beauties of the poets. He is also of opinion, that the boy should not be confined to one branch of study, without being allowed to attempt others till he have made himself master of that. Let several parts of literature engage his attention by turns: let him dedicate a considerable portion of his time to them. He may thus acquire habits of industrious application which will remain with him through life.

With the tender attention of a good man, this sensible and elegant writer still accompanies his pupil through the course of his studies; anxiously insists that he be placed under a master distinguished for purity of morals, and for no mean abilities in his profession; directs his memory to be stored with the noblest passages of the poets, orators, and historians; and carefully discusses and refutes those opinions which represent genius as above industry. The remaining part of his work being employed on the principles of rhetoric, without containing any thing on the subject of education in general, it is not necessary that we should here present an analysis of it to our readers. But since Quinctilian was so distinguished, not only as a rhetorician, but as an instructor of youth, and displays so much good sense and so solid a judgment, formed on long experience, in whatever he advances on the subject of education; we could not, without extreme negligence, omit taking notice of him under this article, and affording our readers an opportunity of being instructed by listening to his sentiments on this head.

18 Milton's Treatis Educat

The name of John Milton is so much revered in Britain, that his sentiments on any subject are interesting to Britons. His life was dedicated to study: During a part of it, he was employed in the task of instructing youth;

youth; and among his other works we find a treatise on education. He had himself been educated according to that plan which has long been established in the English universities; but with that mode of education he was not satisfied. The object of his directions is chiefly to form a scholar. He considered himself as qualified to exhibit a model of "a better education, in extent and comprehension far more large, and yet of time far shorter, and of attainment far more certain, than any that had yet been in practice." The following is the substance of his treatise.

As the end of learning is to cultivate our understandings, and to rectify our dispositions; therefore the design of our applying to the study of languages cannot be merely that we may commit to memory the words of which they consist, or that we may acquire a knowledge of their analogy and structure; but that we may enrich our minds with the treasures of wisdom which they contain. But in the present modes of education this design does not appear to be kept in view. The learner of Latin is burdened with rules, and themes, and verses, and orations; but no care is taken to make him master of the valuable knowledge which the classics contain. And when he advances a little farther, he is driven into the thorny paths of logic and metaphysics. So, when his studies are completed, and he is considered as having received a liberal education, he is almost as destitute of real knowledge as when he first entered a school.

But to render learning truly beneficial instead of the school and university education which youth at present receive, let the place of both school and university be supplied by an academy, in which they may acquire all that is taught at either, except law and physic. Let the academy afford accommodation for 150 persons; 20 of whom may be servants and attendants. As many academies as are necessary may be afterwards erected on the model of this one. Let the youth who are introduced into this academy begin their studies with learning the principal rules of grammar from some good elementary book. In their pronunciation of Latin, let them be taught to follow the pronunciation of the Italians; as that of the English is indistinct, and unsuitable to the genius of the language. Next, read to them some entertaining book on education; such as, the three first books of Quinctilian in Latin, and Cebes, Plutarch, or some other of the Socratic discourses, in Greek; and be careful to seize every opportunity of inspiring them, by seasonable lectures and explanations, with love for learning, admiration of great and virtuous characters, and a disposition to cheerful obedience. At the same time, but at a different hour of the day, let them be instructed in the rules of arithmetic and the elements of geometry. Between supper and bedtime, instruct them in the principles of religion and the sacred history. From the writers on education let your pupils pass to the authors on agriculture, to Cato, Varro, and Columella. Before half these authors be read, they cannot but be pretty well qualified to read most of the prose authors in the Latin language; and they may now, with great propriety, learn the use of the globes, and make themselves acquainted with the ancient and modern maps. Let them, about the same time, begin the study of the Greek tongue, and proceed in it as in the Latin: they will not fail to overcome, in a short time, all the difficulties of grammar; after which they will have access to all the treasures of natural knowledge to be found in Aristotle and Theophrastus. In the same manner they may make themselves acquainted with Vitruvius, Seneca, Mela, Celsus, Pliny, and Solinus. And having thus passed through the principles of arithmetic, geometry, astronomy, and geography, with a general compact of physics; let them next turn their attention to mathematics, in which they may begin with the practical branch of trigonometry, which will serve as an introduction to fortification, architecture, and navigation. To teach them the knowledge of nature, and instruct them in the arts of life, let them have the assistance and instructions, not merely of masters who are acquainted only with books, but of men whose skill has been obtained by actual practice, even of artists and mechanics. Next, let the poets obtain their attention; and they will now read them with ease and pleasure. From the poets let your pupils proceed to the moralists; and, after acquainting themselves with them, they may be allowed the entertainment of some of the best Greek, Latin, and Italian dramatic compositions. From these let them proceed to politics; let them here study the law of Moses, the admirable remains of the ancient lawgivers of Greece, the Roman tables, edicts, and pandects, concluding with the institutions of their mother country. Now let them be more particularly instructed in the principles of theology; for by this time they may have acquired the Hebrew language, together with the Chaldee and the Syriac dialect, and may therefore read the Scriptures in their original language. When their minds are thus furnished, they will be able to enter into the spirit of the noblest historians and poets. To get by heart, and repeat in a proper manner, passages from the writings of some of these, will have the happiest effects in elevating their genius. Let this stately edifice be crowned with logic and rhetoric. Far different would be the effects of such a course of education, from those produced by any which is at present pursued. We should then see abler writers, more eloquent speakers, and wiser statesmen. Similar to this, probably, was the course taught in the famous schools of Pythagoras, Plato, Isocrates, and Aristotle. This would unite the advantages of an Athenian and a Spartan education: for our pupils should be taught the exercises of wrestling and fencing, and the whole military discipline.

19
Remarks.

Such are the ideas of our admired Milton on the subject of education. An enthusiastic admirer of the sciences, arts, and institutions of Greece and Rome; from his religious and political principles, no friend to the universities; it was natural for a man of his learning and ingenuity, in an age of innovation, and influenced by such prejudices, to form such a project as that which we have surveyed. He seems not to have reflected, that it is necessary for children to be long occupied in obtaining a familiar acquaintance with words, before they can gain from books any knowledge of things; overlooking this circumstance, and perceiving plainly that the mode of education which then prevailed confined the attention of youth almost wholly to words, he could not but regard the scheme which he proposed as likely to produce very happy effects. His observation, that the appearances of external nature are among the first objects which attract the attention of youth, which he communicates by directing his pupils to peruse the writers on agriculture and natural history as near the beginning of their studies as possible; if not altogether just, yet must be allowed to be nearly so. Perhaps human actions and passions, and the series of events which happen around us, are, by the time at which we begin our application to learning, the objects which most frequently and strongly engage our attention: But the appearances of external nature are at least the next object of our regard.

20
Locke's Treatise on Education.

Mr Locke, to whose abilities and noble desire to be useful to the world his country is so much indebted, has written, among other things, on the education of youth. He was capable of thinking for himself; but more desirous of rendering himself useful, than of being admired for singularity. He is therefore an author to whom we ought to listen, at least, with respectful attention. If Quinctilian and Milton had been employed as teachers of youth, Mr Locke had been conversant with the world, had inquired into the principles of human nature, and had no doubt endeavoured to examine without prejudice the effects of those modes of education of which he disapproves. When we consider, that, to render himself useful to the rising generation, he could descend from the heights of science to translate the fables of Æsop, and to perform other humble tasks in literature, which a philosopher of less benevolence and virtue would have disdained; we cannot but look with veneration and gratitude on so exalted a character. In his Treatise on Education, the two great objects which Mr Locke keeps in view are, 1st, To preserve and strengthen the bodily constitution; 2dly, To inform the understanding with useful knowledge, and to cherish good dispositions in the heart.

21
Bodily constitution.

In his directions on the first of these heads, he seems extremely anxious to prevent parents and others, in whose hands children are placed, from injuring them by ill-directed tenderness. Plain fare, simple and light clothing, abstinence from physic and from strong liquors, he earnestly recommends as the most judicious means for preserving and confirming the health of the child. In all his gratifications let the strictest moderation be observed. If you permit him to indulge pretty freely in sleep, at least cause him to get up at an early hour in the morning. In one thing, however, few parents will be willing to comply with Mr Locke's advice. He not only directs that the child's feet be frequently bathed in cold water, but even expresses a wish, that his shoes were always kept in such a condition as to admit water freely. This he thinks likely to fortify the constitution of the body in such a manner, as to render him less liable, in the course of life, to such diseases as arise from any unusual exposure to wetness or cold, than others whose feet have been more carefully kept dry. Though he had prosecuted his studies with a design to enter into the profession of physic, yet so unfavourable an opinion did he entertain of the effects produced by medical preparations on the human constitution, that he earnestly insists on the parent to beware of administering any of them to his child. From the desire which Mr Locke discovers to have children exposed to hardship, and restrained from indulgence, in order to confirm the health and invigorate the constitution, we may conjecture him to have been an admirer of that severe mode of education which usually prevails in the earlier periods of the existence of society. He seems to have thought, that if a boy be brought up like a Huron or a Spartan, he must necessarily become robust and healthy; without reflecting, that of those children who are subjected to such a course of education, too great a proportion are unable to survive it: such is the natural delicacy of the human frame.

22
Cultivat
of the po
ers of the
mind.

When he turns his attention to the cultivating of the understanding, and the forming of the dispositions, Mr Locke still deservedly claims the regard of the parent and the preceptor. With a virtuous indignation he reprobates that negligence and folly by which we generally corrupt the heart and spoil the temper of children, even in that period of infancy; so as to render them incorrigible when they advance farther in life. Their appetites are pampered, all their desires are gratified: and if we are at any time disposed to refuse what they ask, they have an all-powerful engine to compel our compliance with their wishes. They assail us with tears; and we then yield to their requests, however hurtful to themselves or inconvenient to us. We often studiously instruct them in vicious tricks, and call forth their evil passions. At so early an age, their rage or cunning can scarcely injure us; and we reflect not that habits of peevishness and deceit must be peculiarly hurtful to themselves.

But though all the foolish desires of children ought not to be gratified, and though we should carefully avoid leading them into any bad habit; yet it is not necessary nor prudent to treat them with harshness or severity. Let them be formed to obedience from their earliest years: let them be accustomed to submit implicitly to the direction of those on whom they depend. But beware of souring their temper and depressing their spirits by harshness: and, on the other hand, remember that it is no less improper to give the boy a habit of neglecting his duty, except when he is allured to it by the hopes of reward. As he advances towards manhood, and attains the use of reason, you may admit him to greater familiarity, and allow him to follow his own inclinations more than at an earlier period: and if, instead of indulging all his freaks in childhood, you have carefully accustomed him to obedience and submission, without enforcing these by improper means, he will now be able to regulate his conduct with some degree of prudence.

But while caution is to be used in bestowing rewards and inflicting punishments, still rewards and punishments are indispensably necessary in the management of the child. Inspire your boy with a sense of shame, and with a generous thirst for praise. Caress and honour him when he does well: treat him with neglect when he acts amiss. This conduct will produce much better effects than if you were at one time to chide and beat him; at another, to reward him with a profusion of sweetmeats and play-things.

Think not that children are to be taught propriety of conduct by loading their memory with rules, directing

recting them how to act on every particular occasion. Burden them not with rules, but impress them with habits.

Be not desirous of forming them at too early an age, to all that politeness and propriety of manners which you wish to distinguish them when they become men. Let them be taught an easy, graceful carriage of body: but give yourself no concern, though they now and then blunder against the punctilios of good breeding; time will correct their awkwardness.

With regard to that important question, whether children ought to be sent to a public school, or are likely to be better trained up in a domestic education? so impossible is it for one master to extend his attention to a number of boys, and so likely is the contagion of vice to be caught among the crowd of a public school, that a private seems more favourable than a public education to virtue, and scarce less favourable to learning.

When you resolve to give your son a domestic education, be careful to regulate that domestic education in a judicious manner. Keep him at a distance from evil example: choose the most favourable seasons for communicating instruction: strictly enforce obedience; but never by blows, except in case of obstinacy, which you find otherwise incurable. If his engagements in life prevent the parent from superintending and directing his son's education personally, let him commit him to the care of a virtuous and judicious tutor. Let the tutor be rather a man of experience in the world than of profound learning; for it is more necessary that the pupil be formed for conducting himself with prudence in the world, and be fortified against those temptations to which he will be exposed when he enters upon active life, than that his head be stuffed with Latin and logic.

Here Mr Locke, notwithstanding that his own mind was stored with the treasures of Grecian and Roman literature, takes occasion to declare himself pretty freely against that application to ancient learning, which was then indispensably required in the education of youth. He considers languages and philosophy as rather having a tendency to render the youth unfit for acting a prudent and becoming part in life than forming for it; and he therefore insists that these should be but in a subordinate degree the objects of his attention.

Let the tutor encourage the child under his care to a certain degree of familiarity; let the pupil be accustomed to give his opinion on matters relative to himself: let him be taught justice, by finding injustice to others prejudicial to himself; let him be taught liberality, by finding it advantageous; let him be rendered superior to teasing his parents or tutor with complaints, by finding his complaints unfavourably received. That you may teach him to restrain every foolish or irregular desire, be sure never to indulge his wishes, save when you find the indulgence proper for him and convenient for yourself. Curiosity, however, is a principle which ought to be industriously roused in the breast of the child, and cherished there by meeting always the readiest gratification. However you may oppose the boy's inclinations in other things, yet refuse him not a proper portion of recreation: let him indulge in play, while he continues to play with keenness and activity; but suffer him not to loiter about in listless indolence. To restrain your child from foolhardy courage, point out to him the dangers to which it exposes him: to raise him above timorous cowardice, and inspire him with manly fortitude, accustom him from the earliest period of life to an acquaintance with such things as he is most likely to be afraid of: subject him now and then to pain, and expose him to danger; but let such trials be judiciously conducted.

Idleness or curiosity sometimes leads children to cruelty in the treatment of such animals as are placed within their power. Dogs, cats, birds, and butterflies often suffer from their inhumanity. But when they seem inclined to such cruelty, let them be carefully watched, and let every means be used to awake their hearts to generous sensibility. Allow them to keep tame birds, dogs, &c. only on condition of their using them with tenderness. Perhaps this unhappy disposition to cruelty is occasioned, or at least fostered, by people's laughing when they behold the impotent efforts of children to do mischief; and often going so far as even to encourage them in maltreating those creatures which are within their reach. We entertain them, too, with stories of fighting and battles; and represent characters distinguished for atrocious acts of inhumanity as great and illustrious. But let such practice be carefully refrained from, if you wish to inspire your child with generous and humane sentiments. Teach him gentleness and tenderness, not only to brute animals, but also to servants and companions.

Curiosity is to be roused and cherished in the breast of the child: but by what means? Answer his inquiries readily: though his questions be put in awkward language, let not that hinder you from attending to the objects of them. Curiosity is natural to the human mind; and if you repress not the curiosity of the child, he will often be moved by its impulse to the pursuit of knowledge. Let him find his eagerness in the pursuit of knowledge a source of applause and esteem. Avoid the folly of those who sport with the credulity of children, by answering their questions in a ludicrous or deceitful manner.

You must, however, not only listen with obliging attention to his questions, and strive to gratify his curiosity; but even whenever he attempts to reason on such subjects as are offered to his observation, be careful to encourage him; praise him if he reasons with any degree of plausibility; even if he blunders, beware of ridiculing or laughing at him. With regard to the boy's playthings: while you indulge him freely in innocent diversions, give him such playthings as may be necessary in the amusements in which he engages, provided they be such as he cannot make himself; but it will be still better for him to exercise his dexterity and ingenuity in making them himself.

After throwing out these things concerning the general principles on which education should be carried on, Mr Locke next proceeds to those particular parts of knowledge in which he thinks every young gentleman ought to be instructed. In virtue, wisdom, breeding, and learning, he comprehends all that is necessary to enable his pupil to act a respectable part in life.

In forming the boy to virtue, the first thing to be done is to inform him of the relation subsisting between human creatures and a supreme independent Being, their creator, preserver, and governor; and to teach him,

that

that obedience and worship are due to that Being. But when you inform the child of the existence of an invisible Being, beware of impressing his mind with any notions concerning spirits or goblins, which may render him incapable of bearing darkness or solitude. In infancy our minds are, by the indiscretion of those about us, generally impressed with such prejudices concerning a thousand frightful forms, ever ready to assail or haunt us under the shade of night, that we become incapable of manly fortitude during the course of life: the soldier who will boldly face death in the field of battle, shall perhaps tremble and take to flight at the rustling of a few leaves, or the grunting of a hog in the dark. But were the imaginations of children not crazed with wild stories concerning spirits and hobgoblins, darkness would be no more alarming to them than light. After informing the child of the existence of a Deity, and teaching him to pray to him; next labour to impress his mind with a veneration for truth, and habituate him to a strict adherence to it on every occasion. Endeavour also to render him gentle and good-natured.

The best means you can use to teach him wisdom or prudence in conducting himself in the ordinary business and intercourse of life, is to teach him to despise the mean shifts of cunning. The rest must be learned by actual experience in life.

The decencies of life, comprehended under the word Good Breeding, form no inconsiderable part of a good education. In teaching these, two things are to be attended to: Inspire the youth with a disposition to please and oblige all with whom he is conversant; next, teach him how to express that disposition in a becoming manner. Let boisterous roughness, haughty contempt of others, censoriousness, impertinent raillery, and a spirit of contradiction, be banished from his temper and behaviour. At the same time, beware of leading him to regard the mere forms of intercourse as a matter of the highest importance. Remember that genuine good breeding is only an easy and graceful way of expressing good sense and benevolence in his conversation and deportment.

Mr Locke, when he comes to give his opinion concerning those parts of learning which are proper to be taught a young gentleman, and the manner in which they ought to be communicated, advises to initiate the child in the art of reading, without letting him know that he is engaged about a matter of any importance, or learning an accomplishment which you are solicitous that he should acquire. Present it to him in the form of an amusement, or teach him to consider it as an high honour to be permitted to learn his alphabet; otherwise he will turn from it with disgust. When by insinuating arts you have allured him to apply to reading, put into his hands such books as are plain, entertaining, and instructive. Insist not on his reading over the Bible: instead of gaining any advantage from an indiscriminate perusal of it at this period of life, he is likely to acquire the most confused notions of religion, and an indifference for the sacred volume during the rest of life: yet it may be highly proper to cause him to peruse some of its beautiful historical passages, and to familiarize him with its elegant and simple moral precepts. After learning to read his mother tongue, the boy's attention ought to be next directed to the art of writing. The easiest way to teach him that art, is to get a plate engraved, after the model of any hand which you think most proper for his imitation. With this plate get a number of copies cast with red ink; the letters of these the learner may trace with his pen filled with black ink: and he will thus in a short time, and without much trouble to you or himself, acquire a decent hand. As drawing is useful on many occasions in life, if the boy be not naturally incapable of acquiring it, he may with great propriety dedicate some part of his time and attention to that art.

When the scholar has attained a tolerable degree of skill in writing, and in reading and speaking his native language, he must next begin an acquaintance with other languages. Among these, the first object of his study will naturally be the Latin. Yet let none waste their time in attempting to acquire a knowledge of Latin, but such as are designed for some of the learned professions, or for the life of a gentleman without a profession. To these last it may be useful; to others it is wholly unserviceable. But in learning the Latin tongue, a much happier method than burdening and perplexing him with rules of grammar, would be to make him speak it with a tutor who was sufficiently master of it for that purpose. Thus might he spend that time which is usually occupied in acquiring this language, in learning some other necessary branches of education. But if you cannot conveniently have the boy taught the language by the way of conversation, let the introductory books be accompanied with an English version, which he may have easy recourse to for the explanation of the Latin. Never perplex him with grammatical difficulties. Reflect that, at his age, it is impossible to enter into the spirit of those things. Render every thing as easy and pleasing as possible: for the attention will not fail to wander, even though you labour not to render the task disagreeable. Skill in grammar may be useful; but it is to those whose lives are to be dedicated to the study of the dead languages: that knowledge which the gentleman and the man of the world may have occasion to derive from the treasures contained in the ancient languages, may be acquired, without a painful study of prosody or syntax. As the learning of any language is merely learning words; if possible, let it be accompanied with the acquisition of some real knowledge of things; such as the nature of plants, animals, &c. their growth and propagation. But if you cannot or will not give your boy a private education, and are still resolved to send him to school, to be whipped through the usual course of Greek and Latin; at least act with so much good sense and humanity, as to insist that he be not burdened and tormented with the composition of Latin themes and verses. Neither let his memory be oppressed with whole pages and chapters from the classics. Such ridiculous exercises have no tendency, whatever prejudice may urge to the contrary, to improve him either in the knowledge of languages or of nature.

Mr Locke seems to wish that the French language, which in his days had attained to higher refinement and a more regular analogy than any of the other modern languages of Europe;—he seems to wish that the French were learned along with the Latin: and he wishes the study of these languages to be accompanied with the study of arithmetic, geography, history, and chronology. Let these branches of knowledge be communicated

communicated to the learner in one of the two languages; and he will thus acquire the language with greater facility. He next points out the advantages of the branches of knowledge which he recommends as proper to be learned together with the languages; but on that head he says nothing singular. One method which he recommends for facilitating the study of language is, to put into the youth's hands, as soon as he has acquired a tolerable knowledge of chronology, some of the most entertaining Latin historians: the interesting nature of the events which they relate will not fail to command his attention, in spite of the difficulty which he must find in making out their meaning. The Bible and Tully's Offices will be his best guides in the study of ethics. The law of nature and nations, as well as the civil and political institutions of his country, will form to him an important object, which he ought to study with the most careful attention. Rhetoric and logic, though generally regarded as objects of great importance in a liberal education, can neither of them contribute much, with all their rules and terms, to render him an acute reasoner or an eloquent speaker; and it is therefore unnecessary for him to honour them with very particular attention. Tully and Chillingworth will be more beneficial in teaching him to reason and to persuade, than all the treatises on rhetoric and logic which he can possibly peruse, or all the lectures on those arts which he can gain opportunities to hear. In every art and every science, practice and experience are infinitely better than rules. Natural philosophy, as contributing to inspire the breast with warmer sentiments of devotion, and serving also to many useful purposes in life, ought to make a part in the young gentleman's studies. But the humble experimental writers on that subject are to be put into his hands in preference to the lofty builders of systems. As for Greek, our pupil is not to be a professed scholar, but a gentleman and a man of the world: and therefore it does not appear necessary that Greek should make a part in the system of his education. But in none of these studies will the pupil ever attain any proficiency, unless he be accustomed to method and regularity in the prosecution of them. In languages, let him gradually ascend from what is simplest to what is most difficult: in history, let him follow the order of time; in philosophy, that of nature.

Dancing, as contributing to ease and gracefulness of carriage, ought to make part in our young gentleman's education. Fencing and riding being fashionable, cannot well be denied him. As he is likely, in the course of life, to have some leisure hours on his hands, and to be sometimes disposed to active recreation, let him learn some mechanical trade, with the exercise of which he may agreeably fill up some of those hours. If he is to possess any property, let him not be unskilled in the management of accounts. Travel, instead of being useful, appears more likely to be hurtful to the understanding and morals of the traveller, unless deferred to a later period than that at which young men are usually sent out to complete their education by traversing through foreign countries.

Here Mr Locke concludes his work with observing, that he does not offer it to the world as a full or comprehensive treatise on the subject of education, but merely as the outlines of what occurred to him as most proper to be observed in breeding up a young gentleman not intended for any learned profession or mechanical employment, but for acting a respectable part in life at the head of a competent hereditary fortune.

23
Remarks.

In considering the sentiments of this respectable philosopher on the subject of education, we perceive, that as he was, on the one hand, superior to those prejudices which render us incapable of distinguishing the defects or absurdities of any custom or institution which has long prevailed; so, on the other hand, he was free from that silly vanity which disposes those who are subject to its influence to affect novelty and singularity of sentiment on every subject which they consider. Though a member of one of the universities, he hesitates not to declare himself against a very laborious attention to classical learning; and his reasoning is, through the whole of his treatise, rather plain and solid than subtle or refined.

Yet, however we respect the soundness of his understanding or the benevolence of his intentions, we cannot avoid observing, that his opinions are not always such as experience justifies. He had no doubt taken notice of some instances in which the too great anxiety of parents about the preservation of their children's health was the very means of rendering their constitution feeble and tender through the course of life; and from that circumstance might be led to propose those expedients which he mentions for preserving the health and strengthening the constitution of children. But a little more observation or inquiry would have easily convinced him, that some of his expedients, instead of strengthening the child's constitution, would in all probability shorten his days.

He had perhaps seen some of the heroes of classical literature, who were familiar with Demosthenes and Cicero, and had Homer and Virgil at their finger ends, —he had seen some of those gentlemen so overloaded with their cargo of Greek and Latin as to be unfit for the ordinary business and intercourse of life; and such instances might tempt him to forget the advantages which he himself, and a long series of philosophers, patriots, and statesmen, with whose names the annals of our country are adorned, had derived from a regular classical education. But as we are afterwards to deliver our own sentiments on the subject, we will not here extend our observations on Mr Locke to a greater length.

24
Rousseau.

An author more distinguished than Mr Locke for tenderness of sentiment, singularity, eloquence, and whim, has presented the public with a work on the subject of education, in which, with unexampled boldness, he inveighs against all the established modes, as well as reprobates whatever had been advanced by former writers on the subject; and at the same time delineates a plan of education which he would persuade us is infinitely superior to those which he explodes. This writer is the amiable and pathetic Rousseau: And though he be often vain, paradoxical, and whimsical; yet the charms of genius and sentiment which adorn his writings will at least engage our attention while he unfolds his opinions.

25
Imprudent management of children in infancy.

He sets out with observing, that our business in the bringing up of children should be, to second and to call forth nature, and that, instead of this, we almost always oppose her intentions and operations. As soon as the child sees the light, he is wrapped in swathing bands. His limbs are thus restrained from that free motion which is necessary to their growth and vigour; and even the internal parts of his frame are rendered incapable of their proper functions. Mothers are too proud or indolent, or too fond of gaiety and dissipation, to submit to the task of nursing their own children. The poor infants are committed to some hireling nurse, who not being attached to them by natural affection, treats them with negligence or inhumanity. But is that mother capable of any delicacy of sentiment, who can permit another to suckle her child, and to share with her, or perhaps wholly supplant her, in the filial affection of that child?

Again, When parents undertake the care of their infant children, they often injure them by mistaken tenderness. They pamper them with delicate meats, cover them with warm clothes, and anxiously keep them at a distance from all that has the appearance of danger: not attending to the economy of nature, who subjects us in infancy to a long train of epidemical distempers, and exposes us during the same period to innumerable dangers; the design of which doubtless is, to teach us a prudent concern for our own safety, and to strengthen and confirm our constitutions.

A child no sooner enters into life, than it begins to cry; and during a great part of infancy continues frequently to shed tears. We either attempt to soothe it into good nature, or seek to silence it by harsher means; and it is thus we infuse into its infant mind those evil passions which we afterwards presume to impute to nature.

As the mother generally disdains to nurse her own child, so the father is seldom at leisure to take any share in the management of his education: he is put into the hands of a tutor. But that tutor whose time and attention can be purchased for money is unworthy of the charge. Either be yourself your son's preceptor, or gain a friend whose friendship to you shall be his sole motive to undertake the task.

26 Management of Emilius during infancy.

After a few preliminary observations to the above purport, our author introduces his Emilius; in whose education he delineates that plan which he prefers. The preceptor whom he would assign Emilius must be young; and must dedicate his attention to Emilius alone, from the time when his pupil enters the world till he attain the full age of manhood. Emilius, to receive the full benefit of his preceptor's system of education, and to afford full scope to it, must possess a genius of the middle class; no prodigy of parts, nor singularly dull; he must have been born to affluent circumstances and an elevated rank in life. His preceptor is invested with the rights, and takes upon him the obligations, of both father and mother. Emilius is, when put into the hands of his preceptor, a well-shaped, vigorous, and healthy child. The first care of the preceptor is to provide him with a nurse, who, as he is new born, must be newly delivered? it is of still higher importance that she be clean, healthy, virtuous, and of mild dispositions. While suckling her charge, she shall feed plentifully, chiefly on a vegetable diet. The child must be frequently bathed, in cold water if possible; if you begin with warm, however, use it by degrees colder and colder, till at length he is able to bear it entirely cold. He is not to be wrapped in swaddling clothes or rollers, or bound with staybands; but put in good warm blankets, and in a roomy cradle: Let him stretch and move his limbs at freedom, and crawl about on hands and knees at his pleasure. The greatest care must now be taken to prevent the child from contracting any habits whatever: Suffer him not to use one arm more than another, or to eat or sleep at stated hours. Prepare him for the enjoyment of liberty, by preserving to him the exercise of his natural abilities, unfettered by any artificial habits.

As soon as the child begins to distinguish objects, let his education begin. Some objects are naturally agreeable, others frightful. Accustom him to look upon any object that may come in his way without being affrighted. Children are at first ignorant of local relations, and learn to distinguish them only by experience; and while Emilius is yet an infant, incapable of speaking or walking, he may be assisted in acquiring the knowledge of these.

In his feeble helpless condition, the child must feel many wants and much uneasiness; tears are the language which nature has given him to make known his distresses and wants. When the child cries, it would be much more prudent and humane to examine what he suffers or stands in need of, than, as is usually done, to rock or sing him asleep; or, when these means succeed not, to threaten or use him brutally.

In managing children, as nature has endowed them with no superfluous powers, we ought not to confine them from the free use of those which they are able to exert. It is our duty to supply their deficiency both of mental and bodily powers; but while we are ready to administer on every occasion to their real wants, we must beware of gratifying their caprice or unreasonable humours. In order to distinguish between their natural and fantastic wants, we must study the language and signs by which they express their wishes and emotions. Though crying be the means which nature has given infants to enable them to procure relief or assistance, yet when they cry they are not always in need of either. They often cry from obstinacy or habits of peevishness. But if, instead of attempting to soothe them by diverting their attention to other objects, we would on such occasions entirely neglect them, they would soon cease to indulge in such fits of crying.

When children begin to speak, we are usually anxious about their language and articulation, and are every moment correcting their blunders. But instead of hoping to teach them purity or correctness of speech by such means as these, let us be careful to speak easily and correctly before them, and allow them to express themselves in the best manner they can. By such means we will be much more likely to obtain our wishes in this matter. When they speak, let us not listen with such solicitude as to relieve them from the necessity of using an open distinct articulation.

When the child attains the power of expressing himself in artificial language, he may then be considered as having reached the second period of infancy. He needs not now make known his wants by tears, and should therefore be discouraged from the use of them. Let his tears be entirely neglected. He now begins to run about, and you are anxious to prevent him from hurting himself; but your anxiety can only render him peevish

peevish or timid. Remove him from any very alarming danger, and then suffer him to run about at his pleasure. He will now and then bleed, and hurt himself; but he will become bold, lively, and cheerful.

In regulating the conduct of your child, let him know that he is dependant; but require not of him an implicit submission to your will. Let his unreasonable desires be opposed only by his natural inability to gratify them, or by the inconveniences attending the gratification. When he asks what is necessary or reasonable, let him instantly obtain it; when he asks what is unreasonable or improper, lend a deaf ear to all his entreaties and demands. Beware of teaching him to establish his authority over you by means of the forms of politeness. A child will scarcely take the trouble to address you with *If you please*, unless he has been made to regard these as a set of magic syllables, by the use of which he may subject every person to his will. His *If you please* then means *I please; pray*, with him, stands for *do*. Though you put in his mouth the words of humility, his tone and air are those of authority that *will* be obeyed.

Sacrifice not the present happiness of your child for the sake of any distant advantage.

Be not too anxious to guard him against natural evil. The liberty which he enjoys while he is now and then permitted to expose himself to blows, or cold, or wetness, is more than a sufficient compensation for all that he thus suffers.

Seek not to impress him with ideas of *duty* or *obligation*. Till children reach the years of discretion, they are incapable of any notions of the distinctions of morality. Avoid therefore even the use of the terms by which they are expressed in their hearing. While they continue to be affected only by sensible objects, seek not to extend their ideas beyond the sphere of sensation. Try all the powers of language, use the plainest and most familiar methods you can contrive; you shall still be unable to give the boy at this age any just ideas of the distinction between right and wrong. He may readily conceive, that for one set of actions you will punish him, and that by another he will obtain your approbation; but farther than this his ideas of *right* and *wrong*, of *virtue* and *vice*, cannot yet be carried.

The powers of the human mind are gradually unfolded. At first, the infant is capable only of perception; by and by, his instincts and passions begin to exert their force; at length, as he advances towards manhood, reason begins to act, and he becomes able to feel the beauty of virtue and the deformity of vice.

But though you seek not to regulate his conduct by notions of *duty*, yet let him feel the yoke of necessity. Let him know, that as he is weaker than you, he must not, therefore, expect that you should be subject to his will; and that, as he has neither skill nor strength to controul the laws of nature, and make every object around him bend to his pleasure, he cannot hope to obtain the gratification of all his wishes. Thus you teach him virtue before he knows what virtue is; and call forth his reason without misleading or perverting it. Let him feel his impotence; but forbid him not to think, that if he had power there would be no reason why he might not at pleasure even turn the world upside down.

Hitherto you have given your pupil no verbal instructions, nor must you yet attempt to instruct him by any other means than experience; let all his knowledge be literally of his own acquisition.

Let not the parent who has observed the conduct of children brought up in the usual way be afraid that, if his child should be treated like our pupil, he would become stupid and vicious. Nature sends not human beings into the world with a predisposition to vice: we sow the seeds of it in the infant heart; and by our absurd modes of treatment, we also enfeeble and pervert the powers of the understanding.

But from the hour of his birth till he attain the age of twelve, the education of Emilius shall be purely negative. Could we but bring him up healthy and robust, and entirely ignorant, till that period, the eyes of his understanding would then be open to every lesson: free from the influence of habit and prejudice, his passions would not then oppose us; and we might render him the wisest and most virtuous of men. If we can but lose time, if we can but advance without receiving any impressions whatever, our gains are unspeakable. Nature gives the powers of every mind some particular direction: but that particular bias, impressed by the hand of nature, cannot be distinguished before the period we have mentioned; and if you counteract nature, instead of seconding her views, the consequences cannot but be highly unfavourable both to the heart and the understanding of your pupil.

Perhaps, in the midst of society, it may be difficult to bring up our pupil without giving him some idea of the relations between man and man, and of the morality of human actions. Let that, however, be deferred as long as possible.

Were Emilius to witness a scene of anger, and to ask the cause of the appearances which he beheld, he should be told that the persons were affected with a fit of sudden illness. We might thus perhaps prevent the unhappy effects of such an example.

The first moral notions which should be communicated to the child are those of property. To communicate the ideas of property to our pupil, we will direct him to take possession of something; for instance, of a piece of ground belonging to some other person, and in a state of cultivation. Let him cultivate this spot of ground anew, sow it with seeds, and look eagerly forward to the time of harvest in the hopes of reaping the fruit of his labours. In the mean time, let the proprietor of the ground take notice of what is done, destroy your pupil's rising crop, and complain of the injustice done him. While the boy laments his loss and the disappointment of his hopes, in all the bitterness of grief, let the proprietor of the ground still insist on the injury done him, and complain of what he suffers by the purpose for which he himself had cultivated and sown the ground being frustrated. Our pupil, now sensible of the reasonableness of the other's claims, will desist from his lamentations, and only beg to have some other spot assigned him which he may cultivate at his pleasure without offending any person. This he will justly consider as his own property, to the productions of which raised by his own labour he has an exclusive right, and in the occupying of which none ought to molest him. In some such manner as this may the nature of property, the idea of which easily refers in the instance to the first occupier, and afterwards the exchange of property, be explained to him.

Another instance of the manner in which the pupil is now to be managed may not be improper in this place. He is possibly so rude and boisterous as to spoil or break whatever is within his reach. Be not angry with him, however: if he break the utensils which he has constant need of, be in no haste to supply him with others in their room; let other things be removed out of his way: if he break the windows of his apartment, let him be exposed night and day to the cold; complain not of the inconvenience yourself, but order matters so that he may feel it. After some time, let them be mended up; and if he break them again, change your method. Tell him calmly, "These windows are mine; I took care to have them put there; and I will prevent their being again broken, by confining you in a dark room." Let all his endeavours to avoid this prove ineffectual. Let him be actually confined, and be liberated only on proposing and agreeing to the condition of breaking no more windows. When he proposes this condition, be ready to listen to him; observe that it is well thought on, and that it is a pity he did not think of it sooner. Consider this engagement between you as sacred; treat him as before, and you cannot fail to attain the end in view.

The moral world now opens to us: But no sooner are we able to distinguish between right and wrong, than we become desirous to conceal those instances in which we act wrong. Lying is therefore a vice of which your pupil is now apt to be guilty: you cannot always prevent, but you can punish; but let the punishments which you inflict appear to the child only the natural consequences of his conduct. If he is in any instance convicted of a lie, let his assertions no longer gain credit. By this means, sooner than by precepts, or any other species of punishment, will you be able to reclaim him from the habit of lying.

The methods generally taken to render children virtuous are preposterous and foolish. To render them generous and charitable, we give them money, and bid them bestow it in alms, while we ourselves give nothing; but the parent or master, and not the child, should bestow the alms. Example might produce the wished-for effect. Besides, children are strangers to the value of money. A gingerbread cake is more to them than a hundred guineas. Though you teach them to give away money, till you persuade them to part readily with those things which they value most, you do not inspire them with generosity. Would you make them liberal by showing them that the most liberal is always best provided for? this is to teach covetousness, not liberality. Example is the only means by which you can, at this period, hope to teach your pupil any of the virtues.

The only lesson of morality that can with any propriety be inculcated on children, is to injure no person. Even the positive precept of doing good, must be considered as subordinate to this negative one of doing no harm. The most virtuous and the most exalted of characters, is the man who does the least harm to his fellow creatures.

In a public education, it will be necessary to attempt the communication of moral instruction at an earlier period than in a private one. In a private education, it will always be best to allow the moral powers of children to ripen as much as possible before you endeavour to inform and direct them by precepts.

There is an inequality among geniuses; and fond mothers and fathers may be disposed to plead for exceptions in favour of such of their children as they view with a partial eye. "The boy's mind is more capacious, his powers are riper, than those of others." But however great the seeming disparity of geniuses may be, it is at bottom but inconsiderable. Let the age of children be therefore regarded as a common measure by which their treatment is to be regulated.

However quick and tenacious the memories of children may seem, they can derive little advantage from the exertions of memory till such time as judgment begins to act. All the knowledge that they acquire in the course of the usual system of education, is merely the knowledge of words. The languages, geography, chronology, in short all that they are taught, and called to display so ostentatiously at this period of life, serve no other purpose than to fill their minds with words.

29
History, how far proper to be put in the hands of boys.

History is esteemed a proper thing to be put into the hands of children. But except you wish to confine their attention to the external and physical actions, it is almost nothing they can acquire by the perusal of it. And if divested of the moral distinctions of actions, of the workings of the passions, and the complication of interests, what is there to render history entertaining? We may indeed easily teach them to repeat the words *kings*, *emperors*, *wars*, *conquests*, *revolutions*, *laws*: but of the things which you use these words to denote, you will find they are hitherto incapable of forming any clear ideas.

But the mere knowledge of words is not science; make your pupil acquainted with things, and he will not fail to acquire their names. Emilius must never be set to get any composition by heart, not even fables: be careful to place before him those scenes and objects, the images of which it may be useful for him to have impressed on his memory; but by no other means seek to assist him to improve that faculty.

Emilius shall not even learn to read till he attain the age of twelve: for, before that period, it can be of no benefit to him; and the labour would only make him unhappy during that period of life which is naturally the golden part of our days. But when he has attained the proper age, matters shall be so ordered, that he shall find his ignorance of letters an inconvenience. A card shall be sent him, which being unable to read, he will apply to some of those about him. They may be unwilling to oblige him, or otherwise engaged. If, at length, it is read to him, that may be when it is now too late to take advantage of some agreeable invitation which it contained. This may be two or three times repeated. At length he becomes eager to learn to read; and accomplishes that almost without assistance.

The principle on which we proceed, is to leave the pupil almost wholly under his own direction, seemingly at at least; to lead him to acquire new accomplishments, solely from the desire of increasing his powers, and extending his influence; and humbly to follow nature, not to force her.

As we are desirous of cultivating his understanding, the means which we employ for that purpose is, to cultivate those abilities on which it depends; he is always active and in motion. Let us first make him a man in point of health and vigour, and he will soon become a man in understanding.

By our constant attention to the welfare of children, we render it unnecessary for them to attend to it themselves. What occasion has your son or pupil to observe whether the aspect of the sky threaten rain, when he knows that you will take care to have him sheltered from a shower; or to regulate the length of his excursions, when he is sure that you will not suffer him to lose his dinner?

While matters are so ordered that Emilius thinks himself subject only to his own will, though all his motions are regulated according to your pleasure; instead of becoming fantastic and capricious, he insenibly acquires the habit of keeping utility in view in all his actions.

The first objects which engage the attention of children are the appearances of the material world around them: our first study is a kind of experimental philosophy; our instruments and instructors are our hands, our feet, and our eyes. By exercising these bodily organs, the boy will acquire more real knowledge even in the period of childhood, than if he should dedicate nine-tenths of his time to books, from the age of six to sixty. All who have examined, with any sagacity, the characters, circumstances, and manners of the ancients, have agreed in attributing to their gymnastic exercises that superior strength of body and mind which renders them objects of admiration to the moderns.

Our pupil's clothes cannot be too light and easy. If tight and close, they fetter and confine his joints and limbs, and likewise obstruct the circulation of the blood; if accustomed to warm clothing, he will soon become incapable of bearing cold.

In every thing let him be habituated to what is plain and hardy. Let his bed be coarse and hard, his clothes plain, his fare simple. Infants must be freely indulged in sleep: but as Emilius is now advanced beyond infancy, he must be accustomed at times to go to bed late and get up early, to be sometimes hastily waked from sleep; and thus to prepare himself for what he may afterwards have occasion to submit to in the course of life.

As this period is in a particular manner that of exercise, and Emilius is encouraged to take as much exercise as he chooses; we must endeavour to prompt, but without seeming to direct him to such as are most proper. Swimming, though not generally attended to, is yet one of the first which a boy ought to learn. It may, on many occasions in life, be of the greatest advantage, by enabling us to save our own life or the life of others. Emilius shall be taught to swim; he shall be taught whatever can really enlarge the sphere of his power: "could I teach him to fly in the air, I would make him an eagle; if to bear the fire, a salamander."

To exercise the senses is not merely to make use of them; it is to learn to judge by them. Call not your pupil to exert his strength on every occasion; but let him learn to judge of the truth of the information which he receives from one sense, by having recourse to the evidence of another.

It is not impossible to improve the senses to a higher degree of perfection than that which they usually attain. Blind men generally possess the sense of touch in a more exquisite degree, than we who have also eyes to guide and inform us. But they acquire this superior delicacy and acuteness of sensation, only by their finding it necessary to have more frequent recourse to the information of that sense. Here is then a wide field for improvement and agreeable exercise to our pupil.

31
Darkness and ghosts.

What a variety of useful diversions might he be led to entertain himself with in the course of the night. The hours of darkness are generally hours of terror, not only to men, but also to the brute animals. Even reason, knowledge, and courage, are not always sufficient to render us superior to the terror which darkness inspires.

This timidity is usually attributed to the tales of ghosts and goblins with which we are frightened in infancy. But it originates from another cause: our ignorance of what is passing around us, and our inability to distinguish objects during that period of darkness. The passion of fear was implanted by nature in the human breast, in order that it might serve to put us on our guard against danger. But in consequence of our being subject to the influence of that passion, when we are ignorant of what surrounds us, imagination calls up dangers on all hands. And such is the cause from which our terror in darkness naturally arises.

But the only way to free our pupil from this tyranny of imagination, is to oppose to it the power of habit. A bricklayer or tyler is never giddy on looking down from the roofs of houses. Neither will our pupil be alarmed by the terrors of darkness, if he be accustomed to go frequently abroad under night. It is easy to contrive a number of little amusements, the agreeableness of which may, for a time, overcome our pupil's aversion for darkness; and thus may a habit be at length impressed.

Let us give yet another instance of the means by which children may be led to do what we wish, without our imposing any restraint on their will. Suppose Emilius is lazy and inactive, and we wish to make him learn to run. When walking out with the young sluggard after dinner, I would sometimes put a couple of his favourite cakes in my pocket; of these each of us should eat one in the course of our walk. After some time I would show him I had put a third cake in my pocket. This he would not fail to ask after finishing his own: no say I, I can eat it myself, or we will divide it;—or stay, we had better let these two little boys there run a race for it. Accordingly I propose the race to the boys; who readily accept the conditions, and one of them carries off the prize. After seeing this several times repeated, Emilius begins to think himself qualified to obtain the third cake as well as any of the little boys, and to look upon running as an accomplishment of some consequence. He seeks an opportunity of being permitted to enter the lists. He runs; and after being two or three times outstripped, is at length successful, and in a short time attains an undoubted superiority.

32 Drawing. As children naturally imitate almost whatever they behold, they are often disposed to attempt drawing. In this our pupil might be obliged, not merely for the sake of the art, but to give him a steady hand and a good eye. But he should draw from nature, not from other drawings or from prints. Were he to draw the likeness of a horse, he should look at the animal: if to attempt a representation of a house, he should view the house itself. In this method he will, no doubt, scratch for a long time without producing any likeness: but he will acquire what we proposed as the ends of his attempting to draw; namely, steadiness of hand and justness of sight, by this method, sooner than by any other.

33 Geometry. Geometry, when taught in the usual way, is certainly above the capacity of children; they cannot go along with us in our reasonings: yet they are not totally incapable of acquiring even this difficult science; if, when they are prosecuting their amusements, you lead them insensibly to observe the properties of the circle, the triangle, and the square, and place them now and then in circumstances when they may have occasion to apply their knowledge of these to real uses in life.

A child has been taught the various relations between the outlines, surfaces, and contents of bodies, by having cakes set before him, cut into all manner of regular solids; by which means he was led to master the whole science of Archimedes, by studying which form contained the greatest quantity.

There is a period between infancy and the age of puberty, at which the growth and improvement of our faculties exceed the increase of our desires. About 12 or 13, when the appetite for the sex has not yet begun to make itself felt, when unnatural wants are yet unknown, no false appetites yet acquired; at that period, though weak as a man, as a child the youth is strong.

This interval, when the individual is able to effect more than is necessary for the gratification of his wishes, contains the most precious moments of his life, which ought to be anxiously filled up in an useful manner. This is the best time for employment, for instruction, for study.

Now, let us begin to consider what is useful; for, hitherto, we have only inquired what was necessary. In entering on our studies, we will make no account of any but such as instinct directs us to pursue: those which the pedant and the pretended philosopher are impelled to pursue solely from the desire of attracting the admiration of mankind, are unworthy of our notice.

The earth which we inhabit, and the sun by whose beams we are enlightened, are the first objects which claim our attention. We will therefore direct the attention of our pupil to the phenomena of nature. We will lead him to the knowledge of geography, not by maps, spheres, and globes: we will lead Emilius out on some beautiful evening to behold the setting sun. Here we take particular notice of such objects as mark the place of his going down. Next morning we visit the spot to contemplate the rising of the glorious luminary. After contemplating for some time the successive appearances which the scene before us assumes, and making Emilius observe the hills and the other surrounding objects, I stand silent a few moments, affecting to be occupied in deep meditation: At last I address him thus: "I am thinking, that when the sun set last night, it went down yonder; whereas this morning you see he is risen on the opposite side of the plain here before us. What can be the meaning of this?" I say nothing more at this time, but rather endeavour to direct his attention to other objects.

This is our first lesson on cosmography.

Our last observation was made about Midsummer; we will next view the rising sun on some fine morning in the middle of winter. This second observation shall be made on the very same spot which we chose for the former. When Emilius and I perceive the sun now emerging above the horizon, we are struck at the change of the place of his rising. By such lessons as these may the pupil be gradually taught a real, not a seeming, acquaintance with the relative motions of the sun and the planets and with geography.

During the first period of childhood, the great object of our system of education was to spend our time as idly as possible, in order that we might avoid employing it to an ill purpose: but our views are now changed with our pupil's progress in life; and we have scarce enough of time for the accomplishment of our necessary pursuits. We therefore proceed as quickly as possible in making ourselves acquainted with the nature of the bodies around us, and the laws by which their motions and appearances are regulated. We keep to this study at present, as being necessary for the most important purposes in life, and as being the most suitable to the present state of our pupil's powers. We still begin with the most common and obvious phenomena of nature, regarding them as mere facts; and, advancing from these, we come to generalize by degrees. 34 Objects ring the cond per of childhood.

As soon as we are so far advanced as to be able to give our pupil an idea of what is meant by the word *useful*, we have attained a considerable influence over his future conduct. On every occasion after this, a frequent question between us will be, Of what use is this? This shall be the instrument by means of which I shall now be able to render him absolutely submissive to my wishes. However, I will allow him to make use of it in his turn, and will be careful not to require of him to do or learn any thing the utility of which he cannot comprehend.

Books only teach people to talk about what they do not understand. Emilius shall have as little recourse as possible to books for instruction. Yet if we can find a book in which all the natural wants of man are displayed in a manner suitable to the understanding of a child, and in which the means of satisfying those wants are gradually displayed with the same ease and simplicity; such a book will be worthy of his most attentive study. There is such a book to be found; but it is neither Aristotle, nor Pliny, nor Buffon; it is Robinson Crusoe. Emilius shall have the adventures of Robinson put into his hands: he 35 Robins Cruso shall imitate his example; even affect his dress; and, like Robinson, learn to provide for himself without the aid of others.

Another employment of Emilius at this period shall be, to visit the shops of various artisans; and when he enters a shop, he shall never come out without lending a hand to the work, and understanding the nature and the reason of what he sees going forward.

Still, however, we are careful to afford not a hint concerning those social relations, the nature of which he is not able to comprehend.

The value and importance of the various arts are ordinarily estimated, not according to their real utility, but by a very injudicious mode of estimation: Those which contribute in a particular manner to the gratification of the fantastic wishes of the rich, are preferred to those which supply the indispensable necessaries of life. But Emilius shall be taught to view them in a different light. Robinson Crusoe shall teach him to value the stock of a petty ironmonger above that of the most magnificent toy-shop in Europe. Let us establish it as a maxim, that we are to lead our pupil to form just notions of things for himself, not to dictate to him ours. He will estimate the works both of nature and art by their relation to his own convenience; and will therefore regard them as more precious than gold—a shoemaker or a mason, as a man of more importance than the most celebrated jeweller in Europe.

The intercourse of the arts consists in the reciprocal exchange of industry; that of commerce, in the exchange of commodities; and that of money, in the exchange of bills and cash. To make our pupil comprehend the nature of these, we have now only to generalize and extend to a variety of examples those ideas of the nature of property, and of the exchange of property, which we formerly communicated to him. The nature of money, as bearing only a conventional value, which it derives from the agreement of men to use it as a sign for facilitating commerce, may be now explained to Emilius, and will be easily comprehended by him. But go no farther: seek not yet to explain to the child, in what manner money has given rise to the numerous chimeras of prejudice and caprice; nor how countries which abound most in gold and silver, come to be the most destitute of real wealth.

Still our views are directed to bring up our pupil in such a manner that he may be qualified to occupy any place in the order of society into which even the caprice of fortune can throw him. Let us make him a man; not a slave, a lord, or a monarch. How much superior the character of a king of Syracuse turned schoolmaster at Corinth, of a king of Macedon become a notary at Rome, to an unhappy Tarquin incapable of supporting himself in a state of independence when expelled from his kingdom!

Whatever be our situation in the world, we can contribute nothing but our personal abilities to society. To exert them is therefore the indispensable duty of every one who enjoys the advantages of a social state; and to cultivate them in our pupil to the best purpose, ought to be the great aim of every course of education. Emilius has already made himself familiar with all the labour of industry; I can therefore bid him cultivate the land which he inherits from his father. But if it should be lost, what shall be his resource? He shall learn a trade, that he may be provided against such an accident. And he shall not be a politician, a painter, a musician, or an architect; to gain employment for his talents in any of these three arts, would cost him no less trouble than to regain his lost estate. He shall learn some simple mechanical art: he will then need only to step into the first shop he sees open, to perform his day's labour, and receive his wages.

It may be here proper to take notice of a mistake into which people generally fall in determining the trade or profession in which they are to place their children. Some accident disposes the child to declare himself for a particular employment: the parent regards that as the employment to which his talents are fitted by the design of nature; and permits him to embrace it without inquiring whether another would have been more suitable or advantageous. But because I am pleased with my occupation, I am not on that account necessarily qualified for it. Inclinations do not confer abilities. It requires more careful and accurate observation than is generally imagined, to distinguish the particular taste and genius with which nature has endowed the mind of a child. We view him carelessly, and of consequence we are apt to mistake casual inclination for original disposition.

But Emilius needs not now to hesitate about the occupation which he is to choose. It is to be some mechanical employment. All the distinction we have now to make is, to prefer one that is cleanly and not likely to be injurious to his health. We shall make choice of that of a joiner. We cannot dedicate all our time to the trade; but at least for two days in the week we will employ ourselves in learning our trade. We will have no workshop erected for our convenience, nor will we have a joiner to wait on us in order to give us the necessary instructions: but for the two days in every week which we dedicate to the purpose of learning a trade, we will go to our master's workshop; we will rise before him in the morning; work according to his orders; eat at his table; and, after doing ourselves the honour of supping with his family, return to our own hard mattresses at night. We shall be treated only according to the merit of our performances. Our master shall find fault with our work when clumsily or negligently done, and be pleased with it only when well executed.

37
New ideas suggested to Emilius by his application to a trade.

While my pupil has been accustomed to bodily exercise and manual labour, his education has been hitherto conducted in such a manner as to give him insensibly a taste for reflection and meditation. Before he has been long a workman, therefore, he will begin to become more sensible of that equality of ranks which takes place in the order of society. He will therefore take notice of his own dependence, and of my apparent wealth, and will be desirous to know why I contribute not my personal exertions to society. I put off the question with telling him, that I bestow my superfluous wealth on him and the poor; and will take to make a bench or table every week, that I may not be quite useless to the public.

And now, when about to enter the most critical period of life, when just on the brink of that age at which the heart and blood begin to feel the impulse of

38 Progress that Emilius has made before the age of puberty.

a new appetite, what progress has our pupil made? what knowledge has he acquired? All his science is merely physical. Hitherto he has scarce acquired any ideas of moral relations; but the essential relations between men and things he has attentively studied. He knows the general qualities of certain bodies; but upon those qualities he has not attempted to reason. He has an idea of abstract space by means of geometrical figures; of abstract quantity, by means of algebraical signs. He has no desire to find out the essence of things; their relations alone interest him. He values nothing external but from its relation to himself. The general consent of mankind, or the caprice of custom, have not yet given any thing a value in his eyes; utility alone is his measure of estimation. He is laborious, temperate, patient, resolute, and bold. His imagination never exaggerates danger. He scarce knows as yet what death is; but should it approach him, he is prepared to submit to necessity. He is virtuous in every thing relative merely to himself. He is prepared to become a virtuous member of society as soon as he shall be made acquainted with the nature of his social relations. He is free from vice and error as far as is possible for human nature. He considers himself as unconnected with others; requires nothing from any person, and thinks none has a right to require any thing of him. Sure a youth arrived thus at his fifteenth year has not mispent the period of his infancy.

39 New measures to be adopted in his education at that age.

But now our pupil has reached the most critical period of life. He now feels the influence of the passion for the sex; and as soon as we become subject to the influence of that passion, we are no longer unsocial beings. The want of a mistress soon produces the want of a friend.

As hitherto we have been careful not to force or anticipate nature, so even now our attention must be directed to divert the impulses of that dangerous appetite which now begins to make itself felt. To confine the growing passions within proper limits, let it be our care to defer as long as possible the time at which they begin to display themselves. For this purpose, let us cautiously guard our words and actions in the presence of our pupil. Let us be careful to give him no premature instructions.

To excite and cherish that sensibility of mind which now first begins to show itself, to extend the care of the youth beyond himself, and to interest him in the welfare of his fellow creatures, let us be careful to put such objects in his way as have a tendency to call forth and refine the feelings. It is not possible for the human heart to sympathize with those who are happier than ourselves: our sympathy is moved only by the sight of misery. We pity in others only those distresses to which we ourselves are liable: and our pity for the misfortunes of others is measured, not by the quantity of the evil, but by the supposed sensibility of the sufferer. Let these observations serve to direct us in what manner we are to form the minds of children to humanity and compassion.

In prosecution of our design, to retard rather than accelerate the growth of the passions, let us, when that critical period which we have so much feared comes on, seclude him as much as possible from the intercourse of society, where so many objects appear to inflame the appetites. Let us be circumspect in the choice of his companions, his employment, his pleasures. Let all our care be directed to nourish his sensibility without inflaming his desires. As his moral powers now begin to unfold themselves, in cultivating them let us proceed not by way of lecture, or by directing his attention to books, but still by leading him to acquire experience. At length the period will arrive for communicating to him some religious instruction. When he knows the nature of his relations to society, he may be informed of his relation to, and dependence upon, a Deity.

[The creed of the Savoyard curate, containing those sentiments concerning religious matters which Rousseau seems to propose as the most proper to be inculcated on his pupil, comes next in the order of the work; but it does not appear to be so closely connected with the subject of education as to render it proper for us to give a view of it in this place. The sentiments which he there advances, the reasonings which he urges, are evidently hostile to revealed religion; and the power of his eloquence has adorned slight and superficial arguments with such a charm, that even the sternest believer, if not absolutely destitute of taste and feeling, must read them with delight.]

And now, notwithstanding all my arts, I can no longer keep back that moment which I have endeavoured to defer to as late a period as possible. As soon as I perceive that it has entirely arrived, I no longer treat Emilius as my pupil or disciple, but as my friend. His affections are now expanded beyond himself; his moral powers have begun to exert themselves, and have received some cultivation; he also is become capable of religious sentiments, and instructed in the nature of his relation to a supreme Being. Besides, it is now requisite, if we consider the period to which nature has conducted him, that he should no longer be treated as a simple child. Hitherto ignorance has been his guardian, but now he must be restrained by his own good sense.

Now is the time for me to give him in my accounts; to show him in what manner his time and mine have been employed; to acquaint him with his station and mine, with our obligations to each other, his moral relations, the engagements he has entered into with regard to others, the degree of improvement which he has attained, the difficulties he will hereafter meet with, and the means by which he may surmount them; —in a word, to point out to him his critical situation, and the new perils which surround him; and to lay before him all the solid reasons which should engage him to watch with the utmost attention over his conduct, and to be cautious of indulging his youthful desires.

40 Means ployed preserv the pur of his ners.

Books, solitude, idleness, a sedentary and effeminate life, the company of women and young people, are what we must carefully avoid at this age. He has learned a trade, he is not unskilled in agriculture; these may be means, but not our only means, for preserving him from the impulse of sensual desire. He is now too familiar with these; he can exercise them without taking the trouble to reflect; and while his hands are busy, his head may be engaged about something quite different from that in which he is employed. He must have some new exercise which may at once fix his attention and cause him to exert his bodily powers.

powers. We can find none more suitable for this purpose than hunting. Now, therefore, Emilius shall eagerly join in the chase; and though I do not wish him to acquire that cruelty of disposition and ferocity of temper which usually distinguish those who dedicate their lives to that barbarous diversion, yet at present it may have the happiest effects in suspending the influence of the most dangerous of passions.

When I have now conducted my pupil so far; have informed him of what I have done for him, and of the difficulty of his situation; and have resigned my authority into his hands; he is so sensible of the dangers to which he is exposed, and of the tender solicitude with which I have watched over him, that he still wishes to continue under my direction. With some feigned difficulty I again resume the reins. My authority is now established. I may command obedience; but I endeavour to guard against the necessity of using it in this manner.

To preserve him from indulging in licentious pleasures, I let him know that nature has designed us for living in a state of marriage, and invite him to go in search of a female companion. I will describe to him the woman whom he is to consider as worthy of his attachment in the most flattering colours. I will array her in such charms, that his heart shall be hers before he has once seen her. I will even name her: her name shall be Sophia. His attachment to this imaginary fair one will preserve him from all the allurements of unlawful love. Besides, I take care to inspire him with such reverence for himself, that notwithstanding all the fury of his desires, he will not condescend to pursue the enjoyments of debauchery. And though I may now sometimes intrust him to his own care, and not seek to confine him always under my eye; yet still I will be cautious to watch over his conduct with careful circumspection.

But as Emilius is to be shortly introduced to his Sophia, it may perhaps be proper for us to inquire into her character, and in what manner she has been brought up.

Dist tive ha ters f th two exe

There is a natural difference between the two sexes. The difference in the structure of their bodies shows them to be destined by nature for different purposes in life, and must necessarily occasion a distinction between their characters. It is vain to ask which of them merits the pre-eminence: each of them is peculiarly fitted to answer the views of nature. Woman is naturally weak and timid, man strong and courageous; the one is a dependant, the other a protector. As the guardian of her virtue, and a restraint on her desires, woman is armed with native modesty. Reason is the guide and governor of man. When a man or a woman are united by conjugal vows, a violation of those vows is evidently more criminal in the woman than in the man. The wife ought to be answerable for the genuineness of the offspring with which she has been intrusted by nature. It is no doubt barbarous and wicked for the husband to defraud his wife of the only reward which she can receive for the severe duties of her sex: but the guilt of the faithless wife is still more atrocious; and the consequences of her infidelity are still more unhappy.

But if nature has established an original distinction between the characters of the two sexes; has formed them for different purposes, and assigned them different duties; it must follow, that the education of the one sex ought to be conducted in a manner different from that of the other. The abilities common to the two sexes are not equally divided between them; but if that share which nature has distributed to woman be scantier than what she has bestowed on man, yet the deficiency is more than compensated by the qualities peculiar to the female. When the woman confines herself to assert her proper rights, she has always the advantage over man; when she would usurp those of the other sex, the advantage is then invariably against her.

But we require not that woman should be brought up in ignorance. Let us consider the delicacy of her sex, and the duties which she is destined to perform; and to these we may accommodate the education which we bestow upon her. While boys like whatever is attended with motion and noise, girls are fond of such decorations as please the eye. Dolls are the favourite plaything of the sex in their infant years. This is an original taste, of the existence of which we have the plainest evidence. All therefore that we ought to do is, to trace and bring it under proper regulation. Allow the girl to decorate her baby in whatever manner she pleases; while employed about that, she will acquire such skill and dexterity in those arts which are peculiar to her sex, that with scarce any difficulty she will acquire needle-work, embroidery and the art of working lace. Her improvements may even be extended as far as designing, an art somewhat connected with taste in dress; but there is no reason that their skill in this art should be carried farther than to the drawing of foliage, fruits, flowers, drapery, and such parts of the art as bear some relation to dress. Always assign reasons for the employment which you give to young girls, but be sure you keep them constantly busy. They ought to be accustomed to laborious industry, as well as to bear the abridgement of their liberty. Use every art to prevent their work from becoming disagreeable to them. For that purpose, let the mother be careful to make herself agreeable. A girl who loves her mother or her aunt, will work cheerfully by them all day; while she to whom her mother is not dearer than all the world besides, seldom turns out well. Never suffer girls, even at their diversions, to be entirely free from restraint, nor allow them to run from one amusement to another. If you now and then detect your daughter using a little artifice to excuse herself from obedience, reflect that artifice is, in a certain degree, natural to the fair sex; and as every natural inclination, when not abused, is upright and good, why should it not be cultivated? In order to give girls proper notions of dress, let them be taught to consider splendour and elegance of dress, as designed only to conceal the natural defects of the person; and to regard it as the noblest triumph, the highest praise, of beauty, to shine with unborrowed lustre in the simplest attire. Forbid not young women to acquire those arts which have a tendency to render them agreeable. Why refuse them the indulgence of learning to dance, to sing, and to study such other accomplishments as afterwards enable them to entertain their husbands? Girls are more disposed to prattle, and at an earlier age, than boys. We may now and then find it necessary

cessary to restrain their volubility. But the proper question to them on such occasions is not, as to boys, *Of what use is this?* but *What effects will this produce?* At this early period, when they are yet strangers to the distinction between good and evil, and therefore unable to form a just judgment concerning any person's conduct, we ought to restrain them carefully from saying what may be disagreeable to those with whom they converse.

Girls are no less incapable than boys of forming distinct notions of religion at an early age. Yet, and even for that very reason, religious instruction should be communicated to them much sooner than to the youth of the other sex. Were we to wait the period when their mental faculties arrive at maturity, we might perhaps lose the happiest time, from our inability to make a right distinction. Since a woman's conduct is subject to public opinion, her belief ought therefore to depend, not on reason, but on authority. Every girl ought to follow the religion of her mother, every married woman that of her husband. They cannot derive a rule of faith from their own inquiry. Let us therefore seek, not so much to instruct them in the reasons of our belief, as to give them clear distinct notions of those articles which we require them to believe. Be more careful to instruct her in those doctrines which have a connexion with morality, than in those mysterious articles which we are required to believe, though we cannot comprehend them.

Such are the principles on which the education of Emilius's unknown mistress has been conducted.

[Notwithstanding the merit of that part of this treatise in which the author entertains us with the courtship between his Emilius and Sophia, it does not appear to be so intimately connected with the subject of education as to render it proper for us to present our readers with a view of it. We therefore pass over the courtship, to give a view of our author's sentiments concerning the advantages to be derived from travelling, and the manner in which it ought to be directed.]

42
Emilius attached to a mistress.

When Emilius has formed a firm attachment to Sophia, and by his assiduities has been so fortunate as to gain her affections, his great wish now is, to be united with her in the bonds of marriage. But as he is still young, is but imperfectly acquainted with the nature of those duties incumbent on him as a member of a particular society, and is even ignorant of the nature of laws and government, I must separate him from his Sophia, and carry him to gain a knowledge of these things, and of the character and circumstances of mankind, in various countries, and under various forms of civil government, by travelling. Much has been said concerning the propriety of sending young people to travel, in order to complete their education. The multiplicity of books is unfavourable to real knowledge. We read with avidity, and think that by reading we render ourselves prodigiously wise. But we impose on ourselves: the knowledge which we acquire from books is a false species of knowledge, that can never render us truly wise.

43
Travel.

To obtain real knowledge, you must observe nature with your own eyes, and study mankind. But to gain this knowledge by travelling, it is not necessary that we should traverse the universe. Whoever has seen ten Frenchmen has beheld them all; and whoever has surveyed and compared the circumstances and manners of ten different nations may be said to know mankind.

To pretend that no advantages may be derived from travelling, because some of those who travel return home without having gained much real improvement, would be highly unreasonable. Young people who have had a bad education, and are sent on their travels without any person to direct or superintend their conduct, cannot be expected to improve by visiting foreign countries. But they whom nature has adorned with virtuous dispositions, and who have been so happy as to receive a good education, and go abroad with a real desire of improvement, cannot but return with an increase of virtue and wisdom. In this manner shall Emilius conduct his travels. To induce him to improve in the most attentive manner that time which he should spend in travelling, I would let him know, that as he had now attained an age in which it might be proper for him to form some determination with regard to the plan of his future life, he ought therefore to look abroad into the world, to view the various orders in society, to observe the various circumstances of mankind under different forms of government, and in different parts of the globe; and to choose his country, his station, and his profession. With these views should Emilius set out on his travels: and with these views, in the course of our travels, we should inquire into the origin of society and government, into the nature of those principles by means of which men are united in a social state, into the various circumstances which have given rise to so many different forms of government, and into the necessary relation between government and manners. Our stay in the great towns should be but short: for as in them corruption of manners has risen to a great height, and dissipation reigns, a long stay in any great town might be fatal to the virtuous dispositions of Emilius. Yet his attachment to Sophia would alone be sufficient to save him from the dangers to which his virtue is exposed. A young man must either be in love, or be a debauchee. Instances may be pointed out in which virtue has been preserved without the aid of love; but to such instances I can give little credit.

44
Return from his travels, and marriage.

Emilius, however, may now return to his Sophia. His understanding is now much more enlightened than when he set out on his travels. He is now acquainted with several forms of government, their advantages and defects, with the characters of several different nations, and with the effects which difference in circumstances may be expected to produce on the characters of nations. He has even been so fortunate as to get acquainted with some persons of merit in each of the countries which he has visited. With these advantages gained, and with affection unchanged and unabated, he returns to his Sophia. After having made him acquainted with the languages, the natural history, the government, the arts, customs, and manners, of so many countries, Emilius eagerly informs me that the period which we had destined for our travels is now expired. I ask, What are then his purposes for life? He replies, that he is satisfied with the circumstances in which nature has placed him, and with my endeavours to render him independent on fortune, and wishes only for his Sophia to be happy. After giving him a few

advices

advices for the regulation of his conduct in life, I conduct him to his Sophia, and behold him united with her in marriage. I behold him happy; with affectionate gratitude he blesses me as the author of his happiness; and I thus receive the reward of all the pains with which I have conducted his education.

45
arks.
Such are the outlines of the system of education proposed by this singular and original genius. For originality of thought, affecting sentiment, enchanting description, and bold vehement eloquence, this book is one of the noblest pieces of composition, not only in the French language, but even in the whole compass of ancient and modern literature. The irregularity of his method, however, renders it a very difficult task to give an abridged view of his work. He conducts his pupil, indeed, from infancy to manhood: But instead of being barely a system of education, his work is besides a treasure of moral and philosophical knowledge. He has chosen a path, and follows it from the bottom to the summit of the hill: yet whenever a flower appears on the right or left hand, he eagerly steps aside to pluck it; and sometimes, when he has once stepped aside, a new object catches his eye and seduces him still farther. Still, however, he returns. His observations are in many places loosely thrown together; and many things are introduced, the want of which would by no means have injured either the unity or the regularity of his work. If we attempt to review the principles on which he proceeds in reprobating the prevalent modes of education, and pointing out a new course, his primary and leading one seems to be, that we ought to watch and second the designs of nature, without anticipating her. As the tree blossoms, the flowers blow, and the fruit ripens at a certain period; so there is a time fixed in the order of nature for the sensitive, another for the intellectual, and another for the moral powers of man to display themselves. We in vain attempt to teach children to reason concerning truth and falsehood, concerning right and wrong, before the proper period arrive: We only confound their notions of things, and load their memories with words without meaning; and thus prevent both their reasoning and moral powers from attaining that strength and acuteness of which they are naturally capable. He attempts to trace the progress of nature, and to mark in what manner she gradually raises the human mind to the full use of all its faculties. Upon the observations which he has made in tracing the gradual progress of the powers of the human mind towards maturity, his system is founded.

As it is impossible to communicate to the blind any just ideas of colours, or to the deaf of sounds: so it must be acknowledged, that we cannot possibly communicate to children ideas which they have not faculties to comprehend. If they are, for a certain period of life, merely sensitive animals, it must be folly to treat them during that period as rational and moral beings. But is it a truth that they are, during any part of life, guided solely by instinct, and capable only of sensation? Or, how long is the duration of that period? Has nature unkindly left them to be, till the age of twelve, the prey of appetite and passion? So far are the facts of which we have had occasion to take notice, concerning the history of infancy and childhood, from leading to such a conclusion, that to us it appears undeniable that children begin to reason very soon after their entrance into life. When the material world first opens on their senses, they are ignorant of the qualities and relations of surrounding objects: they know not, for instance, whether the candle which they look at be near or at a distance; whether the fire with which they are agreeably warmed may also affect them with a painful sensation. But they remain not long in this state of absolute ignorance. They soon appear to have acquired some ideas of the qualities and relative situation of bodies. They cannot, however, acquire such ideas, without exerting reasoning powers in a certain degree. Appearances must be compared, and inferences drawn, before knowledge can be gained. It is not sensation alone which informs us of the relative distances of bodies; nor can sensation alone teach us, that the same effects which we have formerly observed will be again produced by the same cause.

But if children appear capable of reasoning at a very early period, they appear also to be at a very early period subject to the influence of the passions: they are angry or pleased, merry or sad, friends or enemies, even while they hang at the breast; instead of being selfish, they are naturally liberal and social. And if we observe them with candid attention, we will find that the passions do not display themselves sooner than the moral sense. As nature has wisely ordered, that we should not see, and hear, and feel, without being able to compare and draw inferences from our perceptions; so it is a no less certain and evident law of nature, that the passions no sooner begin to agitate the human breast, than we become able to distinguish the beauty and the deformity of virtue and vice. The child is not only capable of gratitude and attachment to the person who treats him with kindness; he is also capable of distinguishing between gratitude and ingratitude, and of viewing each with proper sentiments. He cries when you refuse to gratify his desires; but he boldly insists that he is injured when you use him cruelly or unjustly. It is indeed impossible to attend to the conduct of children during infancy, without being convinced that they are, even then, capable of moral distinctions. So little are they acquainted with artificial language, that we and they do not then well understand each other. But view their actions; consider those signs by which nature has taught them to express themselves. Our limbs, our features, and our senses, are not gradually and by piecemeal bestowed as we advance towards maturity; the infant boy comes not into the world mutilated or defective: why then, in point of mental abilities, should we be for a while brutes, without becoming rational and moral beings till the fulness of time be accomplished? All the differences between the phenomena of manhood and those of infancy and childhood may be accounted for, if we only reflect, that when children come into the world, they are totally unacquainted with all the objects around them; with the appearances of nature, and the institutions of society; that they are sent into the world in a feeble state, in order that the helplessness occasioned by their ignorance may attract the notice and gain the assistance of those who are able to help them; and that they attain not full strength in the powers either of mind or body, nor a sufficient acquaintance with nature, with artificial language, and with the arts and institutions of society, till they arrive at manhood.

Even Rousseau, notwithstanding the art with which he lays down his system, cannot avoid acknowledging indirectly, on several occasions, that our social dispositions, our rational and our moral powers, display themselves at an earlier period than that at which he wishes us to begin the cultivation of them.

But though the great outlines of his system be merely theory, unsupported by facts, nay plainly contradictory to facts; yet his observations on the impropriety or absurdity of the prevalent modes of education are almost always just, and many of the particular directions which he gives for the conducting of education are very judicious. He is often fanciful, and often deviates from the common road, only to show that he is able to walk in a separate path. Yet why should he be opposed with so much virulence, or branded with so many reproachful epithets? His views are liberal and extensive: his heart seems to have glowed with benevolence: his book contains much observation of human actions; displays an intimate acquaintance with the motives which sway the human heart; and if not a perfect system for education, is yet superior to what any other writers had before done upon the subject. It is surely true, that we ourselves often call forth evil passions in the breasts of children, and impress them with bad habits: it is no less true that we put books in their hands, and load their memory with words, when we ought rather to direct their attention to things, to the phenomena of nature, and the simplest arts of life. The form in which he has chosen to communicate his sentiments on the subject of education renders the perusal of it more pleasing, and his precepts more plain, than they would otherwise have been: it is nearly that dramatic form with which we are so much delighted in some of the noblest compositions of the ancients.

After viewing the public establishments for education which existed in some of the most renowned states of antiquity; and after listening to the sentiments of the experienced Quinctilian, the learned Milton, the judicious Locke, and the bold fanciful Rousseau, on this interesting subject; it may now be proper to lay before the reader our own sentiments concerning the education of youth under a few distinct heads.

Indeed, if we were disposed to give abridgements of all the books which have been written on the subject of education, or even to hint at all the various modes which have been recommended by teachers or theorists, we might swell this article to an amazing size: Nay, were we only to take notice of the many elegant and sensible writers who have of late endeavoured to call the attention of the public to this subject, we might extend it to an immoderate length. A Kames, a Priestley, a Knox, a Madame de Sillery, and a Berquin, might well attract and fix our attention. But as, among such a crowd of writers, every thing advanced by each cannot be original; and even of those things which are original, only a certain, and that perhaps even a moderate, proportion, can be just and judicious; and as they often either borrow from one another, or at least agree in a very friendly manner, though in some things they profess a determined hostility; therefore we shall content ourselves with having taken notice of four of the most respectable writers on the subject.

In presenting to our readers the result of our own observations and reflections, we shall throw our thoughts nearly under the following heads. The management of children from their birth till they attain the age of five or six; from that period till the age of puberty; and from that age till manhood; private and public education; religion and morals; the languages; natural philosophy; the education of people of rank and fortune; education of persons designed for a mercantile employment, and for the other humbler occupations in active life not particularly connected with literature; education of the female sex; foreign travel; knowledge of the world; and entrance into active life. We do not pretend to be able to include under these heads every thing worthy of notice in the subject of education: but under these we will be able to comprehend almost every thing of importance that has occurred to us on the subject.

I. *On the Management of Infants from the Time of their Birth till they attain the Age of five or six.*

THE young of no other animal comes into the world in so helpless a state, or continues so long to need assistance, as that of the human species. The calf, the lamb, and the kid, are vigorous and lively at the instant of their birth; require only, for a very short period, nourishment and protection from their respective dams; and soon attain such degrees of strength and activity as to become entirely independent. The infancy of the oviparous animals is not of longer continuance: And, indeed, whatever department of the animal world we may choose to survey, we still find that no species is subject to the same severe laws as man during the first period of life.

46
Man com
pared to
other ani
mals, in r
spect to
the help-
lessness
infancy.

Yet the character and the views of man are so very different from those of the other animals, that a more careful attention to these may perhaps induce us to regard this seeming severity rather as an instance of the peculiar kindness of the author of nature. From every observation which has been hitherto made on the powers and operations of the inferior animals, we are led to consider them as guided and actuated chiefly, if not solely, by instinct, appetite, and sensation: their views extend not beyond the present moment; nor do they acquire new knowledge or prudence as they advance in life. But the character of the human race is much more exalted. We have also powers and organs of sensation, instincts and appetites; but these are the most ignoble parts of our nature: our rational faculties and moral powers elevate us above the brutes, and advance us to an alliance with superior beings. These rational faculties and moral powers render us capable of social life, of artificial language, of art, of science, and of religion. Now, were one of the species to come into the world full grown, possessed of that bodily strength and vigour which distinguishes manhood, his ignorance would still render him inadequate to the duties of life; nay, would even render him unable to procure means for his subsistence; while his manly appearance would deprive him of the compassion and benevolent assistance of others; and his strength and vigour would also render him less docile and obedient than is necessary, in order that

that he may receive instruction in the duties and arts of life. Again, were the period of infancy as short to the human species as to the other animals; were we to be no longer subjected to a parent's authority, or protected by his care, than the bird or the quadruped; we should be exposed to the dangers and difficulties of the world before we had acquired sufficient knowledge or prudence to conduct us through them, before we had gained any acquaintance with the ordinary phenomena of nature, or were able to use the language or practise the arts of men in a social state.

Since then, it is by the benevolence of nature that we are feeble and helpless at our entrance into life, and that our progress towards maturity is slow and gradual; since nature has destined us to be for a considerable time under the care and authority of our parents; and since the manner in which we are managed during that early part of life has so important an influence on our future character and conduct: it is therefore incumbent on parents to direct that tenderness, which they naturally feel for their offspring, in such a manner as to second the views of nature.

When children come into the world, instinct directs them to receive nourishment from the breast, and to claim attention to their pains and wants by crying. We attend to their signs, and strive to render them as easy as we can. They are washed, clothed with such garments as we think most suitable, and suckled either by their mother or by some other woman who is considered as proper for the purpose. The absurd mode of swaddling up infants in such a manner as to confine them almost from all motion, and leave scarce a limb at liberty, which has been so often exclaimed against and represented as highly injurious to the symmetry and vigour of the human frame, is now almost entirely laid aside; and therefore we need not raise our voice against it. Still, however, there are certainly too many pins and bandages used in the dress of infants: these are unfavourable to the circulation of the blood, impede the growth, and often occasion those tears and that peevishness which we rashly attribute to the natural ill humour of the poor creatures. Their dress ought to be loose and cool, so as to press hard on no joint, no vein nor muscle; and to leave every limb at liberty. If too heavy and close, it may occasion too copious a perspiration, and at the same time confine the matter perspired on the surface of the skin; than which nothing can be more prejudicial to the health of the child. It may also, however, be too thin and cool: for as moderate warmth is necessary to the vegetation of plants; so it is no less necessary for promoting the growth of animals: and, therefore, though the dress of infants ought to be loose and easy, yet still it should be moderately warm.

47 D of in- fa

Nur

It is common for mothers in affluent or even in comfortable circumstances, to forego the pleasure of nursing their own children, that they may avoid the fatigues with which it is attended. This practice has long prevailed in various ages and among various nations: it has been often reprobated with all the warmth of passion, and all the vehemence of eloquence, as dishonourable, inhuman, contradictory to the designs of nature, and destructive of natural affection: yet still it prevails; fathers and mothers are still equally deaf to the voice of nature and the declamations of philosophers. Indeed, in a luxurious age, such a practice may be naturally expected to prevail. In such an age, they who are possessed of opulence generally persuade themselves, that, to be happy, is to spend their time wholly amid diversions and amusements, without descending to useful industry, or troubling themselves about the ordinary duties of life. Influenced by such notions, they think it proper for them to manage their family affairs, and to nurse and educate their children, by proxy; nay, to do for themselves nothing that another can perform for them. It is vain to make a serious opposition to these absurd notions; the false views of happiness, the pride and the indolence produced by luxury, will still be too powerful for us. We must not hope to persuade the mother, that to receive the caresses, to behold the smiles, and to mark the bodily and mental powers of her child in their gradual progress towards maturity, would be more than a sufficient compensation for all the fatigues which she would undergo in nursing and watching over him in his infant years. We need not mention, that the mutual affection between a mother and her child, which is partly the effect of instinct, depends also, in no inconsiderable degree, on the child's spending the period of infancy in its mothers's arms; and that when she substitutes another in her place, the child naturally transfers its affection to the person who performs to it the duties of a mother. We need not urge these, nor the various other reasons which seem to recommend to every mother the province of suckling her own children, and watching over their infant years; for we will either not be heard, or be listened to with contempt. Yet we may venture to suggest, that if the infant must be committed to a stranger, some degree of prudence may be employed in selecting the person to whom he is to be intrusted. Her health, her temper, and her manner of speaking, must be attended to. A number of other qualifications are also to be required in a nurse: but it is rather the business of the physician to give directions with regard to these. If her habit of body be any way unhealthy, the constitution of the infant that sucks her milk cannot but be injured: if her temper be rough or peevish, the helpless child subjected to her power will be often harshly treated; its spirit will be broken, and its temper soured: if her pronunciation be inarticulate or too rapid, the child may acquire a bad habit when it first begins to exert its vocal organs, which will not be easily corrected.

49 Influence of treatment in infancy on the abilities and dispositions.

In the milder seasons of the year, infants ought to be frequently carried abroad. Not only is the open air favourable to health, but the freshness, the beauty, the variety, and the lively colours of the scenes of nature, have the happiest effects on the temper, and have even a tendency to enliven and invigorate the powers of the mind. At this period, the faculties of the understanding and the dispositions of the heart generally acquire that particular bias, and those distinguishing features, which characterize the individual during the future part of his life, as quick or dull, mild or passionate; and which, though they be generally attributed to the original conformation of the mind by the hand of nature, yet are owing rather to the circumstances in which we are placed, and the manner in which we are treated, during the first part of life.

When children begin to walk, our fondness disposes us to adopt many expedients to assist them. But these seem to be improper. It is enough for us to watch over them so as to guard them from any danger which they might otherwise incur by their first attempts to move about. Those who advise us not to be too anxious to preserve children from those slight hurts to which they are exposed from their disposition to activity, before they have acquired sufficient strength or caution, certainly give a judicious piece of advice which ought to be listened to. By being too attentive to them, we teach them to be careless of themselves; by seeming to regard every little accident which befals them as a most dreadful calamity, we inspire them with timidity, and prevent them from acquiring manly fortitude. When children begin to lisp out a few words or syllables, the pleasure which we feel at hearing them aim at the use of our language, disposes us to listen to them with such attention as to relieve them from the necessity of learning an open distinct articulation. Thus we teach them to express themselves in a rapid, indistinct, and hesitating manner, which we often find it difficult, sometimes even impossible, to correct, when they are farther advanced. Would we teach them a plain distinct articulation, we ought not only to speak plainly and distinctly in their presence, but also to disregard their questions and requests, if not expressed with all the openness and distinctness of pronunciation of which they are capable.

Man is naturally an imitative animal. Scarce any of our natural dispositions is displayed at an earlier period than our disposition to imitation. Children's first amusements are dramatic performances, imitative of the arts and actions of men. This is one proof among others, that even in infancy our reasoning faculties begin to display themselves; for we cannot agree with some philosophers that children are actuated and guided solely by instinct in their attempts at imitation.

However that be, the happiest use might be made of this principle which discovers itself so early in the infant mind. Whatever you wish the child to acquire, do in his presence in such a manner as to tempt him to imitate you. Thus, without souring his mind by restraint during this gay innocent period of life, you may begin even now to cultivate his natural powers. Were it impossible at this time to communicate any instruction to the boy, without banishing that sprightly gaiety which naturally distinguishes this happy age, it would be best to think only how he might lose his time in the least disadvantageous manner. But this is far from being necessary. Even now the little creature is disposed to imitation, is capable of emulation, and feels a desire to please those whose kindness has gained his affection. Even now his sentiments and conduct may be influenced by rewards when prudently bestowed, and by punishments when judiciously inflicted. Why then should we hesitate to govern him by the same principles, by which the laws of God and society assert their influence on our own sentiments and conduct? Indeed, the imprudent manner in which children are too generally managed at this early period, would almost tempt us to think it impossible to instruct them, as yet, without injuring both their abilities and dispositions. But this is owing solely to the carelessness, stupidity, or capricious conduct of those under whose care they are placed.

50
Obedience whether, and when, to be exacted.

Is implicit obedience to be exacted of children? and at what period of life should we begin to enforce it? As children appear to be capable both of reasoning and of moral distinctions at a very early age; and as they are so weak, so inexperienced, so ignorant of the powers of surrounding bodies, and of the language, institutions, and arts of men, as to be incapable of supporting or conducting themselves without direction or assistance; it seems therefore proper that they be required even to submit to authority. To the necessity of nature both they and we must on many occasions submit. But if the will of a parent or tutor be always found scarce less unalterable than the necessity of nature, it will always meet with the same respectful submissive resignation. It may not perhaps be always proper to explain to children the reasons for which we require their obedience: because, as the range of their ideas is much less extensive than ours; as they do not well understand our language, or comprehend our modes of reasoning; and as they are now and then under the influence of passion and caprice, as well as people who are farther advanced in life; we are therefore likely to fail in making them comprehend our reasons, or in convincing them that they are well grounded. And as it is proper to exact obedience of children; so we should begin to require it as soon as they become capable of any considerable degree of activity. Yet we must not confine them like slaves, without allowing them to speak, to look, or to move, but as we give the word. By such treatment we could expect only to render them peevish and capricious. It will be enough, at first, if we let them know that obedience is to be exacted; and if we restrain them only where, if left at liberty, they would be exposed to imminent danger.

If then, at so early a time of life as before the age of five or six, it is possible to render children obedient, and to communicate to them instruction; what arts, or what learning, ought we to teach them at that period? To give a proper answer to this question, is no easy matter. It seems at first difficult to determine, whether we ought yet to initiate them in letters. But as their apprehension is now quick, and their memory pretty tenacious, there cannot be a more favourable time for this very purpose. As soon as they are capable of a distinct articulation, and seem to possess any power of attention, we may with the greatest propriety begin to teach them the alphabet. The most artful, alluring methods may be adopted to render the hornbook agreeable; or we may use the voice of authority, and command attention for a few minutes; but no harshness, no severity, and scarce any restraint. At the same time, it will be proper to allow the little creatures to run much about in the open air, to exercise their limbs, and to cultivate those social dispositions which already begin to appear, by playing with their equals.

Such are the thoughts which have suggested themselves to us concerning the management of children in mere infancy. What an amiable little creature would the boy or girl be, who were brought up in a manner not inconsistent with the spirit of these few hints? Behold him healthy and vigorous, mild, sprightly, and cheerful:

ful: He is submissive and docile, yet not dull or timid; he appears capable of love, of pity, and of gratitude. His mind is hitherto, however, almost wholly uninformed: he is acquainted but with a few of the objects around him; and knows but little of the language, manners, and institutions of men: but he feels the impulse of an ardent curiosity, and all the powers of his mind are alive and active.

II. *On the Management of Children between the Age of five or six and the Age of Puberty.*

At this period it may be proper, not only to exact obedience, and to call the child's attention for a few minutes now and then to those things of which the knowledge is likely to be afterwards useful to him: but we may now venture to require of him a regular steady application, during a certain portion of his time, to such things as we wish him to learn. Before this time it would have been wrong to confine his attention to any particular task. The attempt could have produced no other effect than to destroy his natural gaiety and cheerfulness, to blunt the natural quickness of his powers of apprehension, and to render hateful that which you wished him to acquire. Now, however, the case is somewhat different: The child is not yet sensible of the advantages which he may derive from learning to read, for instance; or even though he were able to foresee all the advantages which he will obtain by skill in the art of reading through the course of life; yet is it the character of human nature, at every stage of life, to be so much influenced by present objects in preference to future views, that the sense of its utility alone would not be sufficient to induce him to apply to it. Even at the age of 12, of 20, of 50; nay, in extreme old age, when reason is become very perspicacious, and the passions are mortified; still we are unable to regulate our conduct solely by views of utility. Nothing could be more absurd, therefore, than to permit the child to spend his time in foolish tricks, or in idleness, till views of utility should prompt him to spend it in a different manner. No; let us begin early to habituate him to application and to the industrious exertion of his powers. By endowing him with powers of activity and apprehension, and rendering him capable of pursuing with a steady eye those objects which attract his desires, nature plainly points out to us in what manner we ought to cultivate his earlier years. Besides, we can command his obedience, we can awaken his curiosity, we can rouse his emulation, we can gain his affection, we can call forth his natural disposition to imitation, and we can influence his mind by the hope of reward and the fear of punishment. When we have so many means of establishing our authority over the mind of the boy without tyranny or usurpation; it cannot surely be difficult, if we are capable of any moderation and prudence, to cultivate his powers, by making him begin at this period to give regular application to something that may afterwards be useful.

And if the boy must now begin to dedicate some portion of his time regularly to a certain task, what task will be most suitable? Even that to which children are usually first required to apply; continue teaching him to read. Be not afraid that his abilities will suffer from an attention to books at so early an age. Say not that it is folly to teach him words before he have gained a knowledge of things. It is necessary, it is the design of nature, that he should be employed in acquiring a knowledge of things, and gaining an acquaintance with the vocal and written signs by which we denote them, at the same time. These are intimately connected; the one leads to the other. When you view any object, you attempt to give it a name, or seek to learn the name by which men have agreed to distinguish it: in the same manner, when the names of substances or of qualities are communicated to us, we are desirous of knowing what they signify. At the same time, so imperfect is the knowledge of nature which children can acquire from their own unassisted observation, that they must have frequent recourse to our assistance before they can form any distinct notions of those objects and scenes which they behold. Indeed language cannot be taught, without teaching that it is merely a system of signs, and explaining what each particular sign is designed to signify. If, therefore, language is not only necessary for facilitating the mutual intercourse of men, but is even useful for enabling us to obtain some knowledge of external nature, and if the knowledge of language has a natural tendency to advance our knowledge of things; to acquaint ourselves with it must therefore be regarded as an object of the highest importance: it must also be regarded as one of the first objects to which we ought to direct the attention of children. But the very same reasons which prove the propriety of making children acquainted with those artificial vocal signs which we use to express our ideas of things, prove also the propriety of teaching them those other signs by which we express these in writing. It is possible indeed, nay it frequently happens, that we attempt to instruct children in language in so improper a manner as to confound their notions of things, and to prevent their intellectual powers from making that improvement of which they are naturally capable; but it is also possible to initiate them in the art of reading, and in the knowledge of language, with better auspices and happier effects. The knowledge of language may be considered as the key by which we obtain access to all the stores of natural and moral knowledge.

52
Confinement, how far proper.

Though we now agree to confine our pupil to a certain task, and have determined that his first task shall be to learn to read; yet we do not mean to require that he be confined to his task during the greatest part of the day, or that his attention be seriously directed to no other object. To subject him to too severe restraint would produce the most unfavourable effects on his genius, his temper, and his dispositions. It is in consequence of the injudicious management of children, while they are sometimes suffered to run riot, and at other times cruelly confined like prisoners or slaves; it is in consequence of this, that we behold so many instances of peevishness, caprice, and invincible aversion to all serious application at this period of life. But were a due medium observed, were restraint duly tempered with liberty and indulgence, nothing would be more easy than to dispose children to cheerful obedience, and to communicate to them instruction at this age. That part of their time which they are left to enjoy at liberty, they naturally dedicate to their little sports.

The favourite sports of boys are generally active; those of girls, sedentary. Of each we may take advantage, to prepare them for the future employments of life. However, neither are the amusements of boys invariably active, nor those of girls always sedentary; for as yet, the manners and dispositions of the two sexes are distinguished rather by habit or accident than by nature. The disposition to activity which characterizes children, is no less favourable to health than to their improvement in knowledge and prudence; their active sports have a tendency to promote their growth, and add new vigour to their limbs. Perhaps, even at this time, children might be enticed to learn the elements of natural philosophy and natural history amid their amusements and sports. Birds, butterflies, dogs, and other animals, are now favourite objects of their care; their curiosity is powerfully roused by the appearance of any strange object; and many of the simplest experiments of natural philosophy are so pleasing, that they cannot fail to attract the attention even of those who are least under the influence of curiosity. Yet it would be improper to insist on their attention to these things as a task: if we can make them regard them as amusements, it will be well; if not, we must defer them to some happier season. They might also, by proper management, be led to acquire some skill in the arts. They build mimic houses, and fill them with suitable furniture; they construct little boats, and sail them; they will fence-in little gardens, and cultivate them; and we even see them imitate all the labours of the husbandman. Such is the pleasure which man naturally feels in exerting his powers, and in acting with design. Let us encourage this disposition. These are the most suitable amusements in which they can engage.

53 What books most proper.

As the boy's attention to literary objects is still supposed to be continued, he will soon be able to read with some correctness and facility. It becomes an object of importance, and of no small difficulty, to determine what books are to be put into his hands, and in what manner his literary education is to be conducted. After the child is made acquainted with the names and powers of the letters, with their combination into syllables, and with the combination of these again into words, so that he can read with tolerable facility; it will be proper that the pieces of reading which are put into his hands be such as are descriptive of the actions of men, of the scenes of external nature, and of the forms and characters of animals. With these he is already in some degree acquainted; these are the objects of his daily attention; beyond them the range of his ideas does not yet extend; and therefore other subjects will be likely to render his task disagreeable to him. Besides, our present object is to teach him words: in order to teach him words, we must let him know their signification; but till he have acquired a very considerable knowledge of language, till he have gained a rich fund of simple ideas, it will be impossible for him to read or to hear with understanding on any other subject but these. And let us not as yet be particularly anxious to communicate to him religious or moral instruction, otherwise than by our example, and by causing him to act in such a manner as we think most proper. Our great business at present is, to make him acquainted with our language, and to teach him in what manner we use it to express our ideas. By his own observation, and by our instruction, he will soon become capable of comprehending all that we wish to communicate: But let us not be too hasty: the boy cannot long view the actions of mankind, and observe the economy of the animal and the vegetable world, without becoming capable of receiving both religious and moral instruction when judiciously communicated.

54 Writi

As soon as the pupil can read and spell with tolerable facility, and has acquired sufficient strength of arm and fingers to hold a pen, it may be proper to initiate him in the art of writing. If this art is not made disagreeable by the manner in which his application to it is required, he will learn it without difficulty. Children's natural disposition to imitate, particularly whatever depends on manual operation, renders this art peculiarly easy and pleasing to them, when they are not harshly forced to apply to it, nor suffered to get into a habit of performing their task with haste and negligence.

55 Restra

It requires indeed the most cautious prudence, the nicest delicacy, and the most artful address, to prevail with children to give a cheerful and attentive application to any appointed task. If you are too stern and rigid in enforcing application, you may seemingly obtain your object: the child sits motionless, and fixes his eye on his book or copy; but his attention you cannot command; his mind is beyond your reach, and can elude your tyranny; it wanders from the present objects, and flies with pleasure to those scenes and objects in which it has found delight. Thus you are disappointed of your purpose; and, besides, inspire the child with such aversion both to you and to those objects to which you wish him to apply, that perhaps at no future period will he view learning otherwise than with disgust.

56 Gentle

Again, gentleness, and the arts of insinuation, will not always be successful. If you permit the child to apply just when he pleases; if you listen readily to all his pretences and excuses; in short, if you seem to consider learning as a matter not of the highest importance, and treat him with kindness while he pays but little attention and makes but slow progress; the consequences of your behaving to him in this manner will be scarce less unfavourable than those which attend imprudent and unreasonable severity. It is, however, scarce possible to give particular directions how to treat children so as to allure them to learning, and at the same time to command their serious attention. But the prudent and affectionate parent and the judicious tutor will not always be unsuccessful; since there are so many circumstances in the condition of children, and so many principles in their nature, which subject them to our will.

57 Arithm tic.

The principles of arithmetic ought to make a part in the boy's education as soon as his reasoning powers appear to have attained such strength and quickness that he will be able to comprehend them. Arithmetic affords more exercise to the reasoning powers of the mind than any other of those branches of learning to which we apply in our earlier years: and if the child's attention be directed to it at a proper period, if he be allowed to proceed slowly, and if care be taken to make him comprehend fully the principles upon which each particular

particular operation proceeds, it will contribute much to increase the strength and the acuteness of the powers of his understanding.

Where the learned languages are regarded as an object worthy of attention, the boy is generally initiated in them about this time, or perhaps earlier. We have reserved to a separate head the arguments which occur to us for and against the practice of instructing children in the dead languages; and shall therefore only observe in this place, that the study of them ought not to engross the learner's attention so entirely as to exclude other parts of education.

From arithmetic our pupil may proceed to the practical branches of the mathematics: And in all of these, as well as in every other branch of learning, what you teach him will be best remembered and most thoroughly understood, if you afford him a few opportunities of applying his lessons to real use in life. Geometry and geography are two most important branches of education; but are often taught in such a manner, that no real benefit is derived from the knowledge of them. The means which Rousseau proposes for initiating young people in these and in several other of the arts and sciences are excellent; and if judiciously applied, could hardly fail of success.

While boys are engaged in these and in the languages, they may also attend to and cultivate the bodily exercises; such as dancing, fencing, and horsemanship. Each of these exercises is almost absolutely necessary for one who is designed to have intercourse with the world; and besides, they have a tendency to render the powers of the body active and vigorous, and even to add new courage and firmness to the mind.

When our pupil has acquired some knowledge of his own and of the learned languages, has gained some skill in the principles of arithmetic and of practical mathematics, and has received some instruction in the principles of morality and religion, or even before this time, it will be proper to begin him to the practice of composition. Themes, versions, and letters, the first exercises in composition which the boy is usually required to perform, none of them seems happily calculated for leading him to increase his knowledge, or to acquire the power of expressing himself with ease and elegance. Without enlarging on the impropriety or absurdity of these exercises, we will venture to propose something different, which we cannot help thinking would conduce more effectually to the end in view. It has been already observed, that the curiosity of children is amazingly eager and active, and that every new object powerfully attracts their regard: but they cannot view any object without taking notice of its most obvious qualities; any animal, for instance, without taking notice of its shape, its colour, its seeming mildness or ferocity; and they are generally pretty ready to gave an account of any thing extraordinary which they have observed. How easy then would it be to require them to write down an account of any new object exposed to their observation? The task would not be difficult; and every new piece of composition which they presented to us would add so much to their knowledge of nature. We might even require such specimens of their accuracy of observation and skill in language, at times when they enjoyed no opportunities of beholding new or surprising objects: a tree, a flower, a field, a house, an animal, any other simple object, should be the subject of their exercise. After some time, we might require them to describe something more various and complex. They might give an account of several objects placed in a relative situation; as, a stream, and the vale through which it flows; or, a bird, and the manner in which it constructs its nest; or, of one object successively assuming various appearances, as the bud, the flower, the apple. Human actions are daily exposed to their observation, and powerfully attract their attention. By and by, therefore, their task should be to describe some action which had lately passed in their presence. We need not pursue this hint farther; but, if we mistake not, by these means young people might sooner, and much more certainly, be taught to express themselves with ease and correctness in writing, than by any of the exercises which they are at present caused to perform with a view to that. Besides, they would at the same time acquire much more real knowledge. The study of words would then be rendered truly subservient to their acquiring a knowledge of things.

We cannot descend to every particular of that series of education in which we wish the boy to be engaged from that period when he first becomes capable of serious application till he reach the age of puberty. It is not necessary that we should, after having given abstracts of what has been offered to the world by so many respectable writers on the subject.

The few hints which we have thrown out will be sufficient to show, in general, in what manner we wish the youth's education to be conducted during this period. Let the parent and the tutor bear in mind, that much depends on their example, with regard to the disposition and manners of the youth; and let them carefully strive to form him to gentleness, to firmness, to patient industry, and to vigorous courage; let them, if possible, keep him at a distance from that contagion with which the evil example of worthless servants and playfellows will be likely to infect him. Now is the time for sowing the seeds of piety and virtue: if carefully sown now, they will scarce fail to grow up, and bear fruit in future life.

III. *From Puberty to Manhood.*

THIS age is every way a very important period in human life. Whether we consider the change which now takes place in the bodily constitution, or the passion which now first begins to agitate the breast, still we must regard this as a critical season to the youth. The business of those to whose care he is still intrusted, is to watch over him so as to prevent the passion for the sex from hurrying him to shameful and vicious indulgence, and from seducing him to habits of frivolity and indolence; to prevent him from becoming either the shameless rake, or the trifling coxcomb. Though so furious is the impulse of that appetite which now fires the bosom and shoots through the veins of the youth, that to restrain him from the excesses to which it leads can be no easy task; yet if his education has been hitherto conducted with prudence, if he is fond of manly exercises, active, sober, and

and temperate, and still influenced by modesty and the sense of shame; even this may through the blessing of heaven be accomplished. It is impossible to give better directions than those of Rousseau for this purpose. Let the young man know his situation; set before him in a striking light the virtue which he may practise by restraining appetite, and the frightful fatal vices into which he may be hurried. But trust not to precept, nor to any views which you can lay before him, either of the disgracefulness and the pernicious consequences of vice, or of the dignity and the happy fruits of virtue. Something more must be done. Watch over him with the attention of an Argus; engage him in the most active and fatiguing sports. Carefully keep him at a distance from all such company, and such books, as may suggest to his mind ideas of love, and of the gratification at which it aims. But still all your precautions will not counteract the designs of nature; nor do you wish to oppose her designs. The youth under your care must feel the impulse of desire, and become susceptible of love. Let him then fix his affections on some virtuous young woman. His attachment to her will raise him above debauchery, and teach him to despise brutal pleasures: it will operate as a motive to dispose him to apply to such arts, and to pursue such branches of knowledge, as may be necessary for his future establishment in the world. The good sense of Rousseau on this head renders it less necessary for us to enlarge on it; especially as we are to treat of some articles separately which regard the management of youth at this period.

IV. *Religion and Morals.*

60
At what age the principles of religion may be taught.

In pointing out the general plan of education which appears to us the most proper to be pursued in order to form a virtuous and respectable member of society, we took but slight notice of the important objects of religion and morals. At what period and in what manner, ought the principles of religion and morality to be instilled into the youthful mind? It has been before observed, that children are capable of reasoning and of moral distinctions even at a very early age. But they cannot then comprehend our reasonings, nor enter into our moral distinctions; because they are strangers to our language, and to the artificial manner in which we arrange our ideas when we express them in conversation or in writing. It follows, then, that as soon as they are sufficiently acquainted with our language, it must be proper to communicate to them the principles and precepts of morality and religion. Long before this time, they are diligent and accurate observers of human actions. For a short period it is merely the external act which they attend to and observe: soon, however, they penetrate farther; conscious themselves of reflection and volition, they regard us also as thinking beings; conscious of benevolent and of unfriendly dispositions, they regard us as acting with design, and as influenced by passion: naturally imitative animals, they are disposed in their conduct to follow the example which we set before them. By our example we may teach them piety and virtue long before it can be proper to offer them religious or moral instruction in a formal manner.

We cannot presume to determine at what particular period children ought to be first informed of their relations to God and to society, and of the duties incumbent on them in consequence of those relations. That period will be different to different children, according to the pains which have been taken, and the means which have been employed, in cultivating their natural powers. Perhaps even where the most judicious maxims of education have been adopted, and have been pursued with the happiest effects, it cannot be sooner than the age of eight or nine. But even before this period much may be done. Show the child your reverence for religion and virtue; talk in his presence, and in the plainest, simplest terms, though not directly to him, of the existence of God the creator, the preserver and the governor of the world; speak of the constant dependence of every creature on the gracious care of that Being; mention with ardour the gratitude and obedience which we owe to him as our great parent and best benefactor; next, speak of the mutual relations of society; of the duties of children and parents, of masters and servants, of man to man. At length, when his mind is prepared by such discourses which have passed in his presence without being addressed to him, you may begin to explain to him in a direct manner the leading doctrines of religion. He will now be able to comprehend you, when you address him on that important subject: the truths which you communicate will make a powerful impression on his mind; an impression which neither the corruption and dissipation of the world, nor the force of appetite and passion, will ever be able to efface.

61
Habit.

Some writers on this subject have asserted, that youth are incapable of any just ideas of religion till they attain a much more advanced age; and have insisted, that, for this reason, no attempts should be made to communicate to them the articles of our creed in their earlier years. This doctrine, both from its novelty and from its pernicious tendency, has provoked the keenest opposition. It has, however, been opposed rather with keenness than with acuteness or skill. Its opponents seem to have generally allowed that children are incapable of reasoning and of moral distinctions; but they have ascribed wonderful effects to habit. Enrich the memories of children, say they, with the maxims of morality, and with the doctrines of religion; teach them prayers, and call them to engage in all the ordinances of religion. What though they comprehend not the meaning of what they learn? What though they understand not for what purpose you bid them repeat their prayers, nor why you confine them on the Lord's day from their ordinary amusements? Their powers will at length ripen, and they will then see in what they have been employed, and derive the highest advantage from the irksome tasks to which you confined them. You have formed them to habits which they will not be able to lay aside: After this they cannot but be religious at some period of life, even though you have inspired them with a disgust for the exercises of religion. Those good people have also talked of the principle of *the association of ideas*. As no man stands alone in society, say they; so no one idea exists in the mind single and unconnected with others: as you are connected with your parents, your children, your friends, your countrymen; so the idea of a tree, for instance, is connected ed with that of the field in which it grows, of the fruit which it bears, and of contiguous, dissimilar, and resembling objects. When any one set of related ideas have been often presented to the mind in connexion with one another, the mind at length comes to view them as so intimately united, that any particular one among them never fails to introduce the rest. Revisit the scenes in which you spent your earliest years; the sports and companions of your youth naturally arise to your recollection. Have you applied to the study of the classics with reluctance and constraint, and suffered much from the severity of parents and tutors for your indifference to Greek and Latin; you will, perhaps, never through the course of life see a grammar school, without recollecting your sufferings, nor look on a Virgil or Homer without remembering the stripes and confinement which they once occasioned to you. In the same manner, when religious principles are impressed on the mind in infancy in a proper manner, a happy association is formed which cannot fail to give them a powerful influence on the sentiments and conduct in a future life. But if we have advanced to manhood before being informed of the existence of a Deity, and of our relation to him, the principles of religion, when communicated, no longer produce the same happy effects: the heart and the understanding are no longer in the same state; nor will the same associations be formed.

2 Dr Priest- ey opinion con- cerning as- ociation of idea

This doctrine of *the association of ideas* has been adduced by an ingenious writer, distinguished for his discoveries in natural philosophy, and for his labours in controversial divinity, as an argument in behalf of the propriety of instructing youth in the principles of religion even in their earliest years. We admire, we esteem, the spirit which has prompted him to discover so much concern for the interests of the rising generation; but at the same time we will not conceal our opinion, that even this argument ought to be urged with caution. Many of the phenomena of human nature may indeed be explained, if we have recourse to the principle of *association*. The influence of any principle, religious or moral, depends in a great measure on the ideas and images which, in considering it, we have been accustomed to associate with it in our minds. But what are the ideas or images most likely to be associated by children with the doctrines and duties of religion, if we call them to listen to the one and perform the other at too early a period? Will they be such as may assist the influence of religion on their sentiments and conduct in the future part of life? Observe the world: Are those who, in infancy, have been most rigidly compelled to get their catechisms by rote, either the most pious or the best informed in religious matters? Indeed, when we consider what has been said of the influence of habit, and of the association of ideas, we cannot help thinking, that any arguments which on the present occasion may be adduced from either of these, tend directly to prove, not that we ought to pour in religious instruction into the minds of children, without considering whether they be qualified to receive it; but, on the contrary, that we ought cautiously to wait for and catch the proper season;—that season when the youthful mind, no longer a stranger to our language, our sentiments, our views of nature, or our manner of reasoning, will be able to go along with us, when we talk to him of a supreme Being, or our condition as dependant and accountable creatures, of truth, benevolence, and justice.

We flatter ourselves, then, that our readers will readily agree with us, 1st, That the moral and reasoning powers of children begin to display themselves at a very early age, even in infancy. 2dly, That as soon as they have made themselves acquainted with the most obvious appearances of nature, and have gained a tolerable knowledge of our language and our manner of arranging our ideas in reasoning, we may with the greatest propriety begin to instruct them in the principles of religion. 3dly, That the most careful and judicious observation is necessary to enable us to distinguish the period at which children become capable of receiving religious instruction; because, if we either attempt to communicate to them these important truths too early, or defer them till towards manhood, we may fail of accomplishing the great end which we have in view.

63 Catechisms.

If we can be so fortunate as to choose the happiest season for sowing the first seeds of piety in the infant mind, our next care will be to sow them in a proper manner. We must anxiously endeavour to communicate the principles of religion and morality, so as they may be easiest comprehended by the understanding of the learner, and may make the deepest impression on his heart. It would be a matter of the greatest difficulty to give particular directions on this head. The discretion of the parent or tutor must here be his guide. We are afraid that some of the catechisms commonly taught are not very happily calculated to serve the purpose for which they are intended. Yet we do not wish that they should be neglected while nothing more proper is introduced in their room. In instructing children in the first principles of religion, we must beware of arraying piety in the gloomy garb, or painting her with the forbidding features, in which she has been represented by anchorites, monks, and puritans. No; let her assume a pleasing form, a cheerful dress, and an inviting manner. Describe the Deity as the affectionate parent, the benefactor, and though the impartial yet the merciful judge of mankind. Exhibit to them Jesus Christ, the generous friend and Saviour of the posterity of Adam, who with such enchanting benevolence hath said, "Suffer little children to come unto me." Represent to them his yoke as easy, and his burden as light. Insist not on their saying long prayers or hearing tedious sermons. If possible, make the doctrines of religion to appear to them as glad tidings, and its duties as the most delightful of tasks.

V. *The Languages.*

Is the time usually spent in learning the languages usefully occupied? What advantages can our British youth derive from an acquaintance with the languages and the learning of Greece and Rome? Would we listen to many of the fathers, the mothers, and the polite tutors of the present age, they will persuade us, that the time which is dedicated to grammar-schools, and to Virgil, Cicero, Homer, and Demosthenes, is foolishly thrown away; and that no advantages

advantages can be gained from the study of classical learning. They wish their children and pupils to be not merely scholars: they wish them to acquire what may be useful and ornamental when they come to mingle with the world; and for this purpose, they think it much better to teach their young people to smatter out French, to dance, to fence, to appear in company with invincible assurance, and to dress in such a manner as may attract the attention of the ladies. Besides, the tenderness and humanity of those people are amazing. They are shocked at the idea of the sufferings which boys undergo in the course of a classical education. The confinement, the stripes, the harsh language, the burdens laid on the memory, and the pain occasioned to the eyes, during the dreary period spent in acquiring a knowledge of Greek and Latin, affect them with horror when they think of them as inflicted on children. They therefore give the preference to a plan of education in which less intense application is required and less severity employed.

64 Prejudices against classical education.

65 Prejudices for it.

But, again, there are others who are no less warm in their eulogiums on a classical education, and no less industrious in recommending the study of Greek and Latin, than those are eager in their endeavours to draw neglect on the polished languages of antiquity. With this second class, if an adept in Greek and Latin, you are a great and learned man; but without those languages, contemptible for ignorance. They think it impossible to inspire the youthful mind with generous or virtuous sentiments, to teach the boy wisdom, or to animate him with courage, without the assistance of the ancient philosophers, historians, and poets. Indeed their superstitious reverence for the ancient languages, and for those writers whose compositions have rendered Greece and Rome so illustrious, leads them to ascribe many other still more wonderful virtues to a classical education.

With which of these parties shall we join? or shall we mediate between them? Is it improper to call youth to the study of the languages? Is it impossible to communicate any useful knowledge without them? Or are they, though highly useful, yet not always indispensably necessary?

66 Utility of classical learning towards the improvement of our mother tongue.

We have formerly taken notice of one circumstance in favour of a classical education, to which it may be proper to recal the attention of our readers. We observed, that the cultivation of classical learning has a favourable influence on the living languages. It has a tendency to preserve their purity from being debased, and their analogy from becoming irregular. In studying the dead languages, we find it necessary to pay more attention to the principles of grammar than in acquiring our mother tongue. We learn our native language without attending much to its analogy and structure. Of the numbers who speak English through the British dominions, but few are skilled in the inflection of its nouns and verbs, or able to distinguish between adverbs and conjunctions. Desirous only of making their meaning understood, they are not anxious about purity or correctness of speech. They reject not an expression which occurs to them, because it is barbarous or ungrammatical. As they grew up they learned to speak from their mothers, their nurses and others about them; they were soon able to make known their wants, their wishes, and their observations, in words. Satisfied with this, or called at a very early period to a life of humble industry, they have continued to express themselves in their mother tongue without acquiring any accurate knowledge of its general principles. If these people find occasion to express themselves in writing, they are scarce more studious of correctness and elegance in writing than in speaking; or, though they may aspire after those properties, yet they can never attain them. But such writers or speakers can never refine any language, or reduce it to a regular analogy. Neither can they be expected to distinguish themselves as the guardians of the purity and regularity of their native tongue, if it should before have attained a high degree of perfection. But they who, in learning a language different from their native tongue, have found it necessary to pay particular attention to the principles of grammar, afterwards apply the knowledge of grammar which they have thus acquired in using their mother tongue; and by that means become better acquainted with its structure, and learn to write and speak it with more correctness and propriety. Besides, the languages of Greece and Rome are so highly distinguished for their copiousness, their regular analogy, and for various other excellencies, which render them superior to even the chief of modern languages, that the study of them has a natural tendency to improve and enrich modern languages. If we look backwards to the 15th century, when learning began to revive in Europe, and that species of learning which began first to be cultivated was classical literature, we find that almost all the languages then spoken in Europe were wretchedly poor and barbarous. Knowledge could not be communicated, nor business transacted, without calling in the aid of Latin. Classical learning, however, soon came to be cultivated by all ranks with enthusiastic eagerness. Not only those designed to pursue a learned profession, and men of fortune whose object was a liberal education without a view to any particular profession; but even the lower ranks, and the female sex, keenly studied the languages and the wisdom of Greece and Rome. This avidity for classical learning was followed by many happy effects. But its influence was chiefly remarkable in producing an amazing change on the form of the living languages. These soon became more copious and regular; and many of them have consequently attained such perfection, that the poet, the historian, and the philosopher, can clothe their thoughts in them to the greatest advantage. Could we derive no new advantage from the study of the ancient languages, yet would they be worthy of our care, as having contributed so much to raise the modern languages to their present improved state. But they can also conduce to the preservation and support of those noble structures which have been reared by their assistance. The intercourse of nations, the affectation of writers, the gradual introduction of provincial barbarisms, and various other causes, have a tendency to corrupt and debase even the noblest languages. By such means were the languages of Greece and Rome gradually corrupted, till the language used by a Horace, a Livy, a Xenophon, and a Menander, was lost in a jargon unfit for the purposes of composition. But if we would not disdain to take advantage of them, the classical works in those languages might

prevent

prevent that which we use from experiencing such a decline. He who knows and admires the excellencies of the ancient languages, and the beauties of those writers who have rendered them so celebrated, will be the firm enemy of barbarism, affectation, and negligence, whenever they attempt to debase his mother tongue. We venture therefore to assert, that when the polished languages of antiquity cease to be studied among us, our native tongue will then lose its purity, regularity, and other excellencies, and gradually decline till it be no longer known for the language of Pope and of Addison; and we adduce it as an argument in behalf of classical learning, that it has contributed so much to the improvement of the living languages, and is almost the only means that can prevent them from being corrupted and debased.

7
Fo uring
to dustry.

In those plans of education of which the study of the dead languages does not make a part, proper means are seldom adopted for impressing the youthful mind with habits of industry: nor do the judgment, the memory, and the other powers of the mind, receive equal improvement, as they pass not through the same exercises as in a classical education. Let us enter those academies where the way to a complete education leads not through the thorny and rugged paths of classical literature; let us attend to the exercises which the polite teachers cause their pupils to perform. Do they insist on laborious industry or intense application? No; they can communicate knowledge without requiring laborious study. They profess to allow their pupils to enjoy the sweets of idleness, and yet render them prodigies of learning. But are their magnificent promises ever fulfilled? Do they indeed cultivate the understandings of the young people intrusted to their care? They do not: their care is never once directed to this important object. To adorn them with showy and superficial qualities, is all that those gentlemen aim at. Hence, when their pupils come to enter the world and engage in the duties of active life, they appear destitute of every manly qualification. Though they have attained the age, and grown up to the size of manhood, their understandings are still childish and feeble: they are capricious, unsteady, incapable of industry or fortitude, and unable to pursue any particular object with keen, unremitting perseverance. That long series of study and regular application, which is requisite in order to attain skill in the ancient languages, produces much happier effects on the youthful mind. The power of habit is universally felt and acknowledged. As he who is permitted to trifle away the earliest part of his life in idleness or in frivolous occupations, can scarce be expected to display any manly or vigorous qualities when he reaches a more mature age; so, on the contrary, he whose earlier days have been employed in exercising his memory and furnishing it with valuable treasures, in cultivating his judgment and reasoning powers by calling the one to make frequent distinctions between various objects, and the other to deduce many inferences from the comparison of the various objects presented to the understanding, and also in strengthening and improving the acuteness of his moral powers by attending to human actions and characters, and distinguishing between them, as virtuous or vicious, as mean or glorious: he who has thus cultivated his powers, may be naturally expected to distinguish himself when he comes to perform his part in active life, by prudence, activity, firmness, perseverance, and most of the other noble qualities which can adorn a human character. But in the course of a classical education, the powers of the mind receive this cultivation; and therefore these happy effects may be expected to follow from it. The repetitions which are required afford improving exercise to the memory, and store it with the most valuable treasures; the powers of the understanding are employed in observing the distinctions between words; in tracing words to the substances and qualities in nature which they are used to represent; in comparing the words and idioms of different languages, and in tracing the laws of their analogy and construction; while our moral faculties are at the same time improved by attending to the characters which are described, and the events and actions which are related, in those books which we are directed to peruse in order to acquire the ancient languages. We assert therefore that the study of the ancient languages is particularly useful for improving and strengthening all the powers of the mind; and by that means, for preparing us to act our part in life in a becoming manner: and this our readers will readily agree with us in considering as a weighty argument in behalf of that plan of education.

68
Fund of useful and elegant knowledge which ancient authors afford.

But if, after all, classical learning is still to be given up, where shall we find the same treasures of moral wisdom, of elegance, and of useful historical knowledge which the celebrated writers of Greece and Rome afford? Will you content yourself with the modern writers of Italy, France, and England? Or will you deign to survey the beauties of Homer and Virgil through the medium of a translation? No surely; let us penetrate to those sources from which the modern writers have derived most of the excellencies which recommend them to our notice; let us disdain to be imposed upon by the whims or the ignorance of a translator.

Juvat integros accedere fontes.

Farther, classical learning has long been cultivated among us; and both by the stores of knowledge which it has conveyed to the mind, and the habits which it has impressed, has contributed in no small degree to form many illustrious characters. In reviewing the annals of our country, we will scarce find an eminent politician, patriot, general, or philosopher, during the two last centuries, who did not spend his earlier years in the study of the classics.

Yet though we have mentioned these things in favour of classical literature, and were we to descend to minute particulars might enumerate many more facts and circumstances to recommend it; we mean not to argue that it is absolutely impossible to be a wise, a great, or a good man, unless you are skilled in Greek and Latin. Means may, no doubt, be adopted to inspire the young mind with virtuous dispositions, to call forth the powers of the youthful understanding, and to impress habits of industry and vigorous perseverance, without having recourse to the discipline of a grammar school. But we cannot help thinking, for the reasons which we have stated to our readers, that a classical education is the most likely to produce these happy effects.

As we are afterwards to take particular notice of the course of education most suitable for those who are to occupy the humble stations in society, we shall not here inquire whether it be proper to introduce them to an acquaintance with the Greek and Latin classes.

VI. *On the Education of People of Rank and Fortune.*

69 Duties of people of rank.

THOSE whom the kindness of providence has placed in an elevated station, and in affluent circumstances, so that they seem to be born rather to the enjoyment of wealth and honours than to act in any particular profession or employment, have notwithstanding a certain part assigned them to perform, and many important duties to fulfil. They are members of society, and enjoy the protection of the civil institutions of that society to which they belong; they must therefore contribute what they can to the support of those institutions. The labours of the industrious poor are necessary to supply them with the luxuries of life; and they must know how to distribute their wealth with prudence and generosity among the poor. They enjoy much leisure; and they ought to know how to employ their leisure hours in an innocent and agreeable manner. Besides, as their circumstances enable them to attract the regard and respect of those who are placed in inferior stations, and as the poor are ever ready to imitate the conduct of their superiors; it is necessary that they endeavour to adorn their wealth and honours by the most eminent virtues, in order that their example may have a happy influence on the manners of the community.

70 How to form the temper of a young man of fortune.

Their education ought therefore to be conducted with a view to those ends. After what we have urged in favour of a classical education, our readers will naturally presume that we regard it as highly proper for a man of fortune. The youth who is destined to the enjoyment of wealth and honours, cannot spend his earlier years more advantageously than in gaining an acquaintance with the elegant remains of antiquity. The benefits to be derived from classical learning are particularly necessary to him. Care must be taken to preserve him from acquiring a haughty, fierce, imperious temper. The attention usually paid to the children of people of fortune, and the foolish fondness with which they are too often treated, have a direct tendency to inspire them with high notions of their own importance, and to render them passionate, overbearing, and conceited. But if their temper acquire that bias even in childhood, what may be expected when they advance towards manhood, when their attention is likely to be oftener turned to the dignity and importance of that rank which they occupy, and to the pitiful humility of those beneath them? Why, they are likely to be so proud, insolent, resentful, and revengeful, as to render themselves disagreeable and hateful to all who know them: and besides, to be incapable of those delightful feelings which attend humane, benevolent, and mild dispositions. Let the man of fortune, therefore, as he is concerned for the future happiness and dignity of his child, be no less careful to prevent him from being treated in such a manner as to be inspired with haughtiness, caprice, and insolence, than to prevent his mind from being soured by harsh and tyrannical usage.

The manly exercises, as they are favourable to the health, the strength, and even the morals; so they are highly worthy of engaging the attention of the young gentleman. Dancing, fencing, running, horsemanship, the management of the musket, and the motions of military discipline, are none of them unworthy of occupying his time at proper seasons. It is unnecessary to point out the advantages which he may derive from dancing; these seem to be pretty generally understood. Perhaps our men of fortune would be ashamed to make use of their legs for running; but occasions may occur, on which even this humble accomplishment may be useful. Though we wish not to see the young man of fortune become a jockey; yet to be able to make a graceful appearance on horseback, and to manage his horse with dexterity, will not be unworthy of his station and character. If times of public danger should arise, and the state should call for the services of her subjects against any hostile attack, they whose rank and fortune place them in the most eminent stations will be first expected to stand forth; but if unacquainted with those exercises which are connected with the military art, what a pitiful figure must they make in the camp, or on the field of battle?

71 Law.

As the man of fortune may perhaps enjoy by hereditary right, or may be called by the voice of his fellow citizens, to a seat among the legislative body of his country; he ought in his youth to be carefully instructed in the principles of her political constitution, and of those laws by which his own rights and the rights of his fellow citizens are determined and secured.

72 Philosop

Natural philosophy, as being both highly useful and entertaining, is well worthy of the attention of all who can afford to appropriate any part of their time to scientific pursuits; to the man of fortune a taste for natural philosophy might often procure the most delightful entertainment. To trace the wonders of the planetary systems, to mark the process of vegetation, to examine all the properties of that fine element which we breathe, to trace the laws by which all the different elements are confined to their proper functions, and above all to apply the principles of natural philosophy in the cultivation of the ground, are amusements which might agreeably and innocently occupy many of the leisure hours of the man who enjoys a splendid and independent fortune.

73 History morals.

Neither do we suppose civil history and the principles of morals to be overlooked. Without being acquainted with these, how could any just or accurate knowledge of the laws and political constitution of his country be acquired by the young gentleman? History exposes to our observation the fortune and the actions of other human beings, and thus supplies in some measure the place of experience; it teaches prudence, and affords exercise to the moral sense. When history condescends to take notice of individuals, they are almost always such as have been eminent for virtue, for abilities, or for the rank which they held in life; to the rich and great it ought to speak with peculiar efficacy, and they ought to be carefully invited to listen to its voice.

Such then is the manner in which we wish the education of young men of rank and fortune to be conducted,

ducted, in order that they may be prepared for enjoying their opulence and honours with becoming dignity. Let them be early inured to habits of vigorous industry and persevering firmness, by passing through a regular course of classical learning in a free school; let them play and converse with their equals, and not be permitted to form high ideas of their own importance, nor to domineer over servants or inferiors: Let them be carefully instructed in the principles of morality and religion: Let them be taught the manly exercises: Let them be carefully informed of the nature of the political constitution of their country, and of the extent of those civil and political rights which it secures to them and their fellow citizens: Let them be called to trace the annals of mankind through the records of history; to mark the appearances and operations of nature, and to amuse themselves by pursuing these to their general causes. We say nothing of causing the young man of fortune to learn some mechanical art: We think skill in a mechanical art might now and then afford him an innocent and pleasing amusement; but we do not consider it as absolutely necessary, and therefore do not insist on his acquiring it. With those accomplishments we hope he might become an useful member of society, might adorn the rank and fortune to which he is born, and might find wealth and high station a blessing, not a curse. It is peculiarly unfortunate for our age and country, that people of rank and fortune are not so studious that their children acquire these as the more superficial accomplishments.

VII. *On the Education of People designed for a Mercantile Employment, and for the humbler Occupations in Life not particularly connected with Literature.*

Were modern literature in a less flourishing state; were the English and French languages adorned with fewer eminent poetical, historical, and philosophical compositions; we might perhaps insist on it as necessary to give the boy, who is designed for a mercantile employment, a classical education. At present this does not appear absolutely necessary; yet we do

4 Elegant literature. not presume to forbid it as improper. Even the merchant will scarce find reason to repent his having been introduced to the acquaintance of Plato and Cicero. But still, if the circumstances of the parent, or any other just reason, should render it inconvenient, to send the young man who is intended for trade to a free school to study the ancient languages, means may be easily adopted to make up for his loss. Confine him not to writing and accounts alone. These, though particularly useful to the merchant, have no great power to restrain the force of evil passions, or to inspire the mind with generous and virtuous sentiments. Though you burden him not with Latin and Greek, yet strive to inspire him with a taste for useful knowledge and for elegant literature. Some of the purest and most elegant of our poets, the excellent periodical works which have appeared in our language, such as the Spectator, the Adventurer, the Mirror, and the compositions of our British historians, together with some of the best translations of the classics which we possess; these you may with great propriety put into his hands. They will teach him how to think and reason justly, and to express himself in conversation or in writing with correctness and elegance: they will refine and polish his mind, and raise him above low and gross pleasures. And as no man, who has any occasion to speak or write, ought to be entirely ignorant of the principles of grammar, you will therefore be careful to instruct the young man who is designed for a mercantile occupation in the grammar of his mother tongue.

75 Integrity. A sacred regard to his engagements, and an honesty which may prevent him from taking undue advantages or exacting unreasonable profits, are the virtues which a merchant is most frequently called to exercise: punctuality and integrity are the duties most particularly incumbent on the mercantile profession. Temptations will now and then arise to seduce the merchant to the violation of these. But if superior to every such temptation, he is one of the most illustrious characters, and is likely to be one of the most successful merchants. From his earliest years, then, labour to inspire the child whom you intend for trade with a sacred regard for truth and justice: let him be taught to view deceit and fraud, and the violation of a promise, with abhorrence and disdain. Frugality is a virtue which, in the present age, seems to be antiquated or proscribed. Even the merchant often appears better skilled in the arts of profusion than in those of parsimony. The miser, a character at no time viewed as amiable, is at present beheld with double detestation and contempt. Yet, notwithstanding these unfavourable circumstances, fear not to impress upon the young merchant habits of frugality. Let him know the folly of beginning to spend a fortune before he have acquired it. Let him be taught to regard a regular attention to confine his expences within due bounds, as one of the first virtues which can adorn his character.

76 Industry. Frugality and industry are so closely connected, that when we recommend the one of them to the merchant, we will be naturally understood to recommend the other also. It is easy to see, that without industrious application, no man can reasonably expect to meet with success in the occupation in which he engages; and if the merchant thinks proper to leave his business to the management of clerks and shop-keepers, it is not very probable that he will quickly accumulate a fortune. It is, therefore, no less necessary, that he who is intended for trade be early accustomed to habits of sober application, and be carefully restrained from volatility and levity, than that he be instructed in writing, arithmetic, and keeping of accounts.

With these virtues and qualifications the merchant is likely to be respectable, and not unsuccessful, while he continues to prosecute his trade: and if, by the blessing of Providence, he be at length enabled to accumulate a moderate fortune, his acquaintance with elegant literature, and the various habits which he has acquired, will enable him to enjoy it with taste and dignity. Indeed, all the advantages which a man without taste, or knowledge, or virtue, can derive from the possession of even the most splendid fortune, are so inconsiderable, that they can be no adequate reward for the toil which he undergoes, and the mean arts which he practises in acquiring it. At the head of a great fortune a fool can only make himself more ridiculous, and a man of a wicked

wicked and vicious character more generally abhorred, than if fortune had kindly concealed their crimes and follies by placing them in a more obscure station.

77 Education of persons in the lowest ranks.

A considerable part of the members of society are placed in such circumstances, that it is impossible for them to receive the advantages of a liberal education. The mechanic and the husbandman, who earn a subsistence by their daily labour, can seldom afford, whatever parental fondness may suggest, to favour their children with many opportunities of literary instruction. Content if they can provide them with food and raiment till such time as they acquire sufficient strength to labour for their own support, parents in those humble circumstances seldom think it necessary that they should concern themselves about giving their children learning. Happily it is not requisite that those who are destined to spend their days in this low sphere should be furnished with much literary or scientific knowledge. They may be taught to read their mother tongue, to write, and to perform some of the most common and the most generally useful operations of arithmetic: for without an acquaintance with the art of reading, it will scarce be possible for them to acquire any rational knowledge of the doctrines and precepts of religion, or of the duties of morality; the invaluable volume of the sacred Scriptures would be sealed to them: we may allow them to write, in order that they may be enabled to enjoy the sweet satisfaction of communicating accounts of their welfare to their absent friends; and, besides, both writing and arithmetic are necessary for the accomplishment of those little transactions which pass among them. It would be hard, if even the lowest and poorest were denied these simple and easily acquired branches of education; and happily that degree of skill in them which is necessary for the labourer and the mechanic may be attained without greater expence than may be afforded by parents in the meanest circumstances. Let the youth who is born to pass his days in this humble station, be carefully taught to consider honest patient industry as one of the first of virtues: let him be taught to regard the sluggard as one of the most contemptible of characters: teach him contentment with his lot, by letting him know that wealth and honour seldom confer superior happiness: Yet scruple not to inform him, that if he can raise himself above the humble condition to which he was born, by honest arts, by abilities virtuously exerted, he may find some comfort in affluent circumstances, and may find reason to rejoice that he has been virtuous, industrious, and active. In teaching him the principles of religion, be careful to show him religion as intimately connected with morality: teach him none of those mysterious doctrines, whose sole tendency is to foster that enthusiasm which naturally prevails among the vulgar, and to persuade them that they may be pious without being virtuous. Labour to inspire him with an invincible abhorrence for lying, fraud, and theft. Inspire him with a high esteem for chastity, and with an awful regard to the duties of a son, a husband, and a father. Thus may he become respectable and happy, even in his humble station and indigent circumstances; a character infinitely superior, in the eyes of both God and man, to the rich and great man who misemploys his wealth and leisure in shameful and vicious pursuits.

VIII. *On the Education of the Female Sex.*

The abstracts which we have given of some of the most celebrated and original treatises on education, as well as our own observations on this subject, have been hitherto either relative to the education of both sexes, or directed chiefly to the education of the male sex. But as there is a natural difference between the characters of the two sexes, and as there are certain duties peculiar to each of them; it is easy to see that the education of the boy and that of the girl cannot, ought not, to be conducted precisely in the same manner. And since the duties of the female sex are so important to society, and they form so considerable a part of our species, their education, therefore, merits the highest attention.

78 Similari of the ch racters o both sexe in the fi period of life.

In infancy, the instincts, the dispositions, and the faculties of boys and girls seem to be nearly the same. They discover the same curiosity, and the same disposition to activity. For a while they are fond of the same sports and amusements. But by and by, when we begin to make a distinction in their dress; when the girl begins to be more confined to a sedentary life under her mother's eye, while the boys are permitted to ramble about without doors; the distinction between their characters begins to be formed, and their taste and manners begin to become different. The boy now imitates the arts and the active amusements of his father; digs and plants a little garden, builds a house in miniature, shoots his bow, or draws his little cart; while the girl, with no less emulation, imitates her mother, knits, sews, and dresses her doll. They are no longer merely children; the one is now a girl, the other a boy. This taste for female arts, which the girl so easily and naturally acquires, has been judiciously taken notice of by Rousseau, as affording a happy opportunity for instructing her in a very considerable part of those arts which it is proper to teach her. While the girl is busied in adorning her doll, she insensibly becomes expert at needle work, and learns how to adjust her own dress in a becoming manner. And therefore, if she be kindly treated, it will not be a matter of difficulty to prevail with her to apply to these branches of female education. Her mother or governess, if capable of managing her with mildness and prudence, may teach her to read with great facility. For being already more disposed to sedentary application than the boy of the same age, the confinement to which she must submit in order to learn to read will be less irksome to her. Some have pretended that the reasoning powers of girls begin to exert themselves sooner than those of boys. But, as we have already declared our opinion, that the reasoning powers of children of both sexes begin to display themselves at a very early period; so we do not believe that those of the one sex begin to appear or attain maturity, sooner than those of the other. But the different occupations and amusements in which we cause them to engage from their earliest years, naturally call forth their powers in different manners, and perhaps cause the one to imitate our modes of speaking and behaviour sooner than the other. However, as we wish both boys and girls to learn the art of reading at a very early age, even as soon as they are capable of any

any serious application; so we wish girls to be taught the art of writing, arithmetic, and the principles of religion and morals, in the same order in which these are inculated on boys.

We need not point out the reasons which induce us to regard these as accomplishments proper for the female sex: they seem to be generally considered as not only suitable, but necessary. It is our most important privilege, as beings placed in a situation different from that of the inferior animals, that we are capable of religious sentiments and religious knowledge; it therefore becomes us to communicate religious instruction with no less assiduity and care to the youth of the female sex, than to those of our own. Besides, as the care of children during their earlier years belongs in a particular manner to the mother; she, therefore, whom nature has destined to the important duties of a mother, ought to be carefully prepared for the proper discharge of those duties, by being accurately instructed, in her youth, in such things as it will be afterwards requisite for her to teach her children.

Erudition, ow far be-oming in adies

Ladies have sometimes distinguished themselves as prodigies of learning. Many of the most eminent geniuses of the French nation have been of the female sex. Several of our countrywomen have also made a respectable figure in the republic of letters. Yet we cannot approve of giving girls a learned education. To acquire the accomplishments which are more proper for their sex, will afford sufficient employment for their earlier years. If they be instructed in the grammar of their mother tongue, and taught to read and speak it with propriety; be taught to write a fair hand, and to perform with readiness the most useful operations of arithmetic: if they be instructed in the nature of the duties which they owe to God, to themselves, and to society; this will be almost all the literary instruction necessary for them. Yet we do not mean to forbid them an acquaintance with the literature of their country. The periodical writers, who have taught all the duties of morality, the decencies of life, and the principles of taste, in so elegant and pleasing a manner, may with great propriety be put into the hands of our female pupil. Neither will we deny her the historians, the most popular voyages and travels, and such of our British poets as may be put into her hands without corrupting her heart or inflaming her passions. But could our opinion or advice have so much influence, we would endeavour to persuade our countrymen and countrywomen to banish from among them the novelists, those panders of vice, with no less determined severity than that with which Plato excludes the poets from his republic, or that with which the converts to Christianity, mentioned in the Acts, condemned their magical volumes to the flames. Unhappily, novels and plays are almost the only species of reading in which the young people of the present age take delight; and nothing has contributed more effectually to bring on that dissoluteness of manners which prevails among all ranks.

80 namental accomplishments.

81 Dancing.

But we will not discover so much austerity as to express a wish that the education of the female sex should be confined solely to such things as are plain and useful. We forbid not those accomplishments which are merely ornamental, and the design of which is to render them amiable in the eyes of the other sex. When we consider the duties for which they are destined by nature, we find that the art of pleasing constitutes no inconsiderable part of these; and it would be wrong, therefore, to deny them those arts, the end of which is to enable them to please. Let them endeavour to acquire taste in dress: to dress in a neat graceful manner, to suit colours to her complexion, and the figure of her clothes to her shape, is no small accomplishment for a young woman. She who is rigged out by the taste and dexterity of her maid and her milliner, is nothing better than a doll sent abroad to public places as a sample of their handywork. Dancing is a favourite exercise: nay, we might almost call it the favourite study of the fair sex: So many pleasing images are associated with the idea of dancing; dress, attendance, balls, elegance and grace of motion irresistible, admiration, and courtship: and these are so early inculcated on the young by mothers and maids, that we need not be surprised if little Miss consider her lesson of dancing as a matter of much more importance than either her book or sampler. And indeed, though the public in general seem at present to place too high a value on dancing; and though the undue estimation which is paid to it seems owing to that taste for dissipation, and that rage for public amusements, which naturally prevail amid such refinement and opulence; yet still dancing is an accomplishment which both sexes may cultivate with considerable advantage. It has a happy effect on the figure, the air, and the carriage; and we know not if it be not favourable even to dignity of mind: Yet as to be even a first-rate poėt or painter, and to value himself on his genius in these arts, would be no real ornament in the character of a great monarch; so any very superior skill in dancing must serve rather to disgrace than to adorn the lady or the gentleman. There are some arts in which, though a moderate degree of skill may be useful or ornamental, yet superior taste and knowledge are rather hurtful, as they have a tendency to seduce us from the more important duties which we owe to ourselves and to society. Of those, dancing seems to be one: It is said of a certain Roman lady, by an eloquent historian, "that she was more skilled in dancing than became a modest and virtuous woman."

82 Music.

Music, also, is an art in which the youth of the female sex are pretty generally instructed; and if their voice and ear be such as to enable them to attain any excellence in vocal music, it may conduce greatly to increase their influence over our sex, and may afford a pleasing and elegant amusement to their leisure hours. The harpsichord and the spinet are instruments often touched by female hands; nor do we presume to forbid the ladies to exercise their delicate fingers in calling forth the enchanting sounds of these instruments. But still, if your daughter have no voice or ear for music, compel her not to apply to it.

83 Drawing.

Drawing is another accomplishment which generally enters into the plan of female education. Girls are usually taught to aim at some scratches with a pencil: but when they grow up, they either lay it totally aside, or else apply to it with so much assiduity as to neglect their more important duties. We do not consider skill in drawing, any more than skill in poetry, as an accomplishment very necessary for the ladies; yet we agree with Rousseau, that as far as it can contribute to improve their taste in dress, it may not be improper for them

them to pursue it. They may very properly be taught to sketch and colour flowers; but we do not wish them to forget or lay aside this as soon as the drawing-master is dismissed; let them retain it to be useful through life. Though pride can never be lovely, even in the fairest female form; yet ought the young woman to be carefully impressed with a due respect for herself. This will join with her native modesty to be the guardian of her virtue, and to preserve her from levity and impropriety of conduct.

Such are the hints which have occurred to us on the education proper for the female sex, as far as it ought to be conducted in a manner different from that of the male.

IX. *Public and Private Education.*

One question usually discussed by the writers on this subject has not hitherto engaged our attention. It is, Whether it be most proper to educate a young man privately, or send him to receive his education at a public school? This question has been so often agitated, and by people enjoying opportunities of receiving all the information which experience can furnish on the subject, that we cannot be expected to advance any new argument of importance on either side. Yet we may state what has been urged both on the one and the other.

84 Arguments for private education.

They who have considered children as receiving their education in the house and under the eye of their parents, and as secluded in a great measure from the society of other children, have been sometimes led to consider this situation as particularly favourable for their acquiring useful knowledge, and being formed to virtuous habits. Though we reap many advantages from mingling in social life, yet in society we are also tainted with many vices to which he who passes his life in solitary retirement is a stranger. At whatever period of life we begin to mix with the world, we still find that we have not yet acquired sufficient strength to resist those temptations to vice with which we are there assailed. But if we are thus ready to be infected with the contagion of vice, even at any age, no other argument can be necessary to shew the propriety of confining children from those dangerous scenes in which this infection is so easily caught. And whoever surveys the state of morals in a public school with careful and candid attention, even though it be under the management of the most virtuous, judicious, and assiduous teachers, will find reason to acknowledge, that the empire of vice is established there not less fully than in the great world. Nothing, therefore, can be more negligent or inhuman, than for parents to expose their children to those seductions which a great school presents, at a time when they are strongly disposed to imitate any example set before them, and have not yet learned to distinguish between such examples as are worthy of imitation, and those which ought to be beheld with abhorrence. Even when under the parent's eye, from intercourse with servants and visitors their native innocence is likely to suffer considerably. Yet the parent's care will be much more likely to preserve the manners of his child uncorrupted in his own house, than any assiduity and watchfulness of his teachers in a school.

The morals and dispositions of a child ought to be the first objects of our concern in conducting his education: but to initiate him in the principles of useful knowledge is also an important object; and it will be happy, if in a private education virtue be not only better secured, but knowledge also more readily acquired, than in a public. But this actually happens. When one or two boys are committed to the care of a judicious tutor, he can watch the most favourable seasons of communicating instruction; he can awake curiosity and command attention by the gentle arts of insinuation: though he strive not to inflame their breasts with emulation, which leads often to envy and inveterate hatred; yet he will succeed in rendering learning pleasing, by other means less likely to produce unfavourable effects on the temper and dispositions of his pupils. As his attention is not divided among a number, he can pay more regard to the particular dispositions and turn of mind of each of his pupils: he can encourage him who is modest and slow, and repress the quickness and volatility of the other; and he can call forth and improve their powers, by leading them at one time to view the scenes of nature and the changes which she successively undergoes through the varying seasons: at another, to attend to some of the most entertaining experiments of natural philosophy; and again alluring them artfully to their literary exercises. With these he may mix some active games; and he may assume so much of the fondness of the parent, as to join in them with his little pupils. These are certainly circumstances favourable both to the happiness and to the literary improvement of youth; but they are peculiar to a private education. Besides, in a private education, as children spend more of their time with grown-up people than in public; those, therefore, who receive a domestic education, sooner acquire our manner of thinking, of expressing ourselves, and of behaving in our ordinary intercourse with one another. For the very same reason for which girls are often observed to be capable of prudence and propriety of behaviour at an earlier age than boys, those boys who receive a family education will begin sooner to think and act like men, than those who pass their earlier days in a public seminary. And though you educate your son at home, there is no reason why he should be more accustomed to domineer over his inferiors, or to indulge a capricious or inhumane disposition, than if he were brought up among fifty boys, all of the same age, size, and rank, with himself. He may also, in a private education, exercise his limbs with the same activity as in a public one. He cannot indeed engage in those sports for which a party of companions is necessary; but still there are a thousand objects which will call forth his activity: if in the country, he will be disposed to fish, to climb for bird nests, to imitate all that he sees performed by labourers and mechanics: in short, he will run, leap, throw and carry stones, and keenly exert himself in a variety of exercises, which will produce the most favourable effects on the powers both of his mind and body. It may indeed be possible for you to oppose the designs of nature so effectually, if you take pains for that purpose, as to repress the natural activity of your child or pupil, and cause him to pine away his time in listless indolence; but you will thus do violence to his dispositions, as well as to those instincts which nature has for wise purposes implanted in his breast.

And

And the bad consequences which may result from this management are not to be considered as the natural effects of a domestic education, but as the effects of an education carelessly or imprudently conducted.

But there is another consideration which will perhaps be still more likely than any of those which we have hitherto urged, to prevail with the fond parent to give his child a private education. As the infant who is abandoned by its mother to the care of an hireling nurse, naturally transfers its affection from the unnatural parent to the person who supplies her room and performs the duties incumbent upon her; so the boy who is banished from a parent's house at a time when he has scarce begun to know the relation in which he stands to his father and mother, brothers or sisters, soon ceases to regard them with that fondness which he had contracted for them from living in their company and receiving their good offices. His respect, his affection, and his kindness, are bestowed on new objects, perhaps on his master or his companions; or else his heart becomes selfish and destitute of every tender and generous feeling; and when the gentle and amiable affections of filial and fraternal love are thus, as it were torn up by the roots, every evil passion springs up, with a rapid growth, to supply their place. The boy returns afterwards to his father's house: but he returns as a stranger; he is no longer capable of regarding his parents and relations with the same tenderness of affection. He is now a stranger to that filial love which springs up in the breast of the child who is constantly sensible of the tender care of his parents, and spends his earlier years under their roof, in such a manner as to appear the effect of instinct rather than of habit. Selfish views are now the only bond which attaches him to his parents and relations; and by coming under their influence at so early a period of life, he is rendered for ever incapable of all the most amiable virtues which can adorn human nature. Let the parent, therefore, who loves his child, and wishes to obtain from him a mutual return of affection, beware of excluding him from his house, and devolving the sole charge of him upon another, in his childhood.

These views represent a private education as the most favourable to virtue, to knowledge, and to the mutual affection which ought always to unite the parent and his child. But let us now listen to the arguments which are usually urged in behalf of a public education.

rguments r public ucation.

In the first place, it has been asserted, that a public education is much more favourable than a private to the pupil's improvement in knowledge, and much more likely to inspire him with an ardour for learning. In a private education, with whatever assiduity and tenderness you labour to render learning agreeable to your pupil, still it will be but an irksome task. You may confine him to his books but for a very short space in the course of the day, and allow him an alternation of study and recreation. Still, however, you will never be able to render his books the favourite objects of his attention. He will apply to them with reluctance and careless indifference; even while he seems engaged on his lesson, his mind will be otherwise occupied; it will wander to the scenes where he pursues his diversions, and to those objects which have attracted his desires. If the period during which you require his application be extremely short; during the first part of it, he will still be thinking of the amusements from which you have called him, and regretting his confinement; during the last, he will fondly anticipate the moment when he is to be set at liberty, and think of new amusements. Again, if you confine him during a longer period, still more unfavourable effects will follow. Peevishness, dulness, and a determined aversion to all that bears the name of literature, will be naturally impressed on his mind by such treatment. How can it be otherwise? Books possess so few of those qualities which recommend any object to the attention of children, that they cannot be naturally agreeable. They have nothing to attract and detain the eye, the ear, or any of the senses; they present things with which children are unacquainted, and of which they know not the value: children cannot look beyond the letters and words, to the things which these represent; and even though they could, yet it is much more pleasing to view scenes and objects as they exist originally in nature, than to trace their images in a faint and imperfect representation. It is vain, therefore, to hope that children will be prevailed with to pay attention to books by means of any allurements which books can of themselves present. Other means must be used; but those in a private education you cannot command. In a public seminary, the situation of masters with respect to their pupils is widely different. When a number of boys meet together in the same school, each of them soon begins to feel the impulse of a principle which enables the master to command their attention without difficulty, and prompts them to apply with cheerful ardour to tasks which would otherwise be extremely irksome. This principle is a generous emulation, which animates the breast with the desire of superior excellence, without inspiring envy or hatred of a competitor. When children are prudently managed in a great school, it is impossible for them not to feel its impulse. It renders their tasks scarce less agreeable than their amusements, and directs their activity and curiosity to proper objects. View the scholar at a public school, composing his theme, or turning over his dictionary; how alert! how cheerful! how indefatigable! He applies with all the eagerness, and all the perseverance, of a candidate for one of the most honourable places in the temple of fame. Again, behold and pity that poor youth who is confined to his chamber with no companion but his tutor; none whose superiority can provoke his emulation, or whose inferiority might flatter him with thoughts of his own excellence, and thus move him to preserve by industrious application the advantages which he has already gained. His book is before him; but how languid, how listless his posture! how heavy and dull his eye! Nothing is expressed in his countenance but dejection or indignation. Examine him concerning his lesson; he replies with confusion and hesitation. After a few minutes observation, you cannot fail to be convinced that he has spent his time without making any progress in learning; that his spirits are now broken, his natural cheerfulness destroyed; and his breast armed with invincible prejudices against all application in the pursuit of literary knowledge. Besides, in a school there is something more than emulation to render learning

ing less disagreeable than it naturally is to children. The slightest observation of life, or attention to our own conduct in various circumstances, will be sufficient to convince us, that whenever mankind are placed in circumstances of distress, or subjected to any disagreeable restraint, that which a single person bears with impatience or dejection will make a much less impression on his mind if a number of companions be joined with him in his suffering or restraint. It is esteemed a piece of much greater severity to confine a prisoner in a solitary cell, than where he is permitted to mix with others in the same uncomfortable situation. A journey appears much less tedious to a party of travellers, than to him who beats the path alone. In the same manner, when a number of boys in a great school are all busied on the same or on similar tasks, a spirit of industry and perseverance is communicated from one to another over the whole circle; each of them insensibly acquires new ardour and vigour; even though he feel not the spur of emulation, yet, while all are busy around him, he cannot remain idle. These are facts obvious to the most careless observer.

Neither are public schools so unfavourable to the virtue of their members as they have been represented to be. If the masters are men of virtue and prudence, careful to set a good example before their pupils, attentive to the particular character and behaviour of each individual among them, firm to punish obstinate and incorrigible depravity, and even to expel those who are more likely to injure the morals of others than to be reclaimed themselves, and at the same time eager to applaud and to encourage amiable and virtuous dispositions wherever they appear; under the government of such masters, a public school will not fail to be a school of virtue. There will no doubt be particular individuals among the pupils of such a seminary, whose morals may be corrupt and their dispositions vicious; but this, in all probability, will arise from the manner in which they were managed before entering the school, or from some other circumstances, rather than from their being sent for their education to a public school. Again, at a public school, young people enjoy much greater advantages for preparing them to enter the world, than they can possibly be favoured with if brought up in a private and solitary manner. A great school is a miniature representation of the world at large. The objects which engage the attention of boys at a school are different from those which occupy their parents; the views of the boys are less extensive, and they are not yet capable of prosecuting them by so many base and mean arts: but, in other respects, the two scenes, and the actors upon them, nearly resemble each other; on both you behold contending passions, opposite interests, weakness, cunning, folly, and vice. He therefore who has performed his part on the miniature scene, has rehearsed as it were for the greater; if he has acquitted himself well on the one, he may be also expected to distinguish himself on the other; and even he who has not distinguished himself at school, at least enters the world with superior advantages when viewed in comparison with him who has spent his earlier days in the ignorance and solitude of a private and domestic education. Besides, when a number of boys meet at a public seminary of education, separated from their parents and relations; nearly of the same age, engaged in the same studies, and fond of the same amusements; they naturally contract friendships with one another which are more cordial and sincere than any that take place between persons farther advanced in life. A friendship is often formed between two boys at school which continues through life, and is productive of the happiest consequences to each of them. While at school, they mutually assist and encourage each other in their learning; and their mutual affection renders their tasks less burdensome than they might otherwise find them. As they advance in life, their friendship still continues to produce happy effects on their sentiments and conduct: perhaps they are mutually useful to each other by interest or by personal assistance in making their way in the world; or when they are engaged in the cares and bustle of life, their intercourse and correspondence with each other may contribute much to console them amid the vexations and fatigues to which they may be exposed.

Such are the chief arguments usually adduced in favour of a public education. When we compare them with those which have been urged to recommend a private education, we shall perhaps find that each has its peculiar advantages. A public education is the more favourable to the acquisition of knowledge, to vigour of mind, and to the formation of habits of industry and fortitude. A private education, when judiciously conducted, will not fail to be peculiarly favourable to innocence and to mildness of disposition; and notwithstanding what has sometimes been advanced by the advocates for a public education, it is surely better to keep youth at a distance from the seductions of vice till they be sufficiently armed against them, than to expose them to them at an age when they know not to what dangers they lead, and are wholly unable to resist them. Were we to give implicit credit to the specious talk of the two parties, either a private or a public education would form characters more like to angels than to those men whom we ordinarily meet in the world: but they speak with the ardour of enthusiasts; and therefore we must listen with caution both to the facts which they adduce, and to the inferences which they draw. Could we, without exposing children to the contagion of a great town, procure for them the advantages of both a public and a private education at the same time, we would by this means probably succeed best in rendering them both respectable scholars and good men. If we may presume to give our opinion freely, we would advise parents never, except when some unavoidable necessity of circumstances obliges them, to expel their children from under their own roof till they be advanced beyond their boyish years: let the mother nurse her own child; let her and the father join in superintending its education: they may then expect to be rewarded, if they have acted their parts aright, by commanding the gratitude, the affection, and the respect of their child, while he and they continue to live together. Let matters be so ordered, that the boy may reside in his father's house, and at the same time attend a public school: but let the girl be educated wholly under her mother's eye.

86
A mediu
between
the two.

X. On

X. *On Travel.*

ANOTHER question which has been often discussed comes here under our review. The philosophers of ancient Greece travelled in search of knowledge. Books were then scarce, and those few which were to be obtained were no very rich treasuries of useful information. The rhapsodies of a poet, the rude legends of some ill-informed and fabulous historian, or the theories of fanciful philosophers, were all that they could afford. Thales, Lycurgus, Solon, Plato, travelled, seeking that knowledge among more civilized nations which they could not find in their native country. In the course of their travels, they heard the lectures of celebrated philosophers; consulted the priests, who were the guardians of the traditions of antiquity, concerning the nature and origin of those traditions; and observed the institutions of those nations which were most renowned for the wisdom of their legislature. When they set out to visit foreign countries, they seemed to have proposed to themselves a certain end; and by keeping that end steadily in view during the course of their travels, they gained such improvement as to be able on their return to command the veneration of their countrymen by means of the knowledge which they were enabled to communicate. Many besides the philosophers of ancient Greece have travelled for improvement, and have succeeded in their views. But ancient history does not relate to us, that travelling was considered by the Greeks or Romans as necessary to finish the education of their young men of fortune before they entered the scenes of active life. It is true, after Greece became a province of the Roman empire, and the Romans began to admire the science and elegance of Greece, and to cultivate Grecian literature, the young noblemen of Rome often repaired to Rhodes and Athens to complete their studies under the masters of philosophy and eloquence who taught in those cities. But they went thither with the same views with which our youth in modern times are sent to free schools and universities, not to acquire knowledge by the observation of nature, of the institutions, manners, and customs of nations; but merely to hear lectures, read books, and perform exercises. In modern times, a few men of reflection and experience have now and then travelled for improvement: but the greatest part of our travellers, for a long time, were enthusiastic devotees who went in pilgrimage to visit the shrine or relics of some favourite saint; soldiers, who wandered over the earth to destroy its inhabitants; or merchants, whose business as factors between widely distant countries and nations, led them to brave every danger in traversing from one corner of the globe to another. But since the nations of modern Europe have begun to emerge from rudeness, ignorance, and servile depression, they have formed one great commonwealth, the members of which are scarce less intimately connected with each other than were the states of ancient Greece. The consequence of this mutual connexion and dependence is, that almost all the nations of Europe have frequent intercourse with one another; and as some of them are, and have long been, more enlightened and refined than others, those nations who have attained the highest degree of civilization and refinement have naturally attracted the admiration and homage of the rest. Their language has been studied, their manners and arts have been adopted, and even their dress has been imitated. Other nations have thronged to pay the homage due to their superior merit, and to study under them as masters. Hence has arisen the practice which at present prevails among us of sending our youth to complete their education by travelling, before we introduce them to active life, or require them to engage in business. Formerly young men were not sent to travel till after they had proceeded through the forms of a regular education, and had at least attained such an age that they were no longer to be considered as mere boys. But the progress of luxury, the desire of parents to introduce their children into the world at an early age, that they may early attain to wealth and honours, and various other causes, have gradually introduced the practice of sending mere boys to foreign countries, under pretence of affording them opportunities of shaking off prejudices, of storing their minds with truly useful knowledge, and of acquiring those graceful manners and that manly address which will enable them to acquit themselves in a becoming manner when they are called to the duties of active life. How much travelling at such an early age contributes to fulfil the views of parents, a slight survey of the senate-house, the gambling-houses, the race-course, and the cockpit, will convince the sagacious observer.

But we wish to foster no prejudices against neighbouring nations; we entertain no such prejudices in favour of Britain, as to wish to confine our countrymen within the sea-girt isle. Let us inquire what advantages may be gained by travelling, and at what age it may be most proper to set out in pursuit of those advantages.

88
Travel necessary to the acquisition of knowledge.

After all that bookish men have urged, and notwithstanding all that they may continue vehemently to urge, in behalf of the knowledge to be derived from their beloved books; it must still be acknowledged, that books can teach us little more than merely the language of men. Or, if we should grant that books are of higher importance, and that language is the least valuable part of the knowledge which they teach, yet still we need to beware that they lead us not astray; it is better to examine nature with the naked eye, than to view her through the spectacles of books. Neither the theories nor experiments of philosophers, nor the narratives of travellers, nor the relations of historians, though supported by a numerous train of authorities, are worthy of implicit credit. You retire from the world, confine yourself for years to your closet, and read volume after volume, historians, philosophers, and poets; at last you fancy that you have gained an immense store of knowledge: But leave your retirement, return into the world, compare the knowledge which you have treasured up with the appearances of nature; you will find that you have laboured in vain, that it is only the semblance of knowledge which you have acquired, and will not serve for a faithful guide in life, nor even enable you to distinguish yourself for literary merit. Compare the relations of travellers with one another; how seldom do they agree when they describe the same scenes and the same people! Turn your attention to the most respectable historians, compare their accounts of the same events; what disagreement! what contrariety! Where shall truth be found? Listen to the cool, the candid philosophers; what contradictory theories do they build on the same system of facts!

We agree, then, that it is better to seek knowledge by actual observation and experiment, than to receive it at second hand from the information of others. He who would gain an acquaintance with the beauties of external nature, must view them with his own eyes; he who would know the operations of the human understanding, must reflect upon what passes in his own mind; he who would know the customs, opinions, and manners of any people, must mingle with them, must observe their conduct, and listen to their conversation. The arts are acquired by actual practice; the sciences by actual observation in your own person, and by deducing inferences from your observations.

If therefore to extend our knowledge can contribute in any degree to render us happier, wiser, or better; travelling, as being more favourable to knowledge than the study of books, must be highly advantageous. Get well acquainted with your own country; with the manners, the customs, the laws, and the political situation of your countrymen: Get also a knowledge of books; for books would not be altogether useless, though they could serve no other purpose but to teach us the language in which mankind express themselves: And then, if your judgment have attained maturity; if curiosity prompt you; if your constitution be robust and vigorous, and your spirits lively; you may imitate the Solons, Homers, and Platos, of old, and visit foreign countries in search of knowledge, and with a view to bring home something which may be of real utility to yourself and your country. You will, by this time, be so much master of the language of your own country, that you will not lose it while you are learning the languages of foreign nations; your principles of taste and of right and wrong will be so formed and fixed, that you will not despise any institution or custom or opinion merely because it prevails not in your own country; nor yet will you be ready to admire and adopt any thing, merely because it prevails among a foreign nation who are distinguished for profound and extensive knowledge, or for elegance of taste and manners. No; you will divest yourself of every prejudice, and judge only by the fixed unalterable principles which determine the distinction between right and wrong, between truth and falsehood, between beauty and deformity, sublimity and meanness. Your object will not be to learn exotic vices, to mingle in frivolous amusements, or to form a catalogue of inns. Your views, your inquiries, will have a very different direction. You will attend to the state of the arts, of the sciences, of morals, manners, and government; you will also contemplate with eager delight, the grand or beautiful scenes of nature, and examine the vegetable productions of the various regions through which you pass, as well as the different tribes of animals which inhabit them; you will observe what blessings the beneficence of nature has conferred on the inhabitants of each particular division of the globe, and how far the ingenuity and industry of man have taken advantage of the kindness of nature. Thus surveying the face of the earth, and considering how advantages and disadvantages are balanced with each other, through every various region and climate, from one extremity of the globe to another; you will admire and revere that impartiality with which the Author of nature has distributed his benefits to the whole human race. When from the chilly climes and stubborn soil of the north, you turn your eyes to the fertile genial regions of the south, where every tree is loaded with exquisite fruits, and every vegetable is nourishing and delicious; you will be pleased to find, that the inhabitants of the north, by their superior ingenuity and vigour, are able to raise themselves to circumstances no less comfortable and respectable than those which the nations inhabiting between the tropics enjoy: when you behold the French shaking off the yoke of despotism, and aspiring to the sweets of liberty as well as their British neighbours; you will be pleased to see, that the natural gaiety and cheerfulness of the former nation render them not incapable of the energy of the latter. You will be pleased to view the remains of antiquity, and the noble monuments of art; but you will think it below you to trifle away your time in gazing at palaces and churches, and collecting rusty medals and fragments of marble; you will seek the society of eminent men, and eagerly cultivate an acquaintance with the most distinguished artists and men of science who adorn the nations among whom you may happen to sojourn. Knowing that the knowledge which is to be acquired in great towns, is by no means an adequate compensation for the vicious habits which you are liable to contract in them; and besides, that the luxuries, the arts, the manners, the virtues, and the vices of all great towns are nearly the same, so that when you have seen one, you have seen all others; you will avoid taking up your residence for any considerable time in any of the great towns through which you have occasion to pass in the course of your travels. The traveller who has attained the previous accomplishments which we have mentioned as necessary, who sets out with the views which we have supposed him to entertain, and who conducts his travels in this manner, cannot fail to return home enriched with much useful knowledge; he cannot but derive more real improvement from travelling, than he could have gained by spending the same period of time in solitary study: when he returns to his native country, he will appear among his countrymen as more than a philosopher; a sage, and a benefactor. His knowledge is so extensive and accurate, his views are so liberal and enlarged, and he is so superior to prejudices, without being the enemy of any useful establishments, that he will be enabled to command universal esteem, by performing his part in life with becoming dignity and propriety, and perhaps to render his name illustrious, and his memory dear to future times, by some important services to the community to which he belongs, or even to mankind in general.

89
Circumstances
that ren
travelli
unprofit
to the y
of the p
sent ag

But though we have thus far, and we hope for obvious and solid reasons, decided in favour of travelling, as being more likely than a solitary application to books, to furnish the mind with useful and ornamental knowledge; yet we do not see that our British youth either take care to furnish themselves with the previous knowledge which we consider as indispensably necessary in order to prepare them for travelling with advantage, or set out with proper views, or prosecute

secute their travels in a prudent judicious manner. After receiving a very imperfect education, in which religious and moral instruction are almost wholly neglected, and no means are used to inspire the youthful mind with solid, virtuous, manly qualities; but every art is tried to make the young man appear learned, while his mind is destitute of all useful information, and to teach him to assume the confidence of manhood before he has attained even to a moderate degree of sense and prudence;—after an education conducted in this manner, and with these views, the stripling is sent abroad to view the world, and is expected to return home a finished character, an ornament and a comfort to his parents and all his connexions. He is hitherto unacquainted, perhaps, even with the simple events of the history of his native country; and either totally ignorant of classical literature, or but very superficially instructed in it. He has not yet viewed with a discerning eye the manners and customs prevailing among his countrymen; he knows not the nature of the government under which he lives, nor the spirit of those laws by which his civil conduct must be regulated. He has no fixed principles; no clear, distinct views. But to supply all his wants of this nature, he is put into the hands of a travelling governor, who is to be entirely submissive to his will, and yet to serve him both for eyes and intellect. This governor is generally either some macaroni officer, who is considered as well bred, and thought to know the world; or else, perhaps, some cringing son of literature, who, having spent much time among his books, without acquiring such strength or dignity of mind as to raise him above frivolity of manners and conversation or pitiful fawning arts, is therefore regarded as happily qualified for this important charge. This respectable personage and his pupil are shipped off for France, that land of elegant dissipation, frivolity, and fashion. They travel on with eager impatience, till they reach the capital. There the young man is industriously introduced to all the gay scenes which Paris can display. He is, at first, confounded; by and by his senses are fascinated; new desires are awaked in his breast; all around him he sees the sons of dissipation wallowing in debauchery, or the children of vanity fluttering about like so many gaudy insects. The poor youth has no fixed principles: he has not been taught to regard vanity as ridiculous, or to turn from vice with abhorrence. No attempt is made to allure him to these objects, an attention to which can alone render travelling truly beneficial. Hitherto his mind had been left almost wholly uncultivated; and now the seeds of vice are plentifully sown in it. From one great town he is conveyed to another, till he visit almost every place in Europe where profligacy of manners has attained to any uncommon height. In this happy course of education he probably continues to pursue improvement till he is well acquainted with most of the post roads, the principal inns, and the great towns at least in France and Italy; and perhaps till he has worn out his constitution, and rendered his mind totally incapable of any generous sentiments or sober reflection. He then revisits his native country, to the inexpressible happiness of his parents, who now eagerly long to embrace their all-accomplished child. But how miserably are the poor folks disappointed, when they find his constitution wasted, his understanding uninformed, his heart destitute of every manly or generous sentiment: and perceive him to possess no accomplishment, but such as are merely superficial? Perhaps, however, his parents are prevented by their partiality both for their child and for the means which they have adopted in conducting his education, from viewing his character and qualifications in a true light. Perhaps they overlook all his defects, or consider them as ornaments, and regard their dear son as the mirror of perfection. But, unfortunately, though they be blind to the hideous deformity of the monster which they have formed, they cannot hinder it from being conspicuous to others; though they may view their son's character as amiable and respectable, they cannot render it useful, they cannot prevent it from being hurtful to society. Let this youth whose education has been thus wisely conducted, let him be placed at the head of an opulent fortune, advanced to a seat in the legislative body of his country, or called to act in any public character; how will he distinguish himself? As the virtuous patriot, the honest yet able statesman, the skilful general, or the learned upright judge? How will he enjoy his fortune? Will he be the friend of the poor, the steady supporter of the laws and constitution under whose protection he lives? Will he show himself capable of enjoying *otium cum dignitate?* If we reason by the usual laws of probability, we cannot expect that he should: and if we observe the manners and principles of our men of wealth and high birth who have been brought up in this manner, we find our reasonings confirmed.

Such are the opinions which candid observation leads us to entertain with regard to the advantages which may be gained by travelling.

He whose mind has been judiciously cultivated, and who has attained to maturity of judgment, if he set out on his travels with a view to obtain real improvements, and persist invariably in the prosecution of that view, cannot but derive very great advantages from travelling.

But again, those young men whose minds have not been previously cultivated by a judicious education, who set out without a view to the acquisition of real knowledge, and who wander among foreign nations, without attention to any thing but their luxuries, their follies, and their vices, those poor young men cannot gain any real improvement from their travels.

Our countrymen, who travel for improvement, do not appear to derive so much advantage from their travels as were to be wished, because they generally receive too superficial an education, set out at too early a period of life, and direct not their views to objects of real utility and importance.

XI. *On Knowledge of the World, and Entrance into Life.*

90
Unhappy effects of too early introduction into the world.

Much has been said concerning the utility of a knowledge of the world, and the advantage of acquiring it at an early period of life. But those who have the most earnestly recommended this knowledge of the world, have generally explained themselves in so inaccurate a matter concerning it, that it is difficult to understand what ideas they affix to it. They seem to wish,

wish, that, in order to acquire it, young people may be early made acquainted with all the vices and follies of the world, introduced into polite company, carried to public places, and not confined even from the gaming table and the stews. Some knowledge of the world may, no doubt, be gained by these means. But it is surely dearly purchased; nor are the advantages which can be derived from it so considerable, as to tempt the judicious and affectionate parent to expose his child to the infection of vanity, folly, and vice, for their sake. Carry a boy or girl into public life at the age of fourteen or fifteen; show them all the scenes of splendid vanity and dissipation which adorn London or Paris; tell them of the importance of dress, and of the ceremonies of good breeding and the forms of intercourse; teach them that fashionable indifference and assurance which give the *ton* to the manners of our fine gentlemen and fine ladies of the present age. What effects can you expect the scenes into which you introduce them, and the mysteries which you now teach them, to produce on the minds of the children? They have a direct tendency to inspire them with a taste for vanity, frivolity, and dissipation. If you wish them to be like the foolish, the dissipated, and the gay, you are likely to obtain your purpose; but if, on the contrary, your views are to prepare them for discharging the duties of life, you could not adopt more improper means; for though they be well acquainted with all those things on which you place so much value, yet they have not thereby gained any accession of useful knowledge. They are not now more able that before to estimate the real value of objects; nay, their judgment is now more liable than before to be misled in estimating the value of the objects around them. Luxury, vanity, and fashion, have stamped on many things an ideal value. By mingling at an early age in those scenes of the world where luxury, vanity, and fashion, reign with arbitrary away, young people are naturally impressed with all those prejudices which these have a tendency to inspire. Instead of acquiring an useful knowledge of the world, they are rendered incapable of ever viewing the world with an unprejudiced and discerning eye. If possible, therefore, we should rather labour to confine young people from mingling in the scenes of gay and dissipated life till after they have attained maturity of age and judgment. They will then view them in a proper light, and perhaps be happy enough to escape the infectious contagion of vice.

91 What knowle of the world m be safely communi cated t young pe ple.

But there is another and a more valuable knowledge of the world, which we ought industriously to communicate to them as soon as they are capable of receiving it. As soon as they are made thoroughly acquainted with the distinctions between right and wrong, between virtue and vice, between piety and impiety, and have become capable of entering into our reasonings; we ought then to inform them concerning the various establishments and institutions which exist in society; concerning the customs, opinions, and manners of mankind; and concerning the various degrees of strength or weakness of mind, of ingenuity or dulness, of virtuous or vicious qualities, which discriminate those characters which appear in society.

When at length the period arrives at which they must be emancipated from subjection, and committed to the guidance of their own conscience and reason, and of those principles which we have laboured to inculcate on their minds; let us warn them of the dangers to which they are about to be exposed; tell them of the glory and the happiness to which they may attain; inspire them, if possible, with disdain for folly, vanity, and vice, whatever dazzling or enchanting forms they may assume; and then dismiss them to enrich their minds with new stores of knowledge by visiting foreign nations; or, if that should be inconvenient, to enter immediately on the duties of some useful employment in active life. See EDUCATION, SUPPLEMENT.

Edulcoration.

EDULCORATION, properly signifies the rendering substances more mild. Chemical edulcoration consists almost always in taking away acids and other saline substances; and this is effected by washing the bodies to which they adhere in a large quantity of water. The washing of diaphoretic antimony, powder of algaroth, &c. till the water comes off quite pure and insipid, are instances of chemical edulcoration.—In pharmacy, juleps, potions, and other medicines, are said to be *edulcorated*, by adding sugar or syrup.

EDWARD, the name of several kings of England. See (*History of*) ENGLAND.

EDWARDS, GEORGE, fellow of the royal and antiquarian societies, was born at Stratford, a hamlet belonging to Westham in Essex, on the 3d of April 1694. After having spent some time at school, he was put apprentice to a tradesman in Fenchurch street. His master, who was eminent both for his piety and skill in the languages, treated him with great kindness; but about the middle of his apprenticeship, an accident happened which totally put a stop to the hopes of young Edwards's advancing himself in the way of trade. Dr Nicolas, a person of eminence in the physical world, and a relation of his master's, happened to die. The Doctor's books were removed to an apartment occupied by Edwards, who eagerly employed all his leisure hours, both in the day and great part of the night, in perusing those which treated of natural history, sculpture, painting, astronomy, and antiquities. The reading of these books entirely deprived him of any inclination for mercantile business he might have formerly had, and he resolved to travel into foreign countries. In 1716, he visited most of the principal towns in Holland, and in about a month returned to England. Two years after, he took a voyage to Norway, at the invitation of a gentleman who was disposed to be his friend, and who was nephew to the master of the ship in which he embarked. At this time Charles XII. was besieging Fredrickshall; by which means our young naturalist was hindered from making such excursions into the country as otherwise he could have done, for the Swedes were very careful to confine such strangers as could not give

Edwards, Edystone.

give a good account of themselves. But notwithstanding all his precaution, he was confined by the Danish guard, who supposed him to be a spy employed by the enemy to get intelligence of their designs. However, by obtaining testimonials of his innocence, a release was granted. In 1718 he returned to England, and next year visited Paris by the way of Dieppe. During his stay in this country he made two journeys of 100 miles each; the first to Chalons in Champagne, in May 1720; the second on foot, to Orleans and Blois; but an edict happening at that time to be issued for securing vagrants, in order to transport them to America, as the banks of the Mississippi wanted population; our author narrowly escaped a western voyage. On his arrival in England, Mr Edwards closely pursued his favourite study of natural history, applying himself to drawing and colouring such animals as fell under his notice. A strict attention to natural, more than picturesque beauty, claimed his earliest care: birds first engaged his particular attention; and having purchased some of the best pictures of these subjects, he was induced to make a few drawings of his own; which were admired by the curious, who encouraged our young naturalist to proceed, by paying a good price for his early labours. Among his first patrons and benefactors may be mentioned James Theobalds, Esq. of Lambeth; a gentleman zealous for the promotion of science. Our artist, thus unexpectedly encouraged, increased in skill and assiduity; and procured, by his application to his favourite pursuit, a decent subsistence and a large acquaintance. However, he remitted his industry in 1731; when, in company with two of his relations, he made an excursion to Holland and Brabant, where he collected several scarce books and prints, and had an opportunity of examining the original pictures of several great masters at Antwerp, Brussels, Utrecht, and other cities. In December 1733, by the recommendation of the great Sir Hans Sloane, Bart. president of the College of Physicians, he was chosen librarian, and had apartments in the college. This office was peculiarly agreeable to his taste and inclination, as he had the opportunity of a constant recourse to a valuable library, filled with scarce and curious books on the subject of natural history, which he so assiduously studied. By degrees he became one of the most eminent ornithologists in this or any other country. His merit is so well known in this respect, as to render any eulogium on his performances unnecessary: but it may be observed, that he never trusted to others what he could perform himself; and often found it so difficult to give satisfaction to his own mind, that he frequently made three or four drawings to delineate the object in its most lively character, attitude, and representation. In 1743, the first volume of the History of Birds was published in quarto. His subcribers exceeding even his most sanguine expectations, a second volume appeared in 1747. The third volume was published in 1750. In 1751, the fourth volume came from the press. This volume being the last he intended to publish at that time, he seems to have considered it as the most perfect of his productions in natural history; and therefore devoutly offered it up to the great God of nature, in humble gratitude for all the good things he had received from him in this world. Our author, in 1758, continued his labours under a new title, viz. *Gleanings of Natural History*. A second volume of the Gleanings was published in 1760. The third part, which made the seventh and last volume of his works, appeared in 1764. Thus our author, after a long series of years, the most studious application, and the most extensive correspondence to every quarter of the world, concluded a work which contains engravings and descriptions of more than 600 subjects in natural history, not before described or delineated. He likewise added a general index in French and English; which was afterwards perfected, with the Linnæan names, by that great naturalist Linnæus himself, who frequently honoured him with his friendship and correspondence. Some time after Mr Edwards had been appointed library keeper to the Royal College of Physicians, he was, on St Andrew's day, in the year 1750, presented with an honorary compliment by the president and council of the Royal Society, with the gold medal, the donation of Sir Godfrey Copley, Bart. annually given on that day to the author of any new discovery in art or nature, in consideration of his natural history just then completed. A copy of this medal he had afterwards engraved, and placed under the title in the first volume of his history. He was a few years afterwards elected fellow of the Royal Society, and of the Society of Antiquaries, London; and also a member of many of the academies of sciences and learning in different parts of Europe. In compliment to those honorary distinctions from such learned bodies, he presented elegant coloured copies of all his works to the Royal College of Physicians, the Royal Society, and Society of Antiquarians, and to the British museum: also to the Royal Academy of Sciences at Paris, from whom he received the most polite and obliging letter of thanks by their then secretary Monsieur Defouchy. His collection of drawings, which amounted to upwards of 900, were purchased by the earl of Bute. They contain a great number of British as well as foreign birds, and other animals hitherto not accurately delineated or described. After the publication of the last work, being arrived at his 70th near, he found his sight begin to fail, and his hand lost its wonted steadiness. He retired from public employment to a little house which he purchased at Plaistow; previous to which, he disposed of all the copies, as well as plates of his works. The conversation of a few select friends, and the perusal of a few select books, were the amusement of the evening of his life; and now and then he made an excursion to some of the principal cities in England, particularly to Bristol, Bath, Exeter, and Norwich. Some years before his death, the alarming depredation of a cancer, which baffled all the efforts of medical skill, deprived him of the sight of one of his eyes: he also suffered much from the stone, to which at different periods of his life he had been subject. But in the severest paroxysms of pain, he was scarcely known to utter a single complaint. Having completed his 80th year, emaciated with age and sickness, he died, deservedly lamented, on the 23d of July 1772.

EDYSTONE, a lighthouse in the British channel, built on rocks of the same name, which are supposed to have got this appellation from the great variety of contrary sets of the current among them, both upon the tide of flood and the tide of ebb. They are situated nearly south-

south-south-west from the middle of Plymouth sound, according to the true meridian; and the distance, as nearly as can be collected, is 12 miles and a half; and from the same point in the Sound to the Jetty Head, called the Barbican, in the port of Plymouth, is a mile and a half more, which makes the distance of the Edystone from the port of Plymouth to be nearly 14 miles.

"The promontory called Ram Head is the nearest point of land to the Edystone, which bears from thence south scarcely one point west, distant about ten miles, and consequently by the compass is nearly south-west by south.—Those rocks are nearly in a line, but somewhat within that line which joins the *Start* and the *Lizard* Points; and as they lie nearly in the direction of vessels coasting up and down the channel, they must, before a lighthouse was established thereon, have been very dangerous, and often fatal to ships under such circumstances: and many rich ships and other vessels have, in former times, been actually lost upon those rocks, particularly such as were homeward-bound from foreign parts; it being even now a common thing, in foggy and thick hazy weather, for homeward-bound ships from long foreign voyages to make the Edystone lighthouse as the first point of land of Great Britain; so that in the night, and nearly at high water, when the whole range of these rocks is covered, the most careful mariner might run his ship upon them, if nothing was placed there by way of warning.

"The many fatal accidents which so frequently happened, made it a thing very desirable to have a lighthouse built thereon, and that for many years before any competent undertaker appeared. At length, however, we learn, that in the year 1696 Mr Henry Winstanley, of Littlebury in the county of Essex, Gent. was not only hardy enough to undertake it, but was furnished with the necessary powers to put it in execution. This, it is supposed, was done in virtue of the general powers lodged in the master, wardens, and assistants of the Trinity-house at Deptford Strond to erect sea marks, &c. by a statute of Queen Elizabeth, whereby they are impowered 'to erect and set up beacons, marks, and signs for the sea, needful for avoiding the dangers; and to renew, continue, and maintain the same.' But whether Mr Winstanley was a proprietor or sharer of the undertaking under the Trinity-house, or only the directing engineer employed in the execution, does not now appear.

This gentleman had distinguished himself in a certain branch of mechanics, the tendency of which is to raise wonder and surprise. He had at his house at Littlebury a set of contrivances, such as the following:—Being taken into one particular room of his house, and there observing an old slipper carelessly lying on the middle of the floor,—if, as was natural, you gave it a kick with your foot, up started a ghost before you: If you sat down in a certain chair, a couple of arms would immediately clasp you in, so as to render it impossible to disentangle yourself till your attendant set you at liberty: And if you sat down in a certain arbour by the side of a canal, you was forthwith sent out afloat to the middle of the canal, from whence it was impossible for you to escape till the manager returned you to your former place.—Whether those things were shewn to strangers at his house for money, or were done by way of amusement to those that came to visit the place, is uncertain; as Mr Winstanley is said to have been a man of some property: but it is at least certain, that he established a place of public exhibition at Hyde park corner, called *Winstanley's water-works;* which were shewn at stated times at one shilling each person. The particulars of those water-works are not now known; but, according to the taste of the times, we must naturally suppose a great variety of *Jets d'eau*, &c. (A).

"The lighthouse Mr Winstanley built was begun in the year 1696, and was more than four years in building; not (says the architect) for the greatness of the work, but for the difficulty and danger in getting backwards and forwards to the place. The difficulties were many, and the dangers not less. At length, in the third year, all the work was raised, which to the vane was eighty feet. Being all finished, with the lantern, and all the rooms that were in it, they ventured to lodge there soon after midsummer, for the greater dispatch of the work. But the first night the weather came bad, and so continued, that it was eleven days before any boats could come near them again, and not being acquainted with the height of the sea rising, they were almost all the time drowned with wet, and their provisions in as bad a condition, though they worked night and day to make shelter for themselves. In this storm they lost some of their materials, although they did what they could to save them; but the boat then returning, they all left the house to be refreshed on shore; and as soon as the weather permitted, they returned again and finished all, and put up the light on the 14th of November 1698; which being so late in the year, it was three days before Christmas before they had relief to get on shore again, and were almost at the last extremity for want of provisions; but by good providence, then two boats came with provisions, and the family that was to take care of the light.

"The fourth year, finding in the winter the effects the sea had upon the house, and burying the lantern at times, although more than 60 feet high; Mr Winstanley early in the spring encompassed the building with a new work of four feet thickness from the foundation, making all solid near 20 feet high; and taking down the upper part of the first building, and enlarging every part in its proportion, he raised it forty feet higher than it was at first; and yet the sea, in time of storms, flew up in appearance 100 feet (B) above the vane; and at times covered half the side of the house and the lantern as if they were under water.

"On the finishing this building, it was generally said, that in the time of hard weather, such was the height of

---

(A) It appears that the exhibition of these water-works continued some years after the death of Mr Winstanley, as they were existing in the month of September 1709, being mentioned in the Tatler of that date.

(B) Mr Smeaton says this is short of its real height 50 feet.

of the seas, that it was very possible for a six-oared boat to be lifted up upon a wave, and driven through the open gallery of the lighthouse.

"In November 1703, the fabric wanted some repairs, and Mr Winstanley went down to Plymouth to superintend the performance of them. The opinion of the common people was, that the building would not be of long duration. Mr Winstanley, however, held different sentiments. Being amongst his friends previous to his going off with his workmen on account of those reparations, the danger was intimated to him; and it was said, that one day or other the lighthouse would certainly be overset. To this he replied, "He was so well assured of the strength of his building, he should only wish to be there in the greatest storm that ever blew under the face of the heavens, that he might see what effect it would have upon the structure."

"In this wish he was soon gratified; for while he was there with his workmen and light-keepers, that dreadful storm began which raged the most violently upon the 26th November 1703, in the night; and of all the accounts of the kind which history furnishes us with, we have none that has exceeded this in Great Britain, or was more injurious or extensive in its devastation.

"The next morning, when the storm was abated, nothing of the lighthouse was to be seen. The following account of its destruction was printed at the time, by Daniel Defoe, in a book entitled *The Storm.*"

"The loss of the lighthouse called the Edystone, at Plymouth, is another article of which we never heard any particulars, other than this, that at night it was standing, and in the morning all the upper part of the gallery was blown down, and all the people in it perished, and, by a particular misfortune, Mr Winstanley the contriver of it; a person whose loss is very much regretted by such as knew him, as a very useful man to his country. The loss of that lighthouse is also a considerable damage, as it is very doubtful whether it will ever be attempted again; and it was a great security to the sailors, many a good ship having been lost there in former times.

"It was very remarkable, that, as we are informed at the same time the lighthouse aforesaid was blown down, the model of it in Mr Winstanley's house at Littlebury in Essex, above 200 miles from the lighthouse, fell down and was broken to pieces.

"At Plymouth they felt a full proportion of the storm in its utmost fury. The Edystone has been already mentioned; but it was a double loss, in that the lighthouse had not been long down when the *Winchelsea*, a homeward-bound Virginia-man, was split upon the rock where that building stood, and most of her men drowned."

"The great utility of Mr Winstanley's lighthouse had been sufficiently evident to those for whose use it was erected; and the loss of the Winchelsea Virginia-man, before mentioned, proved a powerful incentive to such as were interested, to exert themselves in order for its restoration. It was not, however, begun so soon as might have been expected. In spring of the year 1706, an act of parliament passed enabling the Trinity house to rebuild, but it was no earlier than July that it was begun. The undertaker was a Captain Lovell or Lovett, who took it for the term of ninety-nine years, commencing from the day that a light should be exhibited.

"To enable him to fulfil his undertaking, Captain Lovett engaged Mr John Rudyerd to be his engineer or architect; and his choice, though Mr Rudyerd does not appear to have been bred to any mechanical business or scientifical profession, was not ill made. He at that time kept a linen-draper's shop upon Ludgate-hill. His want of experience, however, was in a degree assisted by Mr Smith and Mr Notcutt, both ship-wrights from the king's yard at Woolwich, who worked with him the whole time he was building the lighthouse.

"It is not very material in what way this gentleman became qualified for the execution of the work: it is sufficient that he directed the performance thereof in a masterly manner, and so as perfectly to answer the end for which it was intended. He saw the errors in the former building, and avoided them: instead of a polygon, he chose a circle for the outline of his building, and carried up the elevation in that form. His principal aim appears to have been use and simplicity; and indeed, in a building so situated, the former could hardly be acquired in its full extent without the latter. He seems to have adopted ideas the very reverse of his predecessor; for all the unwieldy ornaments at top, the open gallery, the projecting cranes, and other contrivances, more for ornament and pleasure than use, Mr Rudyerd laid totally aside: he saw, that how beautiful soever ornaments might be in themselves, yet when they are improperly applied, and out of place, they shew a bad taste, and betray ignorance of its first principle, judgment.

"The building was begun in July 1706, a light was put up in it the 28th July 1708, and it was completely finished in 1709. The quantity of materials expended in the construction, was 500 tons of stone, 1200 tons of timber, 80 tons of iron, and 35 tons of lead; of trenails, screws, and rack-bolts 2500 each.

"Louis XIV. being at war with England during the proceeding with this building, a French privateer took the men at work upon it, together with their tools, and carried them to France; and the captain was in expectation of a reward for the achievement. While the captives lay in prison, the transaction reached the ears of that monarch. He immediately ordered them to be released, and the captors to be put in their place; declaring, that though he was at war with England, he was not at war with mankind; he therefore directed the men to be sent back to their work with presents; observing, that the Edystone lighthouse was so situated, as to be of equal service to all nations having occasion to navigate the channel that divides France from England."

In the year 1715, Captain Lovett being dead, his property in the Edystone lighthouse was sold before a master in chancery to Robert Weston, Esq. —— Noyes, Esq. of Gray's Inn; and —— Cheetham, Esq. an alderman of Dublin, who divided the same into eight shares. After a few years some repairs were found wanting; and in 1723, Mr Rudyerd being, we suppose then dead, Mr John Holland, foreman ship-wright in the dock-yard at Plymouth, became overseer and director of the necessary reparations; which office he again executed in 1734.

Edystone.

"The catastrophe of this light-house took place on the 2d December 1755, when the light-keeper upon watch, about two o'clock in the morning, went into the lantern as usual to snuff the candles; he found the whole in a smoke; and upon opening the door of the lantern into the balcony, a flame instantly burst from the inside of the cupola: he immediately endeavoured to alarm his companions; but they being in bed, and asleep, were not so ready in coming to his assistance as the occasion required. As there were always some leather buckets kept in the house, and a tub of water in the lantern, he attempted to extinguish the fire by throwing water from the balcony upon the outside cover of lead. By this time his companions arriving, he encouraged them to fetch up water with the buckets from the sea; but the height of the place, added to the consternation which must attend such an unexpected event, rendered their efforts fruitless. The flames gathered strength every moment; the poor man with every exertion, having the water to throw four yards higher than himself, found himself unable to stop the progress of the conflagration, and was obliged to desist.

"As he was looking upward with the utmost attention to see the effect of the water thrown, a position which, physiognomists tell us, occasions the mouth naturally to be a little open, a quantity of lead dissolved by the heat of the flames suddenly rushed like a torrent from the roof, and fell upon his head, face, and shoulders, and burnt him in a dreadful manner: from this moment he had a violent internal sensation, and imagined that a quantity of this lead had passed his throat, and got into his body. Under this violence of pain and anxiety, as every attempt had proved ineffectual, and the rage of the flames was increasing, it is not to be wondered that the terror and dismay of the three men increased in proportion; so that they all found themselves intimidated, and glad to make their retreat from the immediate scene of horror into one of the rooms below. They therefore descended as the fire approached, with no other prospect than that of securing their immediate safety, with scarcely any hopes of being saved from destruction.

"How soon the flames were seen on the shore is uncertain; but early in the morning they were perceived by some of the Cawsand fishermen, and intelligence thereof given to Mr Edwards, of Rame, in that neighbourhood, a gentleman of some fortune, and more humanity, who immediately sent out a fishing-boat and men to the relief of the distressed objects in the light-house (c).

"The boat and men got thither about ten o'clock, after the fire had been burning full eight hours; in which time the three light-keepers were not only driven from all the rooms and the staircase, but, to avoid the falling of the timber and red-hot bolts, &c. upon them, they were found sitting in the hole or cave on the east side of the rock under the iron ladder, almost in a state of stupefaction; it being then low water.

"With much difficulty they were taken off; when finding it impossible to do any further service, they hastened to Plymouth. No sooner were they set on shore, than one of the men ran away, and was never afterwards heard of. This circumstance, though it might lead to suspicions unfavourable to the man, Mr Smeaton is of opinion ought not to weigh any thing against him, as he supposes it to have arisen from a panic which sometimes seizes weak minds, and prevents their acting agreeable to the dictates of right reason.

"It was not long before the dreadful news arrived at Plymouth. Alderman Tolcher and his son immediately went to sea, but found it impossible to do any thing with effect. Admiral West also, who then lay in Plymouth sound, sent a sloop properly armed, with a boat and an engine therein, which also carried out Mr Jessop the surveyor. This vessel arrived early in the day. Many attempts were made to play the engine, but the agitation of the sea prevented it from being employed with success. On the succeeding days the fire still continued, and about the 7th the destruction of the whole was completed.

"The man who has been mentioned already was named Henry Hall, of Stonehouse, near Plymouth, and though aged 94 years, being of a good constitution, was remarkably active, considering his time of life. He invariably told the surgeon who attended him, Mr Spry (now Dr Spry) of Plymouth, that if he would do any thing effectual to his recovery, he must relieve his stomach from the lead which he was sure was within him; and this he not only told Dr Spry, but all those about him, though in a very hoarse voice, and the same assertion he made to Mr Jessop.—The reality of the assertion seemed, however, then incredible to Dr Spry, who could scarcely suppose it possible than any human being could exist after receiving melted lead into the stomach; much less that he should afterwards be able to bear towing through the sea from the rock, and also the fatigue and inconvenience from the length of time he was in getting on shore before any remedies could be applied. The man, however, did not shew any symptons of being much worse or better until the sixth day after the accident, when he was thought to mend: he constantly took his medicines, and swallowed many things both liquid and solid, till the tenth or eleventh day; after which he suddenly grew worse; and on the twelfth, being seized with cold sweats and spasms, he soon after expired.

"His body was opened by Dr Spry, and in the stomach was found a solid piece of lead of a flat oval form, which weighed 7 ounces and 5 drachms. So extraordinary a circumstance appearing to deserve the notice of the philosophical world, an account of it was sent to the Royal Society, and printed in the 49th volume of their Transactions, p. 477.

"The light-house being thus demolished, the proprietors immediately turned their thoughts to the rebuilding of it. They had in it a term of near half a century, but some shares being settled by the marriage articles of one of the parties, some impediments arose which could not be overcome without the aid of parliament, which was soon obtained. To one of the partners, Robert Weston, Esq. the management of the business was committed,

---

(c) This benevolent gentleman caught a cold on this occasion which cost him his life.

Edystone.

committed, and he thought it requisite to apply to the earl of Macclesfield, then president of the Royal Society, to recommend a proper person to superintend the work. On communicating the object of his visit, Lord Macclesfield told him, that there was one of the Royal Society whom he would venture to recommend to the business; yet that the most material part of what he knew of him was, his having within the compass of the last seven years recommended himself to the Society by the communication of several mechanical inventions and improvements; and though he had at first made it his business to execute things in the instrument way (without having been bred to the trade), yet on account of the merit of his performances, he had been chosen a member of the Society, and that for about three years past, having found the business of a philosophical instrument-maker not likely to afford an adequate recompense, he had wholly applied himself to such branches of mechanics as were wanted by the proprietors; that he was then somewhere in the north of England, executing a work: and that as he had always satisfied his employers, he would not be likely to undertake what he could not perform.

“ The person thus described was Mr Smeaton, who was written to by Mr Benjamin Wilson the painter, laconically informing him, that he was the person fixed upon to rebuild the Edystone lighthouse. But this intimation conveying to his mind no more than a mere notice that he might, in common with others, deliver in proposals to repair it, not knowing then that it was entirely destroyed, it afforded but little satisfaction, and he returned only a cool answer. Mr Wilson's reply was still more laconic: That the demolition was total, and that as Nathan said unto David, ‘ Thou art the man.’

“ Mr Smeaton immediately divested himself of his engagements in the north, and arrived in London the 23d of February 1756, and had an interview next day with the principal proprietor. The mode of rebuilding then became the subject of their deliberations, which at length ended in a determination to rebuild it with stone.

“ On the 5th of April Mr Smeaton first set his foot on the Edystone rock. He immediately began to take his measures for proceeding on the work. He made all the necessary inquiries on the spot, and in the neighbourhood. He considered the nature and quality of the stone proper to be used, and from whence it might be obtained at the best and cheapest rates. He visited the quarries at Beare in Devonshire, and the isle of Portland, and from the latter of these places he at length determined to be supplied with his materials.

“ Having proceeded thus far, he returned to London, and had a meeting with the proprietors, who, for reasons highly honourable to them, confirmed their determination to rebuild with stone. He accordingly prepared his models and designs, which were approved by his employers, and directed to be exhibited to the lords of the Admiralty, and the masters of the Trinity house. To the former they were shewn; but the latter having fixed their time for viewing them at so distant a day as to hazard the progress of the work, he determined to set off for Plymouth without their inspection.

“ He arrived at Plymouth the 23d of July 1756, and immediately began his operations. He appointed his assistants, hired his men, settled their wages, and drew up rules for their conduct. He also hired a piece of ground for a work-yard. On the 3d of August they went off to the rock, and continued to work as long as the weather would permit. The next winter Mr Smeaton determined to continue at Plymouth, to go through a course of experiments on cements. On the 3d of June 1757, the works were resumed, and on the 12th the first stone was fixed. From this time the erection proceeded with regularity and dispatch, and with no other interruptions than what might be expected from the nature of the work, until the 9th of October 1759, when, after innumerable difficulties and dangers, a happy period was put to the undertaking, without the loss of life or limb to any one concerned in it, or accident by which the work could be said to be materially retarded.

“ It now remained only to wait for a storm to try the durability of the building. The hard weather of 1759, 1760, and 1761, appeared to make no impression. The year 1762 was ushered in by a tempest of the first magnitude, the rage of which was so great, that one of those who had been used to predict its downfal was heard to say, ‘ If the Edystone lighthouse is now standing, it will stand to the day of judgment;’ and in reality, from this time its existence has been so entirely laid out of men's minds, that whatever storms have happened since, no inquiry has ever been made concerning it. So confident was a very intelligent friend of Mr Smeaton's of its durability, that he wrote to him, that he might for ever rid himself of any uneasy thought of the house as to its danger from wind and sea.

“ The lighthouse is attended by three men, who receive 25l. a-year each, with an occasional absence in summer. Formerly there were only two, who watched alternately four hours and four hours; but one being taken ill, and dying, the necessity of an additional hand became apparent. In this dilemma, the living man found himself in an awkward situation. Being apprehensive if he tumbled the dead body into the sea, which was the only way in his power to dispose of it, he might be charged with murder, he was induced for some time to let the dead body lie, in hopes that the boat might be able to land, and relieve him from the distress he was in. By degrees the body became so offensive, that it was not in his power to get quit of it without help; for it was near a month before the attending boat could effect a landing; and then it was not without the greatest difficulty that it could be done, when they did land. To such a degree was the whole building filled with the stench of the corpse, that it was all they could do to get the dead body disposed of and thrown into the sea, and it was some time after that before the rooms could be freed from the noisome stench that was left.

“ It is said, that while two light-keepers only were employed, on some disgust they forbore to speak to each other. A person observing to one of them how happy they might live in their state of retirement, ‘ Yes,’ says the man, ‘ very comfortably, if we could have the use of our tongues; but it is now a full month since my partner and I have spoke to each other.’

“ To these anecdotes we shall add one more, and conclude. A shoemaker was carrying out to the lighthouse in order to be light-keeper. In their way, says the skipper to him, 'How happens it, friend Jacob, that you should choose to go out to be a light-keeper, when you can on shore (as I am told) earn half-a-crown and three shillings a-day in making leathern hose (leathern pipes so called); whereas the light-keeper's salary is but 25l. a-year, which is scarce ten shillings a-week.' Says the shoemaker, 'I go to be a light-keeper, because I don't like confinement.' After this answer had produced its share of merriment, he at last explained himself by saying, that he did not like to be confined to work.

"The whole time between the first stroke upon the rock and leaving the lighthouse complete, was three years nine weeks and three days; from the 5th of December 1755, to exhibiting the light October 1759, was three years ten months and sixteen days; and the whole time of working on the rock 111 days 10 hours (D)."

EEL. See MURÆNA, ICHTHYOLOGY *Index*.

EEL-Fishing. See BOBBING and SNIGGLING.

The silver eel may be catched with several sorts of baits, as powdered beef, garden worms, minnows, hens guts, fish garbage, &c. The most proper time for taking them is in the night, fastening your line to the bank sides, with your laying hook in the water: or a line may be thrown with good store of hooks, baited and plumbed, with a float to discover where the line lies, that they may be taken up in the morning.

Microscopic EELS. See ANIMALCULE, N° 8.

EELS in vinegar, are similar to those in sour paste. The taste of vinegar was formerly thought to be occasioned by the biting of these little animals, but that opinion has been long justly exploded. Mentzelius says, he has observed the actual transformation of these little creatures into flies.

EEL Spear, a forked instrument with three or four jagged teeth, used for catching eels: that with the four teeth is best, which they strike into the mud at the bottom of the river, and if it strike against any eels it never fails to bring them up.

EFFARE', or EFFRAYE', in *Heraldry*, a term applied to a beast rearing on its hind legs, as if it were frighted or provoked.

EFFECT, in a general sense, is that which results from, or is produced by, any cause. See CAUSE.

EFFEMINATE, womanish, unmanly, voluptuous.

EFFEMINATE (*effeminati*), according to the vulgate, are mentioned in several places of scripture. The word is there used to signify such as were consecrated to some profane god, and prostituted themselves in honour of him. The Hebrew word *hadesh*, translated *effeminatus*, properly signifies *consecrated*, and hence was attributed to those of either sex, who publicly prostituted themselves in honour of Baal and Astarte. Moses expressly forbids these irregularities among the Israelites; but the history of the Jews shows, that they were notwithstanding frequently practised. Levit. xxiii. 18.

EFFENDI, in the Turkish language, signifies *master:* and accordingly is a title very extensively applied; as to the mufti and emirs, to the priests of mosques, to men of learning, and of the law. The grand chancellor of the empire is called *reis effendi*.

EFFERVESCENCE, an intestine motion excited betwixt the parts of two bodies of different natures, when they reciprocally dissolve each other. Effervescences are commonly attended with bubbles, vapours, small jets of the liquid, and a hissing noise; and these phenomena are occasioned by the air which at that time disengages itself. Sometimes also they are accompanied with a great degree of heat, from the decomposition of some substances and the formation of new compounds.

Formerly the word *fermentation* was also applied to effervescences; but now that word is confined to the motion naturally excited in animal and vegetable matters, and from which new combinations among their principles take place.

EFFIGY, the portrait, figure, or exact representation of a person.

EFFIGY, is also used for the print or impression of a coin, representing the prince's head who struck it.

EFFIGY, *to execute or degrade in*, denotes the execution or degradation of a condemned contumacious criminal, who cannot be apprehended or seized. In France, they hang a picture on a gallows or gibbet, wherein is represented the criminal, with the quality or manner of the punishment: at the bottom is written the sentence of condemnation. Such persons as are sentenced to death are executed in effigy.

EFFLORESCENCE, among physicians, the same with exanthema. See EXANTHEMA.

EFFLORESCENCE, in *Chemistry*, denotes the formation of a kind of mealy powder on the surface of certain bodies. Efflorescence is occasioned either by decomposition or drying. The efflorescence which happens to cobalt and martial pyrites is of the first; and that observed on the crystals of soda, Glauber's salt, &c. of the latter kind. An efflorescence is sometimes also a species of crystallization; such as the beautiful vegetations which shoot up from different saline substances. See CRYSTALLIZATION.

EFFLORESCENTIA, in *Botany*, (from *effloresco* to bloom); the precise time of the year and month in which every plant shows its first flowers.

Some plants flower twice a-year, as is common between the tropics; others oftener, as the monthly rose. The former are called by botanists *biferæ;* the latter, *multiferæ*.

The time of flowering is determined by the degree of heat which each species requires. Mezereon and snowdrop produce their flowers in February; primrose, in the beginning of March; the greater number of plants, during the month of May; corn, and other grain, in the beginning of June; the vine, in the middle of the same month; several compound flowers, in the months of July and August; lastly, meadow-saffron flowers in the month of October, and announces the speedy approach of winter.

Grass of Parnassus always flowers about the time of cutting

(D) This account is extracted from a Narrative of the Building, and a Description of the Construction of the Edystone Lighthouse with stone. By John Smeaton, Civil Engineer, F. R. S.

cutting down the hay; and in Sweden, the different species of thistle, mountain lettuce, succory, and balsam, seldom flower till after the summer solstice: the countrymen even know, as by a kalendar, that the solstice is past when these plants begin to produce their flowers.

The temperature of the seasons has a great influence both in accelerating and retarding the flowering of plants. All plants are earlier in warm countries: hence such as are cultivated out of their native soil, never flower till the heat of the climate, or situation into which they are removed, is equal to that under the influence of which they produced flowers in their own country. For this reason, all exotics from warm climates are later in this country than many plants which it naturally produces.

In general, we may observe, that the plants of the coldest countries, and those produced on the mountains in all climates, being of equal temperature, flower about the same time, viz. during our spring in Europe.

Plants that grow betwixt the tropics, and those of temperate climates, flower during our summer.

Plants of temperate climates, situated under the same parallel of latitude with certain parts of Europe, but removed much farther to the west, such as Canada, Virginia, and Mississippi, do not produce flowers till autumn.

Plants of temperate climates in the opposite hemisphere to Europe, flower during our winter, which is the summer of these regions.

Linnæus and Adanson have given a sketch of the different times in which plants flower at Upsal and Paris.

EFFLUVIUM, in *Physiology*, a term much used by philosophers and physicians, to express the minute particles which exhale from most, if not all, terrestrial bodies, in form of sensible vapours.

EFFRONTES, in church history, a sect of heretics, in 1534, who scraped their forehead with a knife till it bled, and then poured oil into the wound. This ceremony served them instead of baptism. They are likewise said to have denied the divinity of the Holy Spirit.

EFFUSION, the pouring out of any liquid thing with some degree of force. In the ancient heathen sacrifices there were divers effusions of wine and other liquors, called *libations*.

Effusion, or **Fusion**, in *Astronomy*, denotes that part of the sign Aquarius, represented on celestial globes and planispheres, by the water issuing out of the urn of the water-bearer.

EFT, or **Water Lizard**. See Lacerta, Erpetology *Index*.

EGERIA, or **Ægeria**, a nymph held in great veneration by the Romans. She was courted by Numa Pompilius; and according to Ovid, she became his wife. This prince frequently visited her; and that he might introduce his laws and new regulations into the state, he solemnly declared before the Roman people, that they were previously sanctified and approved by the nymph Egeria. Ovid says, that Egeria was so disconsolate at the death of Numa, that she melted into tears, and was changed into a fountain by Diana. She is reckoned by many as a goddess who presided over the pregnancy of women; and some maintain that she is the same as Lucina.

EGG, in *Physiology*, a body formed in certain females, in which is contained an embryo or fœtus of the same species, under a cortical surface or shell. The exterior part of an egg is a shell; which in a hen, for instance, is a white, thin, and friable cortex, including all the other parts. The shell becomes more brittle by being exposed to a dry heat. It is lined everywhere with a very thin but a pretty tough membrane, which dividing at, or very near the obtuse end of the egg, forms a small bag, where only air is contained. In new laid eggs this follicle appears very little, but becomes larger when the egg is kept.

Within this are contained the albumen or white, and the vitellus or yolk; each of which have their different virtues.

The albumen is a cold, viscous, white liquor in the egg, different in consistence in its different parts. It is observed, that there are two distinct albumens, each of which is enclosed in its proper membrane. Of these one is very thin and liquid: the other is more dense and viscous, and of a somewhat whiter colour; but, in old and stale eggs, after some days incubation, inclining to a yellow. As this second albumen covers the yolk on all sides, so it is itself surrounded by the other external liquid. The albumen of a fecundated egg is as sweet and free from corruption, during all the time of incubation, as it is in new laid eggs; as is also the vitellus. As the eggs of hens consist of two liquors separated one from another, and distinguished by two branches of umbilical veins, one of which goes to the vitellus, and the other to the albumen; so it is very probable that they are of different natures, and consequently appointed for different purposes.

When the vitellus grows warm with incubation, it becomes more humid, and like melting wax or fat; whence it takes up more space. For as the fœtus increases, the albumen insensibly wastes away and condenses: the vitellus, on the contrary, seems to lose little or nothing of its bulk when the fœtus is perfected, and only appears more liquid and humid when the abdomen of the fœtus begins to be formed.

The chick in the egg is first nourished by the albumen: and when this is consumed, by the vitellus, as with milk. If we compare the chalazæ to the extremities of an axis passing through the vitellus, which is of a spherical form, this sphere will be composed of two unequal portions, its axis not passing through its centre; consequently, since it is heavier than the white, its smaller portion must always be uppermost in all positions of the egg.

The yellowish white round spot, called *cicatricula*, is placed on the middle of the smaller portion of the yolk; and therefore, from what has been said in the last paragraph, must always appear on the superior part of the vitellus.

Not long before the exclusion of the chick, the whole yolk is taken into its abdomen; and the shell, at the obtuse end of the egg, frequently appears cracked some time before the exclusion of the chick. The chick is sometimes observed to perforate the shell with its beak. After exclusion, the yolk is gradually wasted, being conveyed into the small guts by a small duct.

Eggs differ very much according to the birds that lay them, as to their colour, form, bigness, age, and the different way of dressing them: those most used in food are hens eggs; of which, such as are new laid are best.

As to the preservation of eggs, it is observed that the egg is always quite full when it is first laid by the hen; but from that time it gradually becomes less and less so, to its decay: and however compact and close its shell may appear, it is nevertheless perforated with a multitude of small holes, though too minute for the discernment of our eyes, the effect of which is a daily decrease of matter within the egg, from the time of its being laid; and the perspiration is much quicker in hot weather than in cold.

To preserve the egg fresh, there needs no more than to preserve it full, and stop its transpiration; the method of doing which is, by stopping up those pores with matter which is not soluble in watery fluids: and on this principle it is, that all kinds of varnish, prepared with spirit of wine, will preserve eggs fresh for a long time, if they are carefully rubbed all over the shell: tallow, or mutton fat, is also good for this purpose.

Artificial Method of Hatching Eggs. See HATCHING.

EGINA. See ÆGINA.

EGINHART, secretary to the emperor Charles the Great, was a German. He is the most ancient historian of that nation, and wrote very eloquently for a man of the 9th century. It is said, that he insinuated himself so well into the favour of Imma, daughter to Charles the Great, that he obtained from her whatever he desired. Charles the Great, having found out the intrigue, did not do as Augustus, who is thought to have banished Ovid, because he believed him to be too much favoured by Julia; for he married the two lovers together, and gave them a fine estate in land.

EGLANTINE. See ROSA, BOTANY *Index*.

EGLON, a king of the Moabites, who oppressed the Israelites for 18 years (Judges iii. 12—14.). Calmet confounds this servitude of the Hebrews with that under Chusan-rishathaim, making it to subsist only eight years, from the year of the world 2591 to 2599; whereas this servitude under Eglon lasted 18 years, and commenced in the year of the world 2661, and 62 years after they had been delivered by Othniel from the subjection of Chusan-rishathaim.

EGRA, a town of Bohemia subject to the house of Austria. E. Long. 12. 30. N. Lat. 50. 21.

EGRET, in *Ornithology*, a species of ardea. See ARDEA, ORNITHOLOGY *Index*.

E G Y P T.

EGYPT, an extensive country of Africa, lying between 30° and 33° of east longitude, and between 21° and 31° of north latitude. It is bounded by the Mediterranean on the north; by the Red sea and isthmus of Suez, which divide it from Arabia, on the east; by Abyssinia or Ethiopia, on the south; and by the deserts of Barca and Nubia on the west; being 600 miles in length from north to south, and about 150 in extreme breadth from east to west.

1 Different names.

As a nation, the Egyptians may with justice lay claim to as high antiquity as any in the world. The country was most probably peopled by Mizraim the son of Ham and grandson of Noah. By its ancient inhabitants it was called *Chemia*, and is still called *Chemi* in the language of the *Copts* or native Egyptians; and this name it is supposed to have received from Ham the son of Noah. In scripture, we find it most generally named *Misraim;* though in the Psalms it is styled the *land of Ham.*—To us it is best known by the name *Egypt*, the etymology of which is more uncertain.—Some derive it from *Ægyptus*, a supposed king of the country; others say it signifies no more than "the land of the *Copts;*" *Aia* in Greek signifying a country, and *Æcoptos* being easily softened into *Ægyptus.*—The most probable opinion, however, seems to be, that it received its name from the blackness of its soil, and the dark colour both of its river and inhabitants: for such a blackish colour is by the Greeks called *ægyptios*, from *gyps*, and *ægyps*, "a vulture;" and by the Latins *subvulturius*. For the same reason, other names of a similar import have been given to this country by the Greeks; such as *Aeria* and *Melambolus:* the river itself was called *Melo* or *Melas;* by the Hebrews, *Shihor;* and by the Ethiopians, *Siris;* all of which signify "black."

Ancient Egypt is by some divided into two parts, the Upper and Lower Egypt: by others into three, the Upper Egypt, properly so called, or *Thebais;* the Middle Egypt, or *Heptanomes;* and the Lower Egypt, the best part of which was the *Delta*, or that space encompassed by the branches of the Nile. See THEBAIS, &c.

The Egyptians, like the Chinese, pretend to an excessive antiquity, pretending to have records for ten, twenty, or even fifty thousand years. Thus their history is so much involved in obscurity and fable, that for many ages it must be passed over in silence.—The first mortal king whom the Egyptians own to have reigned in that country, was *Menes* or *Menas*. At what time he reigned, it would be to very little purpose to inquire. He had been preceded, however, by a set of immortals, who it seems left him the kingdom in a very bad situation: for the whole country, except Thebais, was a morass; the people also were entirely destitute of religion, and every kind of knowledge which could render their life comfortable and happy. Menes diverted the course of the Nile, which before that time had washed the foot of a sandy mountain near the borders of Libya, built the city of Memphis, instructed his subjects, and did other things of a similar kind which are usually attributed to the founders of kingdoms.

2 Invade the she herds.

From the time of Menes, the Egyptian chronology is filled with a list of 330 kings, who reigned 1400 years, but did nothing worthy of notice.—The first distinct piece of history we find concerning Egypt, is the

the irruption of the *Shepherds*, by whom the country was subdued; but whether this revolution happened during the vast interval of indolence above mentioned, or before or after, cannot be known. The affair is thus related by Manetho. It happened, in the reign of Timaus king of Egypt, that God being displeased with the Egyptians, they suffered a great revolution; for a multitude of men, ignoble in their race, took courage, and, pouring from the east into Egypt, made war with the inhabitants; who submitted to them without resistance. The shepherds, however, behaved with the greatest cruelty; burnt the cities, threw down the temples of the gods; and put to death the inhabitants, carrying the women and children into captivity. This people came from Arabia, and were called *Hycsos*, or *king-shepherds*. They held Egypt in subjection for 259 years; at the end of which period, they were obliged by a king of Upper Egypt, named *Amosis*, or *Thethmosis*, to leave the country. This prince's father had, it seems, gained great advantages over them, and shut them up in a place called *Abaris*, or *Avaris*, containing 10,000 acres of land. Here they were closely besieged by Amosis, with an army of 400,000 men; but at last the king, finding himself unable to reduce them by force, proposed an agreement, which was readily accepted. In consequence of this agreement, the shepherds withdrew from Egypt with their families, to the number of 240,000; and, taking the way of the desert, entered Syria: but fearing the Assyrians, who were then very powerful, and masters of Asia, they entered the land of Judæa; and built there a city capable of holding so great a multitude, and called it *Jerusalem*.

According to Mr Bruce, the shepherds who invaded Egypt were no other than the inhabitants of Barabra. They were, he says, *carriers* to the Cushites, who lived farther to the south. The latter had built the many stately temples in Thebes and other cities of Egypt; though, according to him, they had no dwelling places but holes or caves in the rocks. Being a commercial people, they remained at home collecting and preparing their articles, which were dispersed by the *Barabers* or shepherds already mentioned. These, from the nature of their employment, lived in moveable habitations, as the Tartars do at this day. By the Hebrews, he tells us, they were called *phut*, but *shepherds* by every other people; and from the name *baraber*, the word *Barabra* is derived. By their employment, which was the dispersing the Arabian and African goods all over the continent, they had become a great and powerful people; and from their opposite dispositions and manners, became very frequently enemies to the Egyptians. To one Salatis our author ascribes the destruction of Thebes in Upper Egypt, so much celebrated by Homer for its magnificence. But this certainly cannot be the case; for Homer wrote long after the time of Joseph: and we find that even then the Egyptians had the shepherds in abhorrence, in all probability because they had been grievously oppressed by them. Mr Bruce counts three invasions of these people; the first that of Salatis already mentioned, who overthrew the first dynasty of Egyptian kings from Menes, and destroyed Thebes: the second was that of Sabacco or So; for according to him this was not the name of a single prince, but of a people, and signifies *shepherd;* and the third, after the building of Memphis, where 240,000 of them were besieged as above mentioned. But accounts of this kind are evidently inconsistent in the highest degree; for how is it possible that the *third* invasion, antecedent to the building of Jerusalem, could be posterior to the *second*, if the latter happened only in the days of Hezekiah?

In these early ages, however, it would seem that the kingdom of Egypt had been very powerful and its dominion very widely extended; since we find it said, that the *Bactrians* revolted from Osymandyas, another Egyptian king of very high antiquity, and of whose wealth the most marvellous accounts are given.

After an unknown interval of time from this monarch, reigned Sesostris. He was the first great warrior whose conquests are recorded with any degree of distinctness. In what age of the world he lived, is uncertain. Some chronologers, among whom is Sir Isaac Newton, are of opinion, that he is the Sesac or Shishak, who took Jerusalem in the reign of Rehoboam the son of Solomon. Others, however, place him much earlier; and Mr Whiston will have him to be the Pharaoh who refused to part with the Israelites, and was at last drowned in the Red sea. Mr Bryant endeavours to prove that no such person ever existed; but that in his history, as well as that of many ancient heroes, we have an abridgement of that of the Cushites or Babylonians, who spread themselves over great part of the then known world, and everywhere brought the people in subjection to them. His reign is reckoned the most extraordinary part of the Egyptian history; and the following seems to be the least fabulous account that can be got of it. The father of Sesostris was told in a dream, by the god Vulcan, that his son, who was then newly born, or perhaps still unborn, should be lord of the whole earth. His father, upon the credit of this vision, got together all the males in the land of Egypt that were born on the same day with Sesostris; appointed nurses and proper persons to take care of them, and had them treated like his own child; being persuaded that they who had been the constant companions of his youth would prove the most faithful ministers and soldiers. As they grew up, they were inured to laborious exercises; and, in particular, were never permitted to taste any food till they had performed a course of 180 furlongs, upwards of 22 of our miles. When the old king imagined they were sufficiently educated in the martial way he designed them to follow, they were sent by way of trial of their abilities against the Arabians. In this expedition Sesostris proved successful, and in the end subdued that people who had never before been conquered. He was sent to the westward, and conquered the greatest part of Africa; nor could he be stopped in his career till he arrived at the Atlantic ocean. Whilst he was on this expedition, his father died; and then Sesostris resolved to fulfil the prediction of Vulcan, by actually conquering the whole world. As he knew that this must take up a long time, he prepared for his journey in the best manner possible. The kingdom he divided into 36 provinces, and endeavoured to secure the affections of the people by gifts both of money and land. He forgave all who had been guilty of offences, and discharged the debts of all his soldiers. He then constituted his brother Armais the supreme regent; but forbade him to use the diadem, and commanded him to offer no injury to the queen or her children, and to abstain from the royal concubines. His army consisted of 600,000 foot, 24,000 horse, and 27,000 chariots. Besides these land forces, he had at sea two mighty fleets; one, according to Diodorus, of 400 sail. Of these fleets, one was designed to make conquests in the west, and the other in the east; and therefore the one was built on the Mediterranean, and the other on the Red sea. The first of these conquered Cyprus, the coast of Phœnicia, and several of the islands called *Cyclades*; the other conquered all the coasts of the Red sea; but its progress was stopped by shoals and difficult places which the navigators could not pass, so that he seems not to have made many conquests by sea.

With the land forces Sesostris marched against the Ethiopians and Troglodites; whom he overcame, and obliged them to pay him a tribute of gold, ebony, and ivory. From thence he proceeded as far as the promontory of Dira, which lay near the straits of Babelmandel, where he set up a pillar with an inscription in sacred characters. He then marched on to the country where cinnamon grows, or at least to some country where cinnamon at that time was brought, probably some place in India; and here he in like manner set up pillars, which were to be seen for many ages after. As to his farther conquests, it is agreed by almost all authors of antiquity, that he overran and pillaged the whole continent of Asia, and some part of Europe. He crossed the Ganges, and erected pillars on its banks; and from thence he is said to have marched eastward to the very extremity of the Asiatic continent. Returning from thence, he invaded the Scythians and Thracians; but all authors do not agree that he conquered them. Some even affirm, that he was overthrown by them with great slaughter, and obliged to abandon a great part of his booty and military stores. But whether he had good or bad success in these parts, it is a common opinion that he settled a colony in Colchis. Herodotus, however, who gives the most particular account of the conquests of this monarch, does not say whether the colony was designedly planted by Sesostris: or whether part of his army loitered behind the rest, and took up their residence in that region. From his own knowledge, he asserts, that the inhabitants of that country were undoubtedly of Egyptian descent. This was evident from the personal resemblance they bore to the Egyptians, who were swarthy complexioned and frizzle haired; but more especially from the conformity of their customs, particularly circumcision.

The utmost boundary of this mighty monarch's conquests, however, was in the country of Thrace; for beyond this country his pillars were nowhere to be seen. These pillars he was accustomed to set up in every country which he conquered, with the following inscription, or one to the same purpose: "Sesostris, king of kings, and lord of lords, subdued this country by the power of his arms." Besides these, he left also statues of himself; two of which, according to Herodotus, were to be seen in his time; the one on the road between Ephesus and Phocæa, and the other between Smyrna and Sardis: they were armed after the Ethiopian and Egyptian manner; holding a javelin in one hand and a bow in the other. Across the breast they had a line drawn from one shoulder to the other, with the following inscription: "This region I obtained by these my shoulders." They were mistaken for images of Memnon.

3 Return to Egypt.

The reasons given by Sesostris for his returning into Egypt from Thrace, and thus leaving the conquest of the world unfinished, were the want of provisions for his army, and the difficulty of the passes. Most probably, however, his return was hastened by the intelligence he received from the high priest of Egypt, concerning the rebellious proceedings of his brother; who, encouraged by his long absence, had assumed the diadem, violated the queen, and also the royal concubines. On receiving this news, Sesostris hastened from Thrace; and at the end of nine years came to Pelusium in Egypt, attended by an innumerable multitude of captives taken from many different nations, and loaded with the spoils of Asia. The treacherous brother met him at this city; and it is said, with very little probability, that Sesostris accepted of an invitation to an entertainment from him. At this he drank freely, together with the queen and the rest of the royal family. During the continuance of the entertainment, Armais caused a great quantity of dried reeds to be laid round the apartment where they were to sleep; and as soon as they were retired to rest set fire to the reeds. Sesostris perceiving the danger he was in, and that his guards, overcharged with liquor, were incapable of assisting him, rushed through the flames, and was followed by his wife and children. In thanksgiving for this wonderful deliverance, he made several donations to the gods, particularly to Vulcan the god of fire. He then took vengeance on his brother Armais, said to be the Danaus of the Greeks, who, being on this occasion driven out of Egypt, withdrew into Greece.

4 His great works.

Sesostris now laid aside all thoughts of war, and applied himself wholly to such works as might tend to the public good, and his own future reputation. In order to prevent the incursions of the Syrians and Arabians, he fortified the east side of Egypt with a wall which ran from Pelusium through the desert to Heliopolis, for 187½ miles. He raised also an incredible number of vast and lofty mounts of earth, to which he removed such towns as had before been situated too low, in order to secure them from the inundations of the Nile. All the way from Memphis to the sea he dug canals which branched out from the Nile; and not only made an easier communication between different places, but rendered the country in a great measure impassable to an enemy. He erected a temple in every city in Egypt, and dedicated it to the supreme deity of the place; but in the course of such a great undertaking as this necessarily must have been, he took care not to employ any of his Egyptian subjects. Thus he secured their affection, and employed the vast multitude of captives he had brought along with him; and to perpetuate the memory of a transaction so remarkable, he caused to be inscribed on all these temples, "No one native laboured hereon." In the city of Memphis, before the temple of Vulcan, he raised six gigantic statues, each of one stone. Two of them were 30 cubits high, representing himself and his wife; the other four were 20 cubits each, and represented his four

four sons. These he dedicated to Vulcan in memory of his above-mentioned deliverance. He raised also two obelisks of marble 120 cubits high, and charged them with inscriptions, denoting the greatness of his power, his revenues, &c.

5 H leath.

The captives taken by Sesostris are said to have been treated with the greatest barbarity; so that at last they resolved at all events to deliver themselves from a servitude so intolerable. The Babylonians particularly were concerned in this revolt, and laid waste the country to some extent; but being offered a pardon and a place to dwell in, they were pacified, and built for themselves a city, which they called *Babylon*. Towards the conquered princes who waited on him with their tribute the Egyptian monarch behaved with unparalleled insolence. On certain occasions he is said to have unharnassed his horses, and, yoking kings together, made them draw his chariot. One day, however, observing one of the kings who drew his chariot to look back upon the wheels with great earnestness, he asked what made him look so attentively at them? The unhappy prince replied, "O king, the going round of the wheel puts me in mind of the vicissitudes of fortune: for as every part of the wheel is uppermost and lowermost by turns, so it is with men; who one day sit upon a throne, and on the next are reduced to the vilest degree of slavery." This answer brought the insulting conqueror to his senses; so that he gave over the practice, and thenceforth treated his captives with great humanity. At length this mighty monarch lost his sight, and laid violent hands on himself.

6 O n of th ble of P us.

7 A al of P and H n in E t.

8 Egypt conquered by Sabbaco.

After the death of Sesostris, we meet with another chasm of an indeterminate length in the Egyptian history. It concludes with the reign of Amasis or Ammosis; who being a tyrant, his subjects joined Actisanes the king of Ethiopia to drive him out.—Thus Actisanes became master of the kingdom; and after his death follows another chasm in the history, during which the empire is said to have been in a state of anarchy for five generations.—This period brings us down to the times of the Trojan war. The reigning prince in Egypt was at that time called *Cetes*; by the Greeks, *Proteus*. The priests reported that he was a magician; and that he could assume any shape he pleased, even that of fire. This fable, as told by the Greeks, drew its origin from a custom among the Egyptians, perhaps introduced by Proteus. They were used to adorn and distinguish the heads of their kings with the representations of animals or vegetables, or even with burning incense, in order to strike the beholders with the greater awe. Whilst Proteus reigned, Paris or Alexander, the son of Priam king of Troy, was driven by a storm on the coast of Egypt, with Helen, whom he was carrying off from her husband. But when the Egyptian monarch heard of the breach of hospitality committed by Paris, he seized him, his mistress, and companions, with all the riches he had brought away with him from Greece. He detained Helen, with all the effects belonging to Menelaus her husband, promising to restore them to the injured party whenever they were demanded; but commanded Paris and his companions to depart out of his dominions in three days, on pain of being treated as enemies. In what manner Paris afterwards prevailed upon Proteus to restore his mistress, we are not told; neither do we know any thing further of the transactions of this prince's reign nor of his successors, except what has entirely the air of fable, till the days of Sabbaco the Ethiopian, who again conquered this kingdom. He began his reign with an act of great cruelty, causing the conquered prince to be burnt alive; nevertheless, he no sooner saw himself firmly established on the throne of Egypt, than he became a new man; so that he is highly extolled for his mercy, clemency, and wisdom. He is thought to have been the *So* mentioned in Scripture, and who entered into a league with Hoshea king of Israel against Shalmaneser king of Assyria. He is said to have been excited to the invasion of Egypt by a dream or vision, in which he was assured that he should hold that kingdom for fifty years. Accordingly, he conquered Egypt, as had been foretold; and at the expiration of the time above mentioned, he had another dream, in which the tutelar god of Thebes acquainted him, that he could no longer hold the kingdom of Egypt with safety and happiness, unless he massacred the priests as he passed through them with his guards. Being haunted with this vision, and at the same time abhorring to hold the kingdom on such terms, he sent for the priests, and acquainted them with what seemed to be the will of the gods. Upon this it was concluded, that it was the pleasure of the Deity that Sabbaco should remain no longer in Egypt; and therefore he immediately quitted that kingdom, and returned to Ethiopia.

9 Remarkable story of Sethon.

Of *Anysias*, who was Sabbaco's immediate successor, we have no particulars worth notice. After him reigned one Sethon, who was both king and priest of Vulcan. He gave himself up to religious contemplation; and not only neglected the military class, but deprived them of their lands. At this they were so much incensed, that they entered into an agreement not to bear arms under him; and in this state of affairs Sennacherib king of Assyria arrived before Pelusium with a mighty army. Sethon now applied to his soldiers, but in vain: they unanimously persisted in refusing to march under his banner. Being therefore destitute of all human aid, he applied to the god Vulcan, and requested him to deliver him from his enemies. Whilst he was yet in the temple of that god, it is said he fell into a deep sleep; during which he saw Vulcan standing at his side, and exhorting him to take courage. He promised, that if Sethon would but go out against the Assyrians, he should obtain a complete victory over them. Encouraged by this assurance, the king assembled a body of artificers, shop-keepers, and labourers; and, with this undisciplined rabble, marched towards Pelusium. He had no occasion, however, to fight; for the very night after his arrival at Pelusium, an innumerable multitude of field rats entering the enemies camp, gnawed to pieces the quivers, bowstrings, and shield straps. Next morning, when Sethon found the enemy disarmed, and on that account beginning to fly, he pursued them to a great distance, making a terrible slaughter. In memory of this extraordinary event, a statue of Sethon was erected in the temple of Vulcan, holding in one hand a rat, and delivering these words: "Whosoever beholdeth me, let him be pious."

Soon after the death of Sethon, the form of government in Egypt was totally changed. The kingdom was divided into twelve parts, over which as many of the

10 Reign of Psammitichus.

the chief nobility presided. This division, however, subsisted but for a short time. Psammitichus, one of the twelve, dethroned all the rest, 15 years after the division had been made. The history now begins to be divested of fable; and from this time may be accounted equally certain with that of any other nation. The vast conquests of Sesostris, were now no longer known; for Psammitichus possessed no more than the country of Egypt itself. It appears, indeed, that none of the successors of Sesostris, or even that monarch himself, had made use of any means to keep in subjection the countries he had once conquered. Perhaps, indeed, his design originally was rather to *pillage* than to conquer; and therefore, on his return, his vast empire vanished at once. Psammitichus, however, endeavoured to extend his dominions by making war on his neighbours; but by putting more confidence in foreign auxiliaries than in his own subjects, the latter were so much offended, that upwards of 200,000 fighting men emigrated in a body, and took up their residence in Ethiopia. To repair this loss, Psammitichus earnestly applied himself to the advancement of commerce; and opened his ports to all strangers, whom he greatly caressed, contrary to the cruel maxims of his predecessors, who refused to admit them into the country. He also laid siege to the city of Azotus in Syria, which held out for 29 years against the whole strength of the kingdom; from which we may gather, that, as a warrior, Psammitichus was by no means remarkable. He is reported to have been the first king of Egypt that drank wine. He also sent to discover the springs of the Nile; and is said to have attempted to discover the most ancient nation in the world by the following method. Having procured two newly born children, he caused them to be brought up in such a manner that they never heard a human voice. He imagined that these children would naturally speak the original language of mankind: therefore, when, at two years of age, they pronounced the Phrygian word *becos* (or some sound resembling it), which signifies bread, he concluded that the Phrygians were the most ancient people in the world.

11 Succeeded by Nechus.

Nechus, the son and successor of Psammitichus, is the *Pharaoh-Necho* of Scripture, and was a prince of an enterprising and warlike genius. In the beginning of his reign, he attempted to cut through the isthmus of Suez, between the Red sea and the Mediterranean; but, through the invincible obstacles which nature has thrown in the way of such undertakings, he was obliged to abandon the enterprize, after having lost 120,000 men in the attempt. After this he sent a ship, manned with some expert Phœnician mariners, on a voyage to explore the coast of Africa. Accordingly, they performed the voyage; sailed round the continent of Africa; and after three years returned to Egypt, where their relation was deemed incredible.

12 His wars with Josiah and Nebuchadnezzar.

The most remarkable wars in which this king was engaged are recorded in the sacred writings. He went out against the king of Assyria, by the divine command, as he himself told Josiah; but being opposed by the king of Judea, he defeated and killed him at Megiddo; after which he set up, in that country, King Jehoiakim, and imposed on him an annual tribute of 100 talents of silver and one talent of gold. He then proceeded against the king of Assyria; and weakened him so much, that the empire was soon after dissolved. Thus he became master of Syria and Phœnicia; but in a short time, Nebuchadnezzar king of Babylon came against him with a mighty army. The Egyptian monarch, not daunted by the formidable appearance of his antagonist, boldly ventured a battle; but was overthrown with prodigious slaughter, and Nebuchadnezzar became master of all the country to the very gates of Pelusium.

13 Apries a martial successfu prince.

The reign of Apries, the *Pharaoh Hophra* of Scripture, presents us with a new revolution in the Egyptian affairs. He is represented as a martial prince, and in the beginning of his reign very successful. He took by storm the rich city of Sidon; and having overcome the Cypriots and Phœnicians in a sea-fight, returned to Egypt laden with spoil. This success probably incited Zedekiah king of Judea to enter into an alliance with him against Nebuchadnezzar king of Babylon. The bad success of this alliance was foretold by the prophet Jeremiah; and accordingly it happened. For Nebuchadnezzar having sat down with his army before Jerusalem, Apries marched from Egypt with a design to relieve the city; but no sooner did he perceive the Babylonians approaching him, than he retreated as fast as he could, leaving the Jews exposed to the rage of their merciless enemies; who were thereupon treated as Jeremiah had foretold; and by this step Apries brought upon himself the vengeance denounced by the same prophet. The manner in which these predictions were fulfilled is as follows: The Cyreneans, a colony of Greeks, being greatly strengthened by a numerous supply of their countrymen under their third king *Battus* styled *the Happy*, and encouraged by the Pythian oracle, began to drive out their Libyan neighbours, and shared their possessions among themselves. Hereupon Andica king of Libya sent a submissive embassy to Apries, and implored his protection against the Cyreneans. Apries complied with his request, and sent a powerful army to his relief. The Egyptians were defeated with great slaughter; and those who returned complained that the army had been sent off by Apries in order to be destroyed, and that he might tyrannize without controul over the remainder of his subjects. This thought catching the attention of the giddy multitude, an almost universal defection ensued. Apries sent one Amasis, a particular friend, in whom he thought he could confide, to bring back his people to a sense of their duty. But by this friend he was betrayed; for Amasis, taking the opportunity of the present ferment, caused himself to be proclaimed king. Apries then despatched one Patarbemis, with orders to take Amasis, and bring him alive before him. This he found impossible, and therefore returned without his prisoner; at which the king was so enraged, that he commanded Patarbemis's nose and ears to be cut off. This piece of cruelty completed his ruin; for when the rest of the Egyptians who continued faithful to Apries beheld the inhuman mutilation of so worthy and noble a person as Patarbemis was, they to a man deserted Apries, and went over to Amasis.

14 Bad con quences his allia with Z kiah.

15 His sub revolt.

Both parties now prepared for war, the usurper having under his command the whole body of native Egyptians; and Apries only those Ionians, Carians, and other mercenaries whom he could engage in his service.

vice. The army of Apries amounted only to 30,000; but, though greatly inferior in number to the troops of his rival, as he well knew that the Greeks were much superior in valour, he did not doubt of victory. Nay, so far was Apries puffed up with this notion, that he did not believe it was in the power even of any *god* to deprive him of his kingdom. The two armies soon met, and drew up in order of battle near Memphis. A bloody engagement ensued; in which, though the army of Apries behaved with the greatest resolution, they were at last overpowered with numbers, and utterly defeated, the king himself being taken prisoner. Amasis now took possession of the throne without opposition. He confined Apries in one of his palaces, but treated him with great care and respect. The people, however, were implacable, and could not be satisfied while he enjoyed his life. Amasis, therefore, at last found himself obliged to deliver him into their hands. Thus the prediction received its final completion: Apries was delivered up to those *who sought his life;* and who no sooner had him in their power, than they strangled him, and laid his body in the sepulchre of his ancestors.

16 A ies defe d and t n pri- r by A sis.

17 E pt in- v d by N uchad- n ar.

During these intestine broils, which must have greatly weakened the kingdom, it is probable that Nebuchadnezzar invaded Egypt. He had been for 13 years before this employed in besieging Tyre, and at last had nothing but an empty city for his pains. To make himself some amends, therefore, he entered Egypt, miserably harassed the country, killed and carried away great numbers of the inhabitants, so that the country did not recover from the effects of this incursion for a long time after. In this expedition, however, he seems not to have aimed at any permanent conquest, but to have been induced to it merely by the love of plunder, and of this he carried with him an immense quantity to Babylon.

18 H py ad- m stra- t of A sis.

During the reign of Amasis, Egypt is said to have been perfectly happy, and to have contained 20,000 populous cities. That good order might be kept among such vast numbers of people, Amasis enacted a law, by which every Egyptian was bound once a-year to inform the governor of his province by what means he gained his livelihood; and if he failed of this, to put him to death. The same punishment he decreed to those who could not give a satisfactory account of themselves.

This monarch was a great favourer of the Greeks, and married a woman of Grecian extract. To many Greek cities, as well as particular persons, he made considerable presents. Besides these, he gave leave to the Greeks in general to come into Egypt, and settle either in the city of Naucratis, or carry on their trade upon the sea coasts; granting them also temples, and places where they might erect temples to their own deities. He received also a visit from Solon the celebrated Athenian lawgiver, and reduced the island of Cyprus under his subjection.

9 O ds C byses ki of P a.

This great prosperity, however, ended with the death of Amasis, or indeed before it. The Egyptian monarch had some how or other incensed Cambyses king of Persia. The cause of the quarrel is uncertain; but whatever it was, the Persian monarch vowed the destruction of Amasis. In the mean time *Phanes* of Halicarnassus, commander of the Grecian auxiliaries in the pay of Amasis, took some private disgust; and leaving Egypt, embarked for Persia. He was a wise and able general, perfectly well acquainted with every thing that related to Egypt; and had great credit with the Greeks in that country. Amasis was immediately sensible how great the loss of this man would be to him, and therefore sent after him a trusty eunuch with a swift galley. Phanes was accordingly overtaken in Lycia, but not brought back; for making his guard drunk, he continued his journey to Persia, and presented himself before Cambyses, as he was meditating the destruction of the Egyptian monarchy.

20 And Polycrates tyrant of Samos.

At this dangerous crisis also, the Egyptian monarch imprudently made Polycrates the tyrant of Samos his enemy. This man had been the most remarkable perhaps of any recorded in history, for an uninterrupted course of success, without the intervention of one single unfortunate event. Amasis, who was at this time in strict alliance with Polycrates, wrote him a letter, in which, after congratulating him on his prosperity, he told him that he was afraid lest his successes were too many, and he might be suddenly thrown down into the greatest misery. For this reason he advised him voluntarily to take away something from his own happiness; and to cast away that which would grieve him most if he was accidentally to lose it. Polycrates followed his advice, and threw into the sea a signet of inestimable value. This, however, did not answer the intended purpose. The signet happened to be swallowed by a fish, which was taken a few days afterwards, and thus was restored to Polycrates. Of this Amasis was no sooner informed, than, considering Polycrates as really *unhappy*, and already on the brink of destruction, he resolved to put an end to the friendship which subsisted between them. For this purpose he despatched a herald to Samos, commanding him to acquaint Polycrates, that he renounced his alliance, and all the obligations between them; that he might not mourn his misfortunes with the sorrow of a friend. Thus Amasis left Polycrates at liberty to act against him, if he chose to do so; and accordingly he offered to assist Cambyses with a fleet of ships in his Egyptian expedition.

Amasis had not, however, the misfortune to see the calamities of his country. He died about 525 years before Christ, after a reign of 44 years; and left the kingdom to his son Psammenitus, just as Cambyses was approaching the frontiers of the kingdom. The new prince was scarce seated on the throne, when the Persians appeared. Psammenitus drew together what forces he could, in order to prevent them from entering the kingdom. Cambyses, however, immediately laid siege to Pelusium, and made himself master of it by the following stratagem: he placed in the front of his army a great number of cats, dogs, and other animals that were deemed sacred by the Egyptians. He then attacked the city, and took it without opposition; the garrison, which consisted entirely of Egyptians, not daring to throw a dart or shoot an arrow against their enemies, lest they should kill some of the holy animals.

21 Egypt invaded by Cambyses.

22 Cruelty and defeat of the Egyptians.

Cambyses had scarce taken possession of the city, when Psammenitus advanced against him with a numerous army. But before the engagement, the Greeks who served under Psammenitus, to show their indignation

nation against their treacherous countryman Phanes, brought his children into the camp, killed them in the presence of their father and the two armies, and then drank their blood. The Persians enraged at so cruel a sight, fell upon the Egyptians with the utmost fury, put them to flight, and cut the greatest part of of them in pieces. Those who escaped fled to Memphis, where they were soon after guilty of a horrid outrage. Cambyses sent a herald to them in a ship from Mitylene: but no sooner did they see her come into the port, than they flocked down to the shore, destroyed the ship, and tore to pieces the herald and all the crew, afterwards carrying their mangled limbs into the city, in a kind of barbarous triumph. Not long after, they were obliged to surrender: and thus Psammenitus fell into the hands of his inveterate enemy, who was now enraged beyond measure at the cruelties exercised upon the children of Phanes, the herald, and the Mitylenean sailors.

23 Their dreadful punishment by Cambyses.

The rapid success of the Persians struck with such terror the Libyans, Cyreneans, Barcæans, and other dependents or allies of the Egyptian monarch, that they immediately submitted. Nothing now remained but to dispose of the captive king, and revenge on him and his subjects the cruelties which they had committed. This the merciless victor executed in the severest manner. On the 10th day after Memphis had been taken, Psammenitus and the chief of the Egyptian nobility were ignominiously sent into one of the suburbs of that city. The king being there seated in a proper place, saw his daughter coming along in the habit of a poor slave with a pitcher to fetch water from the river, and followed by the daughters of the greatest families in Egypt, all in the same miserable garb, with pitchers in their hands, drowned in tears, and loudly bemoaning their miserable situation. When the fathers saw their daughters in this distress, they burst into tears, all but Psammenitus, who only cast his eyes on the ground and kept them fixed there. After the young women, came the son of Psammenitus, with 2000 of the young nobility, all of them with bits in their mouths and halters round their necks, led to execution. This was done to expiate the murder of the Persian herald and the Mitylenean sailors; for Cambyses caused ten Egyptians of the first rank to be publicly executed for every one of those that had been slain. Psammenitus, however, observed the same conduct as before, keeping his eyes stedfastly fixed on the ground, though all the Egyptians around him made the loudest lamentations. A little after this he saw an intimate friend and companion, now advanced in years, who having been plundered of all he had, was begging his bread from door to door in the suburbs. As soon as he saw this man, Psammenitus wept bitterly; and calling out to him by his name, struck himself on the head as if he had been frantic. Of this the spies who had been set over him to observe his behaviour, gave immediate notice to Cambyses, who thereupon sent a messenger to inquire the cause of such immoderate grief. Psammenitus answered, That the calamities of his own family confounded him, and were too great to be lamented by any outward signs of grief; but the extreme distress of a bosom friend gave more room for reflection, and therefore extorted tears from him. With this answer Cambyses was so affected, that he sent orders to prevent the execution of the king's son; but these came too late, for the young prince had been put to death before any of the rest. Psammenitus himself was then sent for into the city, and restored to his liberty: and had he not showed a desire of revenge, might perhaps have been trusted with the government of Egypt: but being discovered hatching schemes against the government, he was seized, and condemned to drink bull's blood.

24 Egypt comes province the Pers and aft- wards the Gree empire.

The Egyptians were now reduced to the lowest degree of slavery. Their country became a province of the Persian empire: the body of Amasis their late king was taken out of his grave; and after being mangled in a shocking manner was finally burnt. But what seemed more grievous than all the rest, their god Apis was slain, and his priests ignominiously scourged; and this inspired the whole nation with such a hatred to the Persians, that they could never afterwards be reconciled to them. As long as the Persian empire subsisted, the Egyptians could never shake off their yoke. They frequently revolted indeed, but were always overthrown with prodigious loss. At last they submitted, without opposition, to Alexander the Great: after his death, Egypt again became a powerful kingdom, though since the conquest of it by Cambyses to the present time it hath never been governed but by foreign princes, agreeable to the prophecy of Ezekiel. "There shall be no more a prince of the land of Egypt."

25 Assigne Ptolem Lagus, assume title of king.

On the death of Alexander the Great, Egypt, together with Libya, and that part of Arabia which borders on Egypt, were assigned to Ptolemy Lagus as governor under Alexander's son by Roxana, who was but newly born. Nothing was farther from the intention of this governor, than to keep the provinces in trust for another. He did not, however, assume the title of *king*, till he perceived his authority so firmly established that it could not be shaken; and this did not happen till 19 years after the death of Alexander, when Antigonus and Demetrius had unsuccessfully attempted the conquest of Egypt.

From the time of his first establishment on the throne, Ptolemy, who had assumed the title of *Soter*, reigned 20 years; which added to the former 19, make up the 39 years which historians commonly allow him to have reigned alone.—In the 39th year of his reign, he made one of his sons, named *Philadelphus*, partner to the empire; declaring him his successor, to the prejudice of his eldest son named *Ceraunus*; being excited thereto by his violent love for *Berenice* Philadelphus's mother. When the succession was thus settled, Ceraunus immediately quitted the court; and fled at last into Syria, where he was received with open arms by Seleucus Nicator, whom he afterwards murdered.

The most remarkable transaction of this reign was the embellishing of the city of Alexandria, which Ptolemy made the capital of his new kingdom, and of which an account is given under the article ALEXANDRIA. About 284 years before Christ, died Ptolemy Soter, in the 41st year of his reign, and 84th of his age. He was the best prince of his race; and left behind him an example of prudence, justice, and clemency which few of his successors chose to follow. Besides the provinces originally assigned to him, he added to his empire those of Cœlo-Syria, Ethiopia, Pamphylia, Lycia, 26 S eeded b hila- d hus.

Lycia, Caria, and some of the Cyclades. His successor, Ptolemy Philadelphus, added nothing to the extent of the empire; nor did he perform any thing worthy of notice except embellishing further the city of Alexandria, and entering into an alliance with the Romans. In his time, one Magas the governor of Libya and Cyrene, revolted; and held these provinces as an independent prince, notwithstanding the utmost efforts of Ptolemy to reduce him. At last an accommodation took place; and a marriage was proposed between Berenice, the only daughter of Magas, and Ptolemy's eldest son. The young princess was to receive all her father's dominions by way of dowry, and thus they would again be brought under the dominion of Ptolemy's family. But before this treaty could be put in execution, Magas died; and then Apamea, the princess's mother, did all she could to prevent the match. This, however, she was not able to do; though her efforts for that purpose produced a destructive war of four years continuance with Antiochus Theus king of Syria, and the acting of a cruel tragedy in the family of the latter. See SYRIA.

27 emy rgetes a at con- q or.

About 246 years before Christ, Ptolemy Philadelphus died; and was succeeded by his eldest son Ptolemy, who had been married to Berenice the daughter of Magas, as above related. In the beginning of his reign, he found himself engaged in a war with Antiochus Theus king of Syria. From this he returned victorious, and brought with him 2500 statues and pictures, among which were many of the ancient Egyptian idols, which had been carried away by Cambyses into Persia. These were restored by Ptolemy to their ancient temples; in memory of which favour, the Egyptians gave him the surname of *Euergetes*, or the Beneficent. In this expedition he greatly enlarged his dominions, making himself master of all the countries that lie between Mount Taurus and the confines of India. An account of these conquests was given by himself, inscribed on a monument, to the following effect. "Ptolemy Euergetes, having received from his father the sovereignty of Egypt, Libya, Syria, Phœnice, Cyprus, Lycia, Caria, and the other Cyclades, assembled a mighty army of horse and foot, with a great fleet, and elephants, out of Trogloditia and Ethiopia; some of which had been taken by his father, and the rest by himself, and brought from thence, and trained up for war: with this great force he sailed into Asia; and having conquered all the provinces which lie on this side the Euphrates, Cilicia, Pamphylia, Ionia, the Hellespont, and Thrace, he crossed the river with all the forces of the conquered countries, and the kings of those nations, and reduced Mesopotamia, Babylonia, Susiana, Persia, Media, and all the country as far as Bactria."

On the king's return from this expedition, he passed through Jerusalem, where he offered many sacrifices to the God of Israel, and ever afterwards expressed a great favour for the Jewish nation. At this time, the Jews were tributaries to the Egyptian monarchs, and paid them annually 20 talents of silver. This tribute, however, Onias, who was then high priest, being of a very covetous disposition, had for a long time neglected to pay, so that the arrears amounted to a very large sum. Soon after his return, therefore, Ptolemy sent one of his courtiers named *Athenion* to demand the money, and desired him to acquaint the Jews that he would make war upon them in case of a refusal. A young man, however, named *Joseph*, nephew to Onias, not only found means to avert the king's anger, but even got himself chosen his receiver-general, and by his faithful discharge of that important trust, continued in high favour with Ptolemy as long as he lived.

Ptolemy Euergetes having at last concluded a peace with Seleucus the successor of Antiochus Theus king of Syria, attempted the enlargement of his dominions on the south side. In this he was attended with such success, that he made himself master of all the coasts of the Red sea, both on the Arabian and Ethiopian sides, quite down to the straits of Babelmandel. On his return he was met by ambassadors from the Achæans, imploring his assistance against the Etolians and Lacedæmonians. This the king readily promised them: but they having in the mean time engaged Antigonus king of Macedon to support them, Ptolemy was so much offended, that he sent powerful succours to Cleomenes king of Sparta; hoping, by that means, to humble both the Achæans and their new ally Antigonus. In this, however, he was disappointed; for Cleomenes, after having gained very considerable advantages over the enemy, was at last entirely defeated in the battle of Sellasia, and obliged to take refuge in Ptolemy's dominions. He was received by the Egyptian monarch with the greatest demonstrations of kindness; a yearly pension of 24 talents was assigned him, with a promise of restoring him to the Spartan throne; but before this could be accomplished, the king of Egypt died, in the 27th year of his reign, and was succeeded by his son Ptolemy Philopater.

28 Cleomenes king of Sparta takes refuge in Egypt.

Thus we have seen the Egyptian empire brought to a very great height of power; and had the succeeding monarchs been careful to preserve that strength of empire transmitted to them by Euergetes, it is very probable that Egypt might have been capable of holding the balance against Rome, and after the destruction of Carthage prevented that haughty city from becoming mistress of the world. But after the death of Ptolemy Euergetes, the Egyptian empire being governed only by weak or vicious monarchs, quickly declined, and from that time makes no conspicuous figure in history. Ptolemy Philopater began his reign with the murder of his brother; after which, giving himself up to all manner of licentiousness, the kingdom fell into a kind of anarchy. Cleomenes the Spartan king still resided at court; and being now unable to bear the dissolute manners which prevailed there, he pressed Philopater to give him the assistance he had promised for restoring him to the throne of Sparta. This he the rather insisted upon, because he had received advice that Antigonus king of Macedon was dead, that the Achæans were engaged in a war with the Etolians, and that the Lacedæmonians had joined the latter against the Achæans and Macedonians. Ptolemy, when afraid of his brother Magas, had indeed promised to assist the king of Sparta with a powerful fleet, hoping by this means to attach him to his own interest; but now when Magas was out of the way, it was determined by the king, or rather his ministers, that Cleomenes should not be assisted, nor even allowed to leave the kingdom; and this extravagant resolution produced the desperate attempt

29 Ptolemy Philopater a cruel tyrant.

tempt of Cleomenes, of which an account is given in the history of SPARTA.

Of the disorders which now ensued in the government, Antiochus king of Syria, surnamed *the Great*, took the advantage, and attempted to wrest from Ptolemy the provinces of Cœlo-Syria and Palestine. But in this he was finally disappointed; and might easily have been totally driven out of Syria, had not Ptolemy been too much taken up with his debaucheries to think of carrying on the war. The discontent occasioned by this piece of negligence soon produced a civil war in his dominions, and the whole kingdom continued in the utmost confusion till his death, which happened in the 17th year of his reign and 37th of his age.

30 Extraordinary story concerning the Jews.

During the reign of Philopater happened a very extraordinary event with regard to the Jews, which is mentioned in the Maccabees *. The king of Egypt, while on his Syrian expedition, had attempted to enter the temple of Jerusalem: but being hindered by the Jews, he was filled with the utmost rage against the whole nation. On his return to Alexandria, he resolved to make those who dwelt in that city feel the first effects of his vengeance. He began with publishing a decree, which he caused to be engraved on a pillar erected for that purpose at the gate of his palace, excluding all those who did not sacrifice to the gods worshipped by the king. By this means the Jews were debarred from suing to him for justice, or obtaining his protection when they happened to stand in need of it. By the favour of Alexander the Great, Ptolemy Soter, and Euergetes, the Jews enjoyed at Alexandria the same privileges with the Macedonians. In that metropolis the inhabitants were divided into three ranks or classes. In the first were the Macedonians, the original founders of the city, and along with them were enrolled the Jews; in the second were the mercenaries who had served under Alexander; and in the third the native Egyptians. Ptolemy now, to be revenged of the Jews, ordered, by another decree, that they should be degraded from the first rank, and enrolled among the native Egyptians. By the same decree it was enacted, that all of that nation should appear at an appointed time before the proper officers, in order to be enrolled among the common people; that at the time of their enrollment they should have the mark of an ivy leaf, the badge of Bacchus, impressed with a hot iron on their faces; that all who were thus marked should be made slaves; and, lastly, that if any one should stand out against this decree, he should be immediately put to death. That he might not, however, seem an enemy to the whole nation, he declared, that those who sacrificed to their gods should enjoy their former privileges, and remain in the same class. Yet, notwithstanding this tempting offer, 300 only out of many thousand Jews who lived in Alexandria could be prevailed upon to abandon their religion in order to save themselves from slavery.

The apostates were immediately excommunicated by their brethren: and this their enemies construed as done in opposition to the king's order; which threw the tyrant into such a rage, that he resolved to extirpate the whole nation, beginning with the Jews who lived in Alexandria and other cities of Egypt, and proceeding from thence to Judea and Jerusalem itself. In consequence of this cruel resolution, he commanded all the Jews that lived in any part of Egypt to be brought in chains to Alexandria, and there to be shut up in the Hippodrome, which was a very spacious place without the city, where the people used to assemble to see horse races and other public diversions. He then sent for Herman master of the elephants; and commanded him to have 500 of these animals ready against the next day, to let loose upon the Jews in the Hippodrome. But when the elephants were prepared for the execution, and the people were assembled in great crowds to see it, they were for that day disappointed by the king's absence. For, having been late up the night before with some of his debauched companions, he did not awake till the time for the show was over, and the spectators returned home. He therefore ordered one of his servants to call him early on the following day, that the people might not meet with a second disappointment. But when the person awaked him according to his order, the king was not yet returned to his senses; having withdrawn, exceedingly drunk, only a short time before. As he did not remember the order, he therefore fell into a violent passion, and threatened with death the servant who had awaked him; and this caused the show to be put off till the third day. At last the king came to the Hippodrome attended with a vast multitude of spectators; but when the elephants were let loose, instead of falling upon the Jews, they turned their rage against the spectators and soldiers, and destroyed great numbers of them. At the same time, some frightful appearances which were seen in the air so terrified the king, that he commanded the Jews to be immediately set at liberty, and restored them to their former privileges. No sooner were they delivered from this danger than they demanded leave to put to death such of their nation as had abandoned their religion; and this being granted, they despatched the apostates without excepting a single man.

31 Ptolemy Philomet taken pri soner by Antiochu

Philopater was succeeded by Ptolemy Epiphanes; and he, after a reign of 24 years, by Ptolemy Philometor. In the beginning of his reign, a war commenced with the king of Syria, who had seized on the provinces of Cœlo-Syria and Palestine in the preceding reign. In the course of this war, Philometor was either voluntarily delivered up to Antiochus, or taken prisoner. But however this was, the Alexandrians despairing of his ever being able to recover his liberty, raised to the throne his brother Ptolemy, who took the name of *Euergetes II.* but was afterwards called *Physcon* or "the great-bellied," on account of the prominent belly which by his gluttony and luxury he had acquired.

32 and Phys con raise to the throne.

He was scarce seated on the throne, however, when Antiochus Epiphanes, returning into Egypt, drove out Physcon, and restored the whole kingdom except Pelusium, to Philometor. His design was to kindle a war betwixt the two brothers, so that he might have an opportunity of seizing the kingdom for himself. For this reason he kept to himself the city of Pelusium; which being the key of Egypt, he might at his pleasure re-enter the country. But Philometer, apprised of his design, invited his brother Physcon to an accommodation; which was happily effected by their sister Cleopatra. In virtue of this agreement, the brothers were to reign jointly, and to oppose to the utmost of their power Antiochus, whom they considered as a common

---

* Lib. iii. 2. 3, 4, 5.

common enemy. On this the king of Syria invaded Egypt with a mighty army, but was prevented by the Romans from conquering it.

3
Difference between the two brothers decided by the Roman senate.

The two brothers were no sooner freed from the apprehensions of a foreign enemy than they began to quarrel with each other. Their differences soon came to such a height, that the Roman senate interposed. But before the ambassadors employed to inquire into the merits of the cause could arrive in Egypt, Physcon had driven Philometor from the throne, and obliged him to quit the kingdom. On this the dethroned prince fled to Rome, where he appeared meanly dressed, and without attendants. He was very kindly received by the senate; who were so well satisfied of the injustice done him, that they immediately decreed his restoration. He was reconducted accordingly; and on the arrival of the ambassadors in Egypt, an accommodation between the two brothers was negotiated. By this agreement, Physcon was put in possession of Libya and Cyrene, and Philometor of all Egypt and the island of Cyprus; each of them being declared independent of the other in the dominion allotted to them. The treaty, as usual, was confirmed with oaths and sacrifices, and was broken almost as soon as made. Physcon was dissatisfied with his share of the dominions; and therefore sent ambassadors to Rome, desiring that the island of Cyprus might be added to his other possessions. This could not be obtained by the ambassadors; and therefore Physcon went to Rome in person. His demand was evidently unjust; but the Romans, considering that it was their interest to weaken the power of Egypt as much as possible, without further ceremony adjudged the island to him.

4
Island of Cyprus adjudged to Physcon.

Physcon set out from Rome with two ambassadors; and arriving in Greece on his way to Cyprus, he raised there a great number of mercenaries, with a design to sail immediately to that island and conquer it. But the Roman ambassadors telling him, that they were commanded to put him in possession of it by fair means and not by force, he dismissed his army, and returned to Libya, while one of the ambassadors proceeded to Alexandria. Their design was to bring the two brothers to an interview on the frontiers of their dominions, and there to settle matters in an amicable manner. But the ambassador who went to Alexandria, found Philometor very averse from compliance with the decree of the senate. He put off the ambassador so long, that Physcon sent the other also to Alexandria, hoping that the joint persuasions of the two would induce Philometor to comply. But the king, after entertaining them at an immense charge for 40 days, at last plainly refused to submit, and told the ambassadors that he was resolved to adhere to the first treaty. With this answer the Roman ambassadors departed, and were followed by others from the two brothers. The senate, however, not only confirmed their decree in favour of Physcon, but renounced their alliance with Philometor, and commanded his ambassador to leave the city in five days.

5
Philometor refuses to comply.

6
Rebellion against Physcon.

In the mean time, the inhabitants of Cyrene having heard unfavourable accounts of Physcon's behaviour during the short time he reigned in Alexandria, conceived so strong an aversion against him, that they resolved to keep him out of their country by force of arms. On receiving intelligence of this resolution, Physcon dropped all thoughts of Cyprus for the present; and hastened with all his forces to Cyrene, where he soon got the better of his rebellious subjects, and established himself in the kingdom. His vicious and tyrannical conduct, however, soon estranged from him the minds of his subjects, in such a manner, that some of them entering into a conspiracy against him, fell upon him one night as he was returning to his palace, wounded him in several places, and left him for dead on the spot. This he laid to the charge of his brother Philometor; and as soon as he was recovered, took another voyage to Rome. Here he made his complaints to the senate, and showed them the scars of his wounds, accusing his brother of having employed the assassins from whom he received them. Though Philometor was known to be a man of a most humane and mild disposition, and therefore very unlikely to have been concerned in so black an attempt; yet the senate, being offended at his refusing to submit to their decree concerning the island of Cyprus, hearkened to this false accusation; and carried their prejudices so far, that they not only refused to hear what his ambassadors had to say, but ordered them immediately to depart from the city. At the same time, they appointed five commissioners to conduct Physcon to Cyprus, and put him in possession of that island, enjoining all their allies in those parts to supply him with forces for that purpose.

Physcon having by this means got together an army which seemed to him to be sufficient for the accomplishment of his design, landed in Cyprus; but being there encountered by Philometor in person, he was entirely defeated, and obliged to shelter himself in a city called *Lapitho*. Here he was closely besieged, and at last obliged to surrender. Every one now expected that Physcon would have been treated as he deserved; but his brother, instead of punishing, restored him to the government of Libya and Cyrene, adding some other territories instead of the island of Cyprus, and promising him his daughter in marriage. Thus an end was put to the war between the two brothers; for the Romans were ashamed any longer to oppose a prince who had given such a signal instance of his justice and clemency.

37
He is defeated and taken prisoner by Philometor.

On his return to Alexandria, Philometor appointed one Archias governor of Cyprus. But he, soon after the king's departure, agreed with Demetrius king of Syria, to betray the island to him for 500 talents. The treachery was discovered before it took effect; and the traitor, to avoid the punishment due to his crime, laid violent hands on himself. Ptolemy being offended with Demetrius for this attempt on Cyprus, joined Attalus king of Pergamus, and Ariarathes king of Cappadocia, in setting up a pretender to the crown of Syria. This was Alexander Balas; to whom he even gave his daughter Cleopatra in marriage, after he had placed him on the throne of Syria. But he, notwithstanding these and many other favours, being suspected of having entered into a plot against his benefactor, Ptolemy became his greatest enemy; and marching against him, routed his army in the neighbourhood of Antioch. He did not, however, long enjoy his victory; for he died in a few days after the engagement, of the wounds he had received.

38
Death of Philometor.

On the death of Philometor, Cleopatra the queen designed to secure the throne for her son. But some of

39 Monstrous wickedness of Physcon.

40 He is driven out.

of the principal nobility declaring for Physcon, a civil war was about to ensue, when matters were compromised on condition that Physcon should marry Cleopatra, that he should reign jointly with her during his life, and declare her son by Philometor heir to the crown. These terms were no sooner agreed upon than Physcon married Cleopatra, and, on the very day of the nuptials, murdered her son in her arms. This was only a prelude to the cruelties which he afterwards practised on his subjects. He was no sooner seated on the throne, than he put to death all those who had shown any concern for the murder of the young prince. He then wreaked his fury on the Jews, whom he treated more like slaves than subjects, on account of their having favoured the cause of Cleopatra. His own people were treated with little more ceremony. Numbers of them were every day put to death for the smallest faults, and often for no fault at all, but merely to gratify his inhuman temper. His cruelty towards the Alexandrians is particularly mentioned under the article ALEXANDRIA. In a short time, being wearied of his queen, who was also his sister, he divorced her; and married her daughter, who was also called *Cleopatra*, and whom he had previously ravished. In short, his behaviour was so exceedingly wicked, that it soon became quite intolerable to his subjects; and he was obliged to fly to the island of Cyprus with his new queen, and *Memphitis*, a son he had by her mother.

41 Murders his son.

On the flight of the king, the divorced queen was placed on the throne by the Alexandrians; but Physcon, fearing lest a son whom he had left behind should be appointed king, sent for him into Cyprus, and caused him to be assassinated as soon as he landed. This provoked the people against him to such a degree, that they pulled down and dashed to pieces all the statues which had been erected to him at Alexandria. This the tyrant supposed to have been done at the instigation of the queen, and therefore resolved to revenge it on her by killing his own son whom he had by her. He therefore, without the least remorse, caused the young prince's throat to be cut; and having put his mangled limbs into a box, sent them as a present to his mother Cleopatra. The messenger with whom this box was sent, was one of his guards. He was ordered to wait till the queen's birthday, which approached, and was to be celebrated with extraordinary pomp; and in the midst of the general rejoicing, he was to deliver the present.

42 Physcon restored.

The horror and detestation occasioned by this unexampled piece of cruelty cannot be expressed. An army was soon raised, and the command of it given to one *Marsyas*, whom the queen had appointed general, and enjoined to take all the necessary steps for the defence of the country. On the other hand, Physcon having hired a numerous body of mercenaries, sent them, under the command of one *Hegelochus*, against the Egyptians. The two armies met on the frontiers of Egypt, on which a bloody battle ensued; but at last the Egyptians were entirely defeated, and Marsyas was taken prisoner. Every one expected that the captive general would have been put to death with the severest torments; but Physcon, perceiving that his cruelties only exasperated the people, resolved to try whether he could regain their affections by lenity; and therefore pardoned Marsyas, and set him at liberty.—Cleopatra, in the mean time, being greatly distressed by this overthrow, demanded assistance from Demetrius king of Syria, who had married her eldest daughter by Philometor, promising him the crown of Egypt for his reward. Demetrius accepted the proposal without hesitation, marched with all his forces into Egypt, and there laid siege to Pelusium. But he being no less hated in Syria than Physcon was in Egypt, the people of Antioch, taking advantage of his absence, revolted against him, and were joined by most of the other cities in Syria. Thus Demetrius was obliged to return; and Cleopatra, being now in no condition to oppose Physcon, fled to Ptolemais, where her daughter the queen of Syria at that time resided. Physcon was then restored to the throne of Egypt, which he enjoyed without further molestation till his death; which happened at Alexandria, in the 29th year of his reign and 67th of his age.

43 Ptolemy Lathyrus driven out, and Alexander set up.

To Physcon succeeded Ptolemy Lathyrus, about 122 years before Christ; but he had not reigned long, before his mother, finding that he would not be entirely governed by her, by false surmises stirred up the Alexandrians, who drove him from the throne, and placed on it his youngest brother Alexander. Lathyrus after this was obliged to content himself with the government of Cyprus, which he was permitted to enjoy in quiet. Ptolemy Alexander, in the mean time, finding he was to have only the shadow of sovereignty, and that his mother Cleopatra was to have all the power, stole away privately from Alexandria. The queen used every artifice to bring him back, as well knowing that the Alexandrians would never suffer her to reign alone. At last her son yielded to her entreaties; but soon after, understanding that she had hired assassins to despatch him, he caused her to be murdered.

44 Lathyrus restored.

The death of the queen was no sooner known to the Alexandrians, than, disdaining to be commanded by a parricide, they drove out Alexander, and recalled Lathyrus.—The deposed prince for some time led a rambling life in the island of Cos; but having got together some ships, he, the next year, attempted to return into Egypt. But being met by *Tyrrhus*, Lathyrus's admiral, he was defeated, and obliged to fly to Myra in Lycia. From Myra he steered his course towards Cyprus, hoping that the inhabitants would place him on the throne, instead of his brother. But *Chareas*, another of Lathyrus's admirals, coming up with him while he was ready to land, an engagement ensued, in which Alexander's fleet was dispersed, and he himself killed.

45 Cyrenaic bequeath to the R mans.

During these disturbances, *Apion* king of Cyrenaica, the son of Ptolemy Physcon by a concubine, having maintained peace and tranquillity in his dominions during a reign of 21 years, died, and by his will left his kingdom to the Romans; and thus the Egyptian empire was considerably reduced and circumscribed.

46 City of Thebes ruined.

Lathyrus being now delivered from all competitors, turned his arms against the city of Thebes, which had revolted from him. The king marched in person against the rebels; and, having defeated them in a pitched battle, laid close siege to their city. The inhabitants defended themselves with great resolution for three years. At last, however, they were obliged to submit, and the city was given up to be plundered by the soldiery. They left everywhere the most melancholy

choly monuments of their avarice and cruelty; so that Thebes, which till that time had been one of the most wealthy cities of Egypt, was now reduced so low that it never afterwards made any figure.

47
Aander IIcceeds Lyrus.

About 76 years before Christ, Ptolemy Lathyrus was succeeded by Alexander II. He was the son of the Ptolemy Alexander, for whom Lathyrus had been driven out; and had met with many adventures. He was first sent by Cleopatra into the island of Cos, with a great sum of money, and all her jewels; as thinking that would be the safest place where they could be kept. When Mithridates king of Pontus made himself master of that island, the inhabitants delivered up to him the young Egyptian prince, together with all the treasures. Mithridates gave him an education suitable to his birth; but he, not thinking himself safe with a prince who had shed the blood of his own children, fled to the camp of Sylla the Roman dictator, who was then making war in Asia. From that time he lived in the family of the Roman general, till news was brought to Rome of the death of Lathyrus. Sylla then sent him to Egypt to take possession of the throne. But, before his arrival, the Alexandrians had chosen Cleopatra for the sovereign. To compromise matters, however, it was agreed, that Ptolemy should marry her, and take her for his partner in the throne. This was accordingly done; and 19 days after marriage, the unhappy queen was murdered by her husband, who for 15 years afterwards showed himself such a monster of wickedness, that a general insurrection at last ensued among his subjects, and he was obliged to fly to Pompey the Great, who was then carrying on the war against Mithridates king of Pontus. But Pompey refusing to concern himself in the matter, he retired to the city of Tyre, where he died some months after.

8
Mties Clbatra, annur-detier.

9
Les his kiom to Ro-ma

When he was forced to shut himself up in the city of Tyre, Alexander had sent ambassadors to Rome, in order to influence the senate in his favour. But, dying before the negotiation was finished, he made over by his last will all his rights to the Roman people, declaring them heirs to his kingdom: not out of any affection to the republic; but with a view to raise disputes between the Romans and his rival Auletes, whom the Egyptians had placed on the throne. The will was brought to Rome, where it occasioned warm debates. Some were for taking immediate possession of the kingdom. Others thought that no notice should be taken of such a will, because Alexander had no right to dispose of his dominions in prejudice of his successor, and to exclude from the crown those who were of the royal family of Egypt. Cicero represented, that such a notorious imposition would debase the majesty of the Roman people, and involve them in endless wars and disputes; that the fruitful fields of Egypt would be a strong temptation to the avarice of the people, who would insist on their being divided among them; and lastly, that by this means the bloody quarrels about the Agrarian laws would be revived. These reasons had some weight with the senate; but what chiefly prevented them from seizing on Egypt at this time was, that they had lately taken possession of the kingdom of Bithynia in virtue of the will of Nicomedes, and of Cyrene and Libya by the will of Apion. They thought, therefore, that if they should, on the like pretence, take possession of the kingdom of Egypt, this might too much expose their design of setting up a kind of universal monarchy, and occasion a formidable combination against them.

50
Character of Auletes the new king.

Auletes, who was now raised to the throne by the Egyptians, is said to have surpassed all the kings that went before him in the effeminacy of his manners. The name *Auletes*, which signifies the *flute-player*, was given him because he piqued himself on his skill in performing upon that instrument, and was not ashamed even to contend for the prize in the public games. He took great pleasure in imitating the manners of the Bacchanals; dancing in a female dress, and in the same measures that they used during the solemnities of their god Bacchus; and hence he had the surname of the *New Dionysius* or *Bacchus*. As his title to the crown was disputable (he being only the son of a concubine), the first care of Auletes was to get himself acknowledged by the Romans, and declared their ally. This was obtained by applying to Julius Cæsar, who was at this time consul, and immensely in debt. Cæsar being glad of such an opportunity of raising money, made the king of Egypt pay pretty dear for his alliance. Six thousand talents, a sum equal to 1,162,500l. sterling, were paid partly to Cæsar himself, and partly to Pompey, whose interest was necessary for obtaining the consent of the people. Though the revenues of Egypt amounted to twice this sum, yet Auletes found it impossible for him to raise it without severely taxing his subjects. This occasioned a general discontent; and while the people were almost ready to take up arms, a most unjust decree passed at Rome for seizing the island of Cyprus. When the Alexandrians heard of the intentions of the republic, they pressed Auletes to demand that island as an ancient appendage of Egypt; and, in case of a refusal, to declare war against that haughty and imperious people, who, they now saw, though too late, aimed at nothing less than the sovereignty of the world. With this request the king refused to comply; upon which his subjects, already provoked beyond measure at the taxes with which they were loaded, flew to arms, and surrounded the palace. The king had the good luck to escape their fury, and immediately leaving Alexandria, set sail for Rome.

51
Is acknowledged by the Romans.

52
Is driven from the throne, and flies to Rome.

In his way to that city, he landed on the island of Rhodes, where the famous Cato at that time was, being on his way to Cyprus, to put the unjust decree of the senate into execution. Auletes, desirous to confer with a man of his prudence, immediately sent to acquaint him with his arrival. He imagined, that, upon this notice, Cato would immediately come and wait upon him; but the proud Roman told the messenger, that if the king of Egypt had any thing to say to Cato, he might, if he thought proper, come to his house. Accordingly the king went to pay him a visit; but was received with very little ceremony by Cato, who did not even vouchsafe to rise out of his seat when he came into his presence. When Auletes had laid his affairs before this haughty republican, he was blamed by him for leaving Egypt, the richest kingdom in the world, in order to expose himself, as he said, to the indignities he would meet with at Rome. There Cato told him, that nothing was in request but wealth and grandeur. All the riches of Egypt, he said, would not be

53
Cato's advice to him.

sufficient to satisfy the avarice of the leading men in Rome. He therefore advised him to return to Egypt; and strive, by a more equitable conduct, to regain the affections of his people. He even offered to reconduct him thither, and employ his good offices in his behalf. But though Ptolemy was sensible of the propriety of this advice, the friends he had with him dissuaded him from following it, and accordingly he set out for Rome.

54
Infamous conduct of Auletes.

On his arrival in this metropolis, the king found, to his great concern, that Cæsar, in whom he placed his greatest confidence, was then in Gaul. He was received, however, by Pompey with great kindness. He assigned him an apartment in his own house, and omitted nothing that lay in his power to serve him. But, notwithstanding the protection of so powerful a man, Auletes was forced to go from house to house like a private person, soliciting the votes of the senators. After he had spent immense treasures in procuring a strong party in the city, he was at last permitted to lay his complaints before the senate; and at the same time there arrived an embassy from the Alexandrians, consisting of 100 citizens, to acquaint the senate with the reason of their revolt.

55
Berenice raised to the throne of Egypt.

When Auletes first set out for Rome, the Alexandrians, not knowing what was become of him, placed on the throne his daughter Berenice; and sent an embassy into Syria to Antiochus Asiaticus, inviting him into Egypt to marry the queen, and reign in partnership with her. Antiochus was dead before the arrival of the ambassadors; upon which the same proposal was made to his brother Seleucus, who readily accepted it. This Seleucus is described by Strabo as monstrously deformed in body, and still more so in mind. The Egyptians nicknamed him *Cybiosactes*, or *the Scullion:* a name which seemed more fit for him than any other. He was scarce settled on the throne, when he gave a signal instance of his sordid and avaricious temper. Ptolemy the first had caused the body of Alexander the Great to be deposited in a coffin of massy gold. This the king seized upon; and by that means provoked his wife Berenice to such a degree, that she caused him to be murdered. She then married one Archelaus, high priest of Comana in Pontus, who pretended to be the son of Mithridates the Great; but was, in fact, only the son of that monarch's general.

56
She marries Seleucus, and murders him.

57
Marries Archelaus.

Auletes was not a little alarmed on hearing of these transactions, especially when the ambassadors arrived, which he feared would overturn all the schemes he had laboured so much to bring about. The embassy was headed by one Dion, a celebrated Academic philosopher who had many powerful friends at Rome. But Ptolemy found means to get both him and most of his followers assassinated; and this intimidated the rest to such a degree, that they durst not execute their commission, or, for some time, even demand justice for the murder of their colleagues.

58
Auletes murders the Egyptian ambassadors.

The report of so many murders, however, at last spread a general alarm. Auletes, sure of the protection of Pompey, did not scruple to own himself the perpetrator of them. Nay, though an action was commenced against one Ascitius, an assassin, who had stabbed Dion the chief of the embassy above mentioned, and the crime was fully proved; yet he was acquitted by the venal judges, who had all been bribed by Ptolemy. In a short time, the senate passed a decree, by which it was enacted, that the king of Egypt should be restored by force of arms. All the great men in Rome were ambitious of this commission; which, they well knew, would be attended with immense profit. Their contests on this occasion took up a considerable time; and at last a prophecy of the Sybil was found out, which forbade the assisting an Egyptian monarch with an army. Ptolemy, therefore, wearied out with so long a delay, retired from Rome, where he had made himself generally odious, to the temple of Diana at Ephesus, there to wait the decision of his fate. Here he remained a considerable time: but as he saw that the senate came to no resolution, though he had solicited them by letters so to do; at last, by Pompey's advice, he applied to Gabinius the proconsul of Syria. This Gabinius was a man of a most infamous character, and ready to undertake any thing for money. Therefore, though it was contrary to an express law for any governor to go out of his province without positive orders from the senate and people of Rome, yet Gabinius ventured to transgress this law, upon condition of being well paid for his pains. As a recompense for his trouble, however, he demanded 10,000 talents; that is, 1,937,500l. sterling. Ptolemy, glad to be restored on any terms, agreed to pay the above-mentioned sum; but Gabinius would not stir till he had received one half of it. This obliged the king to borrow it from a Roman knight named *Caius Rabirius Posthumius;* Pompey interposing his credit and authority for the payment of the capital and interest.

59
His restora
tion de-
creed by th
senate.

60
Gabinius
undertake
to restore
him for a
great sum.

Gabinius now set out for Egypt, attended by the famous Mark Antony, who at this time served in the army under him. He was met by Archelaus, who since the departure of Auletes had reigned in Egypt jointly with Berenice, at the head of a numerous army. The Egyptians were utterly defeated, and Archelaus taken prisoner in the first engagement. Thus Gabinius might have put an end to the war at once: but his avarice prompted him to dismiss Archelaus on his paying a considerable ransom; after which, pretending that he had made his escape, fresh sums were demanded from Ptolemy for defraying the expences of the war. For these sums Ptolemy was again obliged to apply to Rabirius, who lent him what money he wanted at a very high interest. At last, however, Archelaus was defeated and killed, and thus Ptolemy again became master of all Egypt.

61
Archelau
defeated
and kil

62
Berenic
put to
death a
the peop
oppresse

No sooner was Auletes firmly settled on the throne, than he put to death his daughter Berenice, and oppressed his people with the most cruel exactions, in order to procure the money he had been obliged to borrow while in a state of exile. These oppressions and exactions the cowardly Egyptians bore with great patience, being intimidated by the garrison which Gabinius had left in Alexandria. But neither the fear of the Romans, nor the authority of Ptolemy, could make them put up an affront offered to their religion. A Roman soldier happened to kill a cat, which was an animal held sacred and even worshipped by the Egyptians; and no sooner was this supposed sacrilege known, than the Alexandrians made a general insurrection, and gathering together in crowds, made their way through

through the Roman guards, dragged the soldier out of his house, and, in spite of all opposition, tore him in pieces.

63 In atitude of uletes.

Notwithstanding the heavy taxes, however, which Ptolemy laid on his people, it doth not appear that he had any design of paying his debts. Rabirius, who, as we have already observed, had lent him immense sums, finding that the king affected delays, took a voyage to Egypt, in order to expostulate with him in person. Ptolemy paid very little regard to his expostulations; but excused himself on account of the bad state of his finances. For this reason he offered to make Rabirius collector general of his revenues, that he might in that employment pay himself. The unfortunate creditor accepted the employment for fear of losing his debt. But Ptolemy soon after, upon some frivolous pretence or other, caused him and all his servants to be closely confined. This base conduct exasperated Pompey as much as Rabirius; for the former had been in a manner security for the debt, as the money had been lent at his request, and the business transacted at a country house of his near Alba. However, as Rabirius had reason to fear the worst, he took the first opportunity of making his escape, glad to get off with life from his cruel and faithless debtor. To complete his misfortunes, he was prosecuted at Rome as soon as he returned, 1. For having enabled Ptolemy to corrupt the senate with sums lent him for that purpose. 2. For having debased and dishonoured the character of a Roman knight, by farming the revenues, and becoming the servant of a foreign prince. 3. For having been an accomplice with Gabinius, and sharing with him the 10,000 talents which that proconsul had received for his Egyptian expedition. By the eloquence of Cicero he was acquitted; and one of the best orations to be found in the writings of that author was composed on this occasion. Gabinius was also prosecuted; and, as Cicero spoke against him, he very narrowly escaped death. He was, however, condemned to perpetual banishment, after having been stripped of all he was worth. He lived in exile till the time of the civil wars, when he was recalled by Cæsar, in whose service he lost his life.

4 L es his ch en to th re of th o- ma

Auletes enjoyed the throne of Egypt about four years after his re-establishment; and at his death left his children, a son and two daughters, under the tuition of the Roman people. The name of the son was *Ptolemy*, those of the daughters were *Cleopatra* and *Arsinoe*. This was the Cleopatra who afterwards became so famous, and had so great a share in the civil wars of Rome. As the transactions of the present reign, however, are so closely connected with the affairs of Rome, that they cannot be well understood without knowing the situation of the Romans at that time, we refer for an account of them to the *History of Rome*.

St of E- gy ll its con est by the iph of C wan.

With Cleopatra ended the family of Ptolemy Lagus, the founder of the Grecian empire in Egypt, after it had held that country in subjection for the space of 294 years. From this time Egypt became a province of the Roman empire, and continued subject to the emperors of Rome or Constantinople. In the year 642, it was conquered by the Arabs under Amru Ebn al As, one of the generals of the caliph Omar. In the year 889, an independent government was set up in this kingdom by Ahmed Ebn Tolun, who rebelled against Al Mokhadi caliph of Bagdad. It continued to be governed by him and his successors for 27 years, when it was again reduced by Al Moctasi caliph of Bagdad. In about 30 years after, we find it again an independent state, being joined with Syria under Mahomet Ebn Taj, who had been appointed governor of these provinces. This government, however, was also but short-lived; for in the year 968 it was conquered by Jawhar, one of the generals of Moez Ledinillah, the Fatemite caliph of Cairwan in Barbary. See BARBARY, N° 34.

66 Moez takes possession of his new kingdom.

No sooner was Moez informed of the success of his general, than he prepared with all expedition to go and take possession of his new conquest. Accordingly he ordered all the vast quantities of gold which he and his predecessors had amassed, to be cast into ingots, of the size and figure of the millstones used in hand-mills, and conveyed on camels backs into Egypt. To shew that he was fully determined to abandon his dominions in Barbary, and to make Egypt the residence of himself and his successors, he caused the remains of the three former princes of his race to be removed from Cairwan in Barbary, and to be deposited in a stately mosque erected for that purpose in the city of Cairo in Egypt. This was a most effectual method to induce his successors to reside in Egypt also, as it was become an established custom and duty among those princes frequently to pay their respectful visits to the tombs of their ancestors.

67 Will not suffer prayers to be said for the caliph of Bagdad.

To establish himself the more effectually in his new dominions, Moez suppressed the usual prayers made in the mosques for the caliphs of Bagdad, and substituted his own name in their stead. This was complied with not only in Egypt and Syria, but even throughout all Arabia, the city of Mecca alone excepted. The consequence was, a schism in the Mahommedan faith, which continued upwards of 200 years, and was attended with continual anathemas, and sometimes destructive wars between the caliphs of Bagdad and of Egypt.—Having fully established himself in his kingdom, he died in the 45th year of his age, three years after he had left his dominions in Barbary; and was succeeded by his son Abu Al Mansur Barar, surnamed Aziz Billah.

68 Unsuccessful expedition into Syria.

The new caliph succeeded to the throne at the age of 21; and committed the management of affairs entirely to the care of Jawhar, his father's long-experienced general and prime minister. In 978, he sent this famous warrior to drive out Al Aftekin, the emir of Damascus. The Egyptian general accordingly formed the siege of that place; but at the end of two months was obliged to raise it, on the approach of an army of Karmatians under the command of Al Hakem. As Jawhar was not strong enough to venture an engagement with these Karmatians, it was impossible for him to hinder them from effecting a junction with the forces of Al Aftekin. He therefore retreated, or rather fled, towards Egypt with the utmost expedition; but being overtaken by the two confederate armies, he was soon reduced to the last extremity. He was, however, permitted to resume his march, on condition that he passed under Al Aftekin's sword and Al Hakem's lance; and to this disgraceful condition Jawhar found himself obliged to submit. On his arrival in Egypt, he he immediately advised Al Aziz to undertake an expedition in person into the east, against the combined army of Turks, Karmatians, and Damascenes, under the command of Al Aftekin and Al Hakem. The caliph followed his advice; and advancing against his enemies, overthrew them with great slaughter. Al Aftekin himself escaped out of the battle; but was afterwards taken and brought to Al Aziz, who made him his chamberlain, and treated him with great kindness. Jawhar, in the mean time, was disgraced on account of his bad success: and in his disgrace he continued till his death, which happened in the year of our Lord 990, and of the Hegira 381.

69 Aleppo desieged without success.

This year Al Aziz having received advice of the death of Saado'dawla prince of Aleppo, sent a formidable army under the command of a general named *Manjubekin*, to reduce that place. Lulu, who had been appointed guardian to Saado'dawla's son, finding himself pressed by the Egyptians, who carried on the siege with great vigour, demanded assistance from the Greek emperor. Accordingly, he ordered a body of troops to advance to Lulu's relief. Manjubekin, being informed of their approach, immediately raised the siege, and advanced to give them battle. An obstinate engagement ensued, in which the Greeks were at last overthrown with great slaughter. After this victory, Manjubekin pushed on the siege of Aleppo very briskly; but finding the place capable of defending itself much longer than he at first imagined, and his provisions beginning to fail, he raised the siege. The caliph upon this sent him a very threatening letter, and commanded him to return before Aleppo. He did so; and continued the siege for 13 months; during all which time it was defended by Lulu with incredible bravery. At last, the Egyptians hearing that a numerous army of Greeks was on their way to relieve the city, they raised the siege, and fled with the utmost precipitation. The Greeks then took and plundered some of the cities which Al Aziz possessed in Syria; and Manjubekin made the best of his way to Damascus, where he set up for himself. Al Aziz being informed of this revolt, marched in person against him with a considerable army; but being taken ill by the way, he expired, in the 21st year of his reign and 42d of his age.

Al Aziz was succeeded by his son Abu Al Mansur, surnamed Al Hakem; who, being only 11 years of age, was put under the tuition of a eunuch of approved integrity.

70 Strange madness of the caliph Al Hakem.

This reign is remarkable for nothing so much as the madness with which the caliph was seized in the latter part of it. This manifested itself first by his issuing many preposterous edicts; but at length grew to such a height, that he fancied himself a god, and found no fewer than 16,000 persons who owned him as such. These were mostly the Dararians, a new sect sprung up about this time, who were so called from their chief, Mohammed Ebn Ishmael, surnamed Darari. He is supposed to have inspired the mad caliph with this impious notion; and, as Darari set up for a second Moses, he did not scruple to assert that Al Hakem was the great Creator of the universe. For this reason, a zealous Turk stabbed him in the caliph's chariot. His death was followed by a three days uproar in the city of Cairo; during which, Darari's house was pulled down, and many of his followers massacred. The sect, however, did not expire with its author. He left behind him a disciple named Hamza, who, being encouraged by the mad caliph, spread it far and wide through his dominions. This was quickly followed by an abrogation of all the Mahommedan fasts, festivals, and pilgrimages, the grand one to Mecca in particular; so that the zealous Mahometans were now greatly alarmed, as justly supposing that Al Hakem designed entirely to suppress the worship of the true God, and introduce his own in its place. From this apprehension, however, they were delivered by the death of the caliph; who was assassinated, by a contrivance of his own sister, in the year 1020.

Al Hakem was succeeded by his son Al Thaher, who reigned 15 years; and left the throne to a son under seven years of age, named Al Mostanser Billah.—In the year 1041, a revolt happened in Syria; but Al Mostanser having sent a powerful army into that country, under the command of *Anushtekin*, he not only reduced the rebels, but considerably enlarged the Egyptian dominions in Syria.

71 Al Mosta ser attempts th conquest Bagdad.

In 1054, a Turk named Al Bassasiri, having quarrelled with the vizir of Al Kayem caliph of Bagdad, fled to Egypt, and put himself under the protection of Al Mostanser. The latter, imagining this would be a favourable opportunity for enlarging his dominions, and perhaps seizing on the city of Bagdad, supplied Bassasiri with money and troops. By this assistance, he was enabled to possess himself of Arabian Irak, and ravaged that province to the very gates of Bagdad. On this, Al Kayem wrote to Togrol Beg, or Tangrolipix, the Turkish sultan, who possessed very extensive dominions in the east, to come to his assistance. The sultan immediately complied with this request, and soon arrived at Bagdad with a formidable army and 18 elephants. Of this Bassasiri gave notice to Al Mostanser, and entreated him to exert himself further for his support against so powerful an enemy. This was accordingly done, but nothing worthy of notice happened till the year 1058. At this time Bassasiri having found means to excite Ibrahim the sultan's brother to a revolt, Togrol Beg was obliged to employ all his force against him. This gave Bassasiri an opportunity of seizing on the city of Bagdad itself; and the unfortunate caliph, according to some, was taken prisoner, or, according to others, fled out of the city. Bassasiri, on his entry, caused Al Mostanser to be immediately proclaimed caliph in all quarters of the city. Al Kayem's vizir he caused to be led on a camel through the streets of Bagdad, dressed in a woollen gown, with a high red bonnet, and leathern collar about his neck; a man lashing him all the way behind. Then being sewed up in a bull's hide, with the horns placed over his head, and hung upon hooks, he was beaten without ceasing till he died. The imperial palace was plundered, and the caliph himself detained a close prisoner

72 Caliph of Bagdad sisted by Togrol Beg.

73 Bagdad taken.

74 The ca restored

This success was but short-lived; for, in 1059, Togrol Beg defeated his brother Ibrahim, took him prisoner, and strangled him with a bow string. He then marched to Bagdad, which Bassasiri thought proper to abandon at his approach. Here the caliph Al Kayem was delivered up by Mahras, the governor of a city called *Haditha*, who had the charge of him. The caliph

caliph was immediately restored to his dignity; which Bassasiri no sooner understood, than he again advanced towards the city. Against him Togrol Beg sent a part of his army under some of his generals, while he himself followed with the rest. A battle ensued, in which the army of Bassasiri was defeated, and he himself killed. His head was brought to Togrol Beg, who caused it to be brought on a pike through the streets of Bagdad.

5 De ne of he gyp- a mpire.

Thus the hopes of Al Mostanser were entirely frustrated; and from this period we may date the declension of the Egyptian empire under the caliphs. They had made themselves masters of almost all Syria; but no sooner was Bassasiri's bad success known, than the younger part of the citizens of Aleppo revolted, and set up Mahmud Azzo'dawla, who immediately laid siege to the citadel. Al Mostanser sent a powerful army against him, which Azzo'dawla entirely defeated, and took the general himself prisoner; and soon after this he made himself master both of the city and citadel, with all their dependencies. In his new dominions he behaved with the greatest cruelty, destroying every thing with fire and sword, and making frequent incursions into the neighbouring provinces, which he treated in the same manner.

6 Ter le fa- min nd lag

This disaster was soon followed by others still more terrible. In 1066, a famine raged over all Egypt and Syria, with such fury, that dogs and cats were sold for four or five Egyptian dinars each, and other provisions in proportion. Multitudes of people died in Cairo for want of food. Nay, so great was the scarcity, that the vizir had but one servant left who was able to attend him to the caliph's palace, and to whom he gave the care of his horse when he alighted at the gate. But at his return, he was surprised to find that the horse had been carried off, killed and eaten by the famished people. Of this he complained to the caliph; who caused three of them who had carried off the horse to be hanged. Next day, however, he was still more surprised to hear, that all the flesh had been picked off the bones of the three unhappy criminals, so that nothing but the skeletons were left. And to such a degree of misery were the inhabitants, not only in Cairo but through all Egypt, reduced, that the carcases of those who died were sold for food at a great price, instead of being buried. All this time the caliph showed the greatest kindness and beneficence towards his unhappy subjects; insomuch that of 10,000 horses, mules, and camels, which he had in his stables when the famine began, he had only three left when it was removed.

nva d by he ks.

The famine was followed by a plague; and this by an invasion of the Turks under Abu Ali Al Hasan Naserod'dawla, the very general who had been sent against the rebel Azzo'dawla and defeated by him. He began with besieging the caliph in his own palace; and the unhappy prince, being in no condition to make resistance, was obliged to buy himself off at the expence of every thing valuable that was left in his exhausted capital and treasury. This, however, did not hinder those merciless plunderers from ravaging all the Lower Egypt from Cairo to Alexandria, and committing the most horrid cruelties through that whole tract.—This happened in the years 1067 and 1068; and in 1069 and 1070, there happened two other revolts in Syria: so that this country was now almost entirely lost.

78 Jerusalem taken.

In 1095 died the caliph Al Mostanser, having reigned 60 years; and was succeeded by his son Abul Kasem, surnamed Al Mostali. The most remarkable transaction of this prince's reign, was his taking the city of Jerusalem from the Turks in 1098; but this success was only of short duration; for it was the same year taken by the crusaders.

79 A revolution in the kingdom.

From this time to the year 1164, the Egyptian history affords little else than an account of the intestine broils and contests between the vizirs or prime ministers, who were now become so powerful, that they had in a great measure stripped the caliphs of their civil power, and left them nothing but a shadow of spiritual dignity. These contests at last gave occasion to a revolution, by which the race of Fatemite caliphs was totally extinguished. This revolution was accomplished in the following manner. One *Shawer*, having overcome all his competitors, became vizir to Al Aded, the eleventh caliph of Egypt. He had not been long in possession of this office, when Al Dargam, an officer of rank, endeavoured to deprive him of it. Both parties quickly had recourse to arms; and a battle ensued, in which Shawer was defeated, and obliged to fly to Nuroddin prince of Syria, by whom he was graciously received, and who promised to reinstate him in his office of vizir. As an inducement to Nuroddin to assist him more powerfully, Shawer told him that the crusaders had landed in Egypt, and made a considerable progress in the conquest of it. He promised also that, in case he was reinstated in his office, he would pay Nuroddin annually the third part of the revenues of Egypt; and would, besides, defray the whole expence of the expedition.

As Nuroddin bore an implacable hatred to the Christians, he readily undertook an expedition against them, for which he was to be so well paid. He therefore sent an army into Egypt under the command of Shawer and a general named *Asadoddin*. Dargam, in the mean time, had cut off so many generals whom he imagined favourable to Shawer's interest, that he thereby weakened the military force of the kingdom, and in a great measure deprived himself of the power of resistance. He was therefore easily overthrown by Asadoddin, and Shawer reinstated in the office of vizir. The faithless minister, however, no sooner saw himself firmly established in his office, than he refused to fulfil his engagements to Nuroddin by paying the stipulated sums. Upon this, Asadoddin seized Pelusium and some other cities. Shawer then entered into an alliance with the crusaders, and Asadoddin was besieged by their combined forces in Pelusium. Nuroddin, however, having invaded the Christian dominions in Syria, and taken a strong fortress called *Harem*, Shawer and his confederates thought proper to hearken to some terms of accommodation, and Asadoddin was permitted to depart for Syria.

In the mean time, Nuroddin, having subdued the greatest part of Syria and Mesopotamia, resolved to make Shawer feel the weight of his resentment on account of his perfidious conduct. He therefore sent back Asadoddin into Egypt with a sufficient force, to compel Shawer to fulfil his engagements: but this

the

the vizir took care to do before the arrival of Asadoddin; and thus, for the present, avoided the danger. It was not long, however, before he gave Nuroddin fresh occasion to send this general against him. That prince had now driven the crusaders almost entirely out of Syria, but was greatly alarmed at their progress in Egypt; and consequently offended at the alliance which Shawer had concluded with them, and which he still persisted in observing. This treaty was also thought to be contrived on purpose to prevent Shawer from being able to fulfil his promise to Nuroddin, of sending him annually a third of the revenues of Egypt. Nuroddin therefore again despatched Asadoddin into Egypt, in the year 1166, with a sufficient force, and attended by the famous Salahaddin, or Saladin, his own nephew. They entered the kingdom without opposition, and totally defeated Shawer and the crusaders. They next made themselves masters of Alexandria; and, after that, overran all the Upper Egypt. Saladin was left with a considerable garrison in Alexandria; but Asadoddin was no sooner gone, than the crusaders laid siege to that city. This at last obliged Asadoddin to return to its relief. The great losses he had sustained in this expedition probably occasioned his agreeing to a treaty with Shawer, by which he engaged to retire out of Egypt, upon being paid a sum of money.

Asadoddin was no sooner gone, than Shawer entered into a fresh treaty with the Franks. By this new alliance he was to attack Nuroddin in his own dominions, as he was at that time engaged in quelling some revolters, which would effectually prevent his sending any more forces into Egypt. This treaty so provoked the Syrian prince, that he resolved to suspend his other conquests for some time, and exert his whole strength in the conquest of Egypt.

80
Conquests of the crusaders.

By this time the crusaders had reduced Pelusium, and made a considerable progress in the kingdom, as well as in some other countries, through the divisions which reigned among the Mahometan princes. In such places as they conquered, they put almost every body to the sword; Christians as well as Mahometans; selling their prisoners for slaves, and giving up the towns to be plundered by the soldiers. From Pelusium they marched to Cairo; which was then in no posture of defence, and in the utmost confusion, by reason of the divisions which reigned in it. Shawer, therefore, as soon as he heard of their approach, caused the ancient quarter called *Mesr* to be set on fire, and the inhabitants to retire into the other parts. He also prevailed upon the caliph to solicit the assistance of Nuroddin; which the latter was indeed pretty much inclined of himself to grant, as it gave him the fairest opportunity he could have wished for, both of driving the crusaders out of Egypt, and of seizing the kingdom to himself. For this purpose he had already raised an army of 60,000 horse under his general Asadoddin; and on the receipt of Al Aded's message, gave them orders to set out immediately. The crusaders were now arrived at Cairo; and had so closely besieged that place, that neither Shawer nor the caliph knew any thing of the approach of the Moslem army which was hastening to their relief. The vizir, therefore, finding it impossible to hold out long against the enemy, had recourse to his old subterfuge of treaties and high promises. He sent the enemy 100,000 dinars, and promised them 900,000 more, if they would raise the siege; which they, dreading the approach of Asadoddin, very readily accepted.

81
They are repulsed by the army of Nuroddin prince of Damascu

The army of Nuroddin now approached the capital by hasty marches, and were everywhere received with the greatest demonstrations of joy. Asadoddin, on his arrival at Cairo, was invited by Al Aded to the royal palace, where he was entertained in the most magnificent manner, and received several presents; nor were Saladin and the other principal officers less magnificently treated. Shawer also, conscious of his perfidious conduct, was no les assiduous in attending punctually upon him. But having invited the general and some others to an entertainment, he had formed a scheme of having them seized and murdered. The plot, however, being discovered, Shawer himself had his head cut off, and Asadoddin was made vizir in his stead. He did not, however, long enjoy his new dignity; for he died two months and five days after his instalment, being succeeded in his office of vizir by his nephew Saladin.

82
Saladin becomes vizi of Egypt.

The new vizir was the youngest of all the grandees who aspired to that office, but had already given some signal proofs of his valour and conduct. What determined the caliph to prefer him to all the rest is not known; but it is certain that some of them were highly displeased with his promotion, and even publicly declared that they would not obey him. In order to gain these to his interest, therefore, Saladin found it necessary to distribute among them part of the vast treasures left by his uncle; by which means he soon governed Egypt without controul, as had been customary with the vizirs for some time before. Soon after his being installed into the office of vizir, he gave a total defeat to the negroes who guarded the royal palace, and had opposed his election; by which means, and a strong garrison he had placed in the castle of Cairo, his power became firmly established. Though he had not the least intention of continuing in his allegiance to Nuroddin, he did not think it prudent at first to declare himself. He sent for his father, however, and the rest of his family, who were in Nuroddin's dominions, in order, as he said, to make them partakers of his grandeur and happiness. Nuroddin did not think proper to deny this request; though, being already jealous of the great power of Saladin, he insisted that his family should consider him only as one of his generals in Egypt.

A good understanding subsisted between Nuroddin and Saladin for some time, which did not a little contribute to raise the credit of the latter with the Egyptians. In 1169, Nuroddin sent him orders to omit the name of Al Aded, the caliph of Egypt, in the public prayers, and substitute that of the caliph of Bagdad in its place. This was at any rate a dangerous attempt; as it might very readily produce a revolt in favour of Al Aded: or if it did not, it gave Saladin an opportunity of engrossing even that small remnant of power which was left to the caliph. Al Aded, however, was not sensible of his disgrace; for he was on his deathbed, and past recovery, when Nuroddin's orders were executed. After his death, Saladin seized on all his wealth and valuable effects; which consisted of jewels of prodigious size, sumptuous furniture, a library containing

83
Seizes effects the ca

containing 100,000 volumes, &c. His family he caused to be closely confined in the most private and retired part of the palace; and either manumitted his slaves, or kept them for himself, or disposed of them to others.

spi to e own.

Saladin was now arrived at the highest pitch of wealth, power, and grandeur. He was, however, obliged to behave with great circumspection with regard to Nuroddin: who still continued to treat him as his vassal, and would not suffer him to dispute the least of his commands. He relied for advice chiefly on his father Ayub; who was a consummate politician, and very ambitious of seeing his son raised to the throne of Egypt. He therefore advised Saladin to continue stedfast in his resolutions; and, whilst he amused Nuroddin with feigned submissions, to take every method in his power to secure himself in the possession of so valuable a kingdom. Nuroddin himself, however, was too great a master in the art of dissimulation to be easily imposed on by others; and therefore, though he pretended to be well pleased with Saladin's conduct, he was all this time raising a powerful army, with which he was fully determined to invade Egypt the following year. But while he meditated this expedition, he was seized with a quinsy at the castle of Damascus, which put an end to his life, in the year 1173.

ubd A- bia elix.

Saladin, though now freed from the apprehensions of such a formidable enemy, dared not venture to assume the title of *Sovereign*, while he saw the successor of Nuroddin at the head of a very powerful army, and no less desirous than able to dispossess him. For this reason his first care was to secure to himself an asylum, in case he should be obliged to leave Egypt altogether. For this purpose he chose the kingdom of Nubia; but having despatched his brother Malek Turanshah thither, at the head of a considerable army, the latter was so much struck with the sterility and desolate appearance of the country, that he returned without attempting any thing. Saladin then sent his brother into Arabia Felix, in order to subdue that country, which had been for some time held by Abdalnabi an Arabian prince. Malek entered the country without opposition; and having brought Abdalnabi to a general action, entirely defeated him, took him prisoner, and threw him into irons. He then overran and reduced under subjection to Saladin great part of the country, taking no fewer than 80 castles or fortresses of considerable strength.

ssu e t of ltal

After this good fortune, Saladin, now sure of a convenient place of refuge in case of any misfortune, assumed the title of *Sultan* or sovereign of Egypt; and was acknowledged as such by the greater part of the states. The zeal of the Egyptians for the Fatemite caliphs, however, soon produced a rebellion. One *Al Kanz*, or *Kanzanaddowla*, governor of a city in Upper Egypt, assembled a great army of blacks, or rather swarthy natives; and marching directly into the lower country, was there joined by great numbers of other Egyptians. Against them Saladin despatched his brother Malek, who soon defeated and entirely dispersed them. This, however, did not prevent another insurrection under an impostor, who pretended to be David the son of Al Aded the last Fatemite caliph, and had collected a body of 100,000 men. But before these had time to do any great damage, they were surprised by the sultan's forces, and entirely defeated. Above 300 were publicly hanged, and a vast number perished in the field, insomuch that it was thought scarce a fourth part of the whole body escaped.

About this time Saladin gained a considerable advantage over the crusaders, commanded by William II. king of Sicily. That prince had invaded Egypt with a numerous fleet and army, with which he laid close siege to Alexandria both by sea and land. Saladin, however, marched to the relief of the city with such surprising expedition, that the crusaders were seized with a sudden panic, and fled with the utmost precipitation, leaving all their military engines, stores, and baggage behind.

87 Saladin made sovereign of Damascus.

In the year 1175, the inhabitants of Damascus begged of Saladin to accept the sovereignty of that city and its dependencies; being jealous of the minister, who had the tuition of the reigning prince, and who governed all with an absolute sway. The application was no sooner made, than the sultan set out with the utmost celerity to Damascus, at the head of a chosen detachment of 700 horse. Having settled his affairs in that city, he appointed his brother Saif Al Islam governor of it; and set out for Hems, to which he immediately laid siege. Having made himself master of this place, he then proceeded to Hamah. The city very soon surrendered, but the citadel held out for some time. Saladin pretended that he accepted the sovereignty of Damascus and the other places he had conquered, only as deputy to Al Malek Al Saleh, the successor of Nuroddin, and who was then under age; and that he was desirous of sending Azzoddin, who commanded in the citadel, with a letter to Aleppo, where the young prince resided. This so pleased Azzoddin, that he took the oath of fidelity to Saladin, and immediately set out with the sultan's letter. He had not, however, been long at Aleppo before he was by the minister's orders thrown into prison; upon which his brother, who had been appointed governor of the citadel of Hamah in his absence, delivered it up to Saladin without further ceremony. The sultan then marched to Aleppo, with a design to reduce it: but, being vigorously repulsed in several attacks, he was at last obliged to abandon the enterprise. At the same time, Kamschlegin, Al Malek's minister or vizir, hired the chief of the Batanists, or Assassins *, to murder him. Several attempts were made in consequence of this application; but all of them, happily for Saladin, miscarried.

After raising the siege of Aleppo, Saladin returned to Hems, which place the crusaders had invested. On his approach, however, they thought proper to retire; after which, the sultan made himself master of the strong castle belonging to that place, which before he had not been able to reduce. This was soon followed by the reduction of Baalbec: and these rapid conquests so alarmed the ministers of Al Malek, that, entering into a combination with some of the neighbouring princes, they raised a formidable army, with which they designed to crush the sultan at once. Saladin, fearing the event of a war, offered to cede Hems and Hamah to Al Malek, and govern Damascus only as his lieutenant: but these terms being rejected, a battle ensued; in which the allied army was utterly defeated, and the shattered remains of it shut up in the city of Aleppo. This produced a treaty, by which Saladin

88 Defeats his enemies.

* See *Assassin*.

Saladin was left master of all Syria, excepting only the city of Aleppo and the territory belonging to it.

89 Receives a terrible overthrow from the crusaders.

In 1176 Saladin returned from the conquest of Syria, and made his triumphal entry into Cairo. Here, having rested himself and his troops for some time, he began to encompass the city with a wall 29,000 cubits in length, but which he did not live to finish. Next year he led a very numerous army into Palestine against the crusaders. But here his usual good fortune failed him. His army was entirely defeated. Forty thousand of his men were left dead on the field; and the rest fled with so much precipitation, that, having no towns in the neighbourhood where they could shelter themselves, they traversed the vast desert between Palestine and Egypt, and scarce stopped till they reached the capital itself. The greatest part of the army by this means perished; and as no water was to be had in the desert above mentioned, almost all the beasts died of thirst before the fugitives arrived on the confines of Egypt. Saladin himself seemed to have been greatly intimidated; for in a letter to his brother Al Malek, he told him, that "he was more than once in the most imminent danger; and that God, as he apprehended, had delivered him from thence, in order to reserve him for the execution of some grand and important design."

In the year 1182, the sultan set out on an expedition to Syria, with a formidable army, amidst the acclamations and good wishes of the people. He was, however, repulsed with loss both before Aleppo and Al Mawsel, after having spent much time and labour in besieging these two important places.

90 The Christians receive a great defeat at sea.

In the mean time, a most powerful fleet of European ships appeared on the Red sea, which threatened the cities of Mecca and Medina with the utmost danger. The news of this armament no sooner reached Cairo, than Abu Becr, Saladin's brother, who had been left viceroy in the sultan's absence, caused another to be fitted out with all speed under the command of Lulu, a brave and experienced officer, who quickly came up with them, and a dreadful engagement ensued. The Christians were defeated after an obstinate resistance, and all the prisoners butchered in cold blood. This proved such a terrible blow to the Europeans, that they never more ventured on a like attempt.

91 Saladin's rapid conquests.

In 1183, Saladin continued to extend his conquests. The city of Amida in Mesopotamia surrendered to him in eight days; after which, being provoked by some violences committed by the prince of Aleppo, he resolved at all events to make himself master of that place. He was now attended with better success than formerly; for as his army was very numerous, and he pushed on the siege with the utmost vigour, Amadoddin the prince capitulated, upon condition of being allowed to possess certain cities in Mesopotamia which had formerly belonged to him, and being ready to attend the sultan on whatever expedition he pleased. After the conquest of Aleppo, Saladin took three other cities, and then marched against his old enemies the crusaders. Having sent out a party to reconnoitre the enemy, they fell in with a considerable detachment of Christians; whom they easily defeated, taking about 100 prisoners, with the loss of only a single man on their side. The sultan, animated by this first instance of success, drew up his forces in order of battle, and advanced against the crusaders, who had assembled their whole army at Sepphoris in Galilee. On viewing the sultan's troops, however, and perceiving them to be greatly superior in strength to what they had at first apprehended, they thought proper to decline an engagement, nor could Saladin with all his skill force them to it. But though it was found impossible to bring the crusaders to a decisive engagement, Saladin found means to harass them greatly, and destroyed great numbers of their men. He carried off also many prisoners, dismantled three of their strongest cities, laid waste their territories, and concluded the campaign with taking another strong town.

92 Christians totally defeated.

For three years Saladin continued to gain ground on the crusaders, yet without any decisive advantage; but in 1187, the fortune of war was remarkably unfavourable to them. The Christians now found themselves obliged to venture a battle, by reason of the cruel ravages committed in their territories by Saladin, and by reason of the encroachments he daily made on them. Both armies therefore being resolved to exert their utmost efforts, a most fierce and bloody battle ensued. Night prevented victory from declaring on either side, and the fight was renewed with equal obstinacy next day. The victory was still left undecided; but the third day the sultan's men finding themselves surrounded by the enemy on all sides but one, and there also hemmed in by the river Jordan, so that there was no room to fly, fought like men in despair, and at last gained a most complete victory. Vast numbers of the Christians perished on the field. A large body found means to retire in safety to the top of a neighbouring hill covered with wood; but being surrounded by Saladin's troops, who set fire to the wood, they were all obliged to surrender at discretion. Some of them were butchered by their enemies as soon as they delivered themselves into their hands, and others thrown into irons. Among the latter were the king of Jerusalem himself, Arnold prince of Al Shawbec and Al Carac, the masters of the Templars and Hospitalers, with almost the whole body of the latter. So great was the consternation of the Christians on this occasion, that one of Saladin's men is said to have taken 30 of them prisoners, and tied them together with the cord of his tent, to prevent them from making their escape. The masters of the Templars and Hospitalers, with the knights acting under them, were no sooner brought into Saladin's presence, than he ordered them all to be cut in pieces. He called them *Assassins* or *Batanists*; and had been wont to pay 50 dinars for the head of every Templar or Hospitaler that was brought him. After the engagement, Saladin seated himself in a magnificent tent, placing the king of Jerusalem on his right hand, and Arnold prince of Al Shawbec and Al Carac on his left. Then he drank to the former, who was at that time ready to expire with thirst, and at the same time offered him a cup of snow water. This was thankfully received; and the king immediately drank to the prince of Al Carac, who sat near him. But here Saladin interrupted him with some warmth: "I will not (says he) suffer this cursed rogue to drink; as that, according to the laudable and generous custom of the Arabs, would secure to him his life." Then, turning

turning towards the prince, he reproached him with having undertaken the expedition while in alliance with himself, with having intercepted an Egyptian caravan in the time of profound peace, and massacring the people of which it was composed, &c. Notwithstanding all this, he told him, he would grant him his life, if he would embrace Mahometanism. This condition, however, was refused; and the sultan, with one stroke of his scimitar, cut off the prince's head. This greatly terrified the king of Jerusalem; but Saladin assured him he had nothing to fear, and that Arnold had brought on himself a violent death by his want of common honesty.

93 Further conquests.

The crusaders being thus totally defeated and dispersed, Saladin next laid siege to Tiberias, which capitulated in a short time. From thence he marched towards Acca or Ptolemais, which likewise surrendered after a short siege. Here he found 4000 Mahometan prisoners in chains, whom he immediately released. As the inhabitants enjoyed at present a very extensive trade, the place being full of merchants, he found there not only vast sums of money, but likewise a great variety of wares exceedingly valuable, all which he seized and applied to his own house. About the same time his brother Al Malec attacked and took a very strong fortress in the neighbourhood; after which the sultan divided his army into three bodies, that he might with the greater facility overrun the territories of the Christians. Thus, in very short time, he made himself master of Neapolis, Cæsarea, Sepphoris, and other cities in the neighbourhood of Ptolemais, where his soldiers found only women and children, the men having been all killed or taken prisoners. His next conquest was Joppa, which was taken by storm after a vigorous resistance. Every thing being then settled, and a distribution made of the spoils and captives, Saladin marched in person against Tebrien, a strong fortress in the neighbourhood of Sidon; which was taken by assault, after it had sustained a siege of six days. No sooner was he master of this place, than he ordered the fortress to be razed, and the garrison put to the sword. From Tebrien the victorious sultan proceeded to Sidon itself; which being deserted by its prince, surrendered almost on the first summons. Berytus was next invested, and surrendered in seven days. Among the prisoners Saladin found in this place the prince of a territory called *Hobeil*, who by way of ransom delivered up his dominions to him, and was of consequence released. About the same time, a Christian ship, in which was a nobleman of great courage and experience in war, arrived at the harbour of Ptolemais, not knowing that it was in the hands of Saladin. The governor might easily have secured the vessel; but neglecting the opportunity, she escaped to Tyre, where the above-mentioned nobleman, together with the prince of Hobeil, contributed not a little to retrieve the affairs of the Christians, and enable them to make a stand for four years after.

Jerusalem taken.

Saladin in the mean time went on with his conquests. Having made himself master of Ascalon after a siege of 14 days, he next invested Jerusalem. The garrison was numerous, and made an obstinate defence; but Saladin having at last made a breach in the walls by sapping, the besieged desired to capitulate. This was at first refused: upon which the Christian ambassador made the following speech: "If that be the case, know, O sultan, that we who are extremely numerous, and have been restrained from fighting like men in despair only by the hopes of an honourable capitulation, will kill all our wives and children, commit all our wealth and valuable effects to the flames, massacre 5000 prisoners now in our hands, leave not a single beast of burden or animal of any kind belonging to us alive, and level with the ground the rock you esteem sacred, together with the temple Al Aksa. After this we will sally out upon you in a body; and doubt not but we shall either cut to pieces a much greater number of you than we are, or force you to abandon the siege." This desperate speech had such an effect upon Saladin, that he immediately called a council of war, at which all the general officers declared, that it would be most proper to allow the Christians to depart unmolested. The sultan therefore allowed them to march out freely and securely with their wives, children, and effects; after which he received ten dinars from every man capable of paying that sum, five from every woman, and two from every young person under age. For the poor who were not able to pay any thing, the rest of the inhabitants raised the sum of 30,000 dinars.

Most of the inhabitants of Jerusalem were escorted by a detachment of Saladin's troops to Tyre; and soon after, he advanced with his army against that place. As the port was blocked up by a squadron of five men of war, Saladin imagined that he should easily become master of it. But in this he found himself mistaken. For, one morning by break of day, a Christian fleet fell upon his squadron, and entirely defeated it; nor did a single vessel escape their pursuit. A considerable number of the Mahometans threw themselves into the sea during the engagement; most of whom were drowned, though some few escaped. About the same time Saladin himself was vigorously repulsed by land; so that, after calling a council of war, it was thought proper to raise the siege.

In 1188, Saladin though his conquests were not so rapid and considerable as hitherto, continued still superior to his enemies. He reduced the city of Laodicea and some others, together with many strong castles; but met also with several repulses. At last he took the road to Antioch; and having reduced all the fortresses that lay in his way, many of which had been deemed impregnable, Bohemond prince of Antioch was so much intimidated, that he desired a truce for seven or eight months. This Saladin found himself obliged to comply with, on account of the prodigious fatigues his men had sustained, and because his auxiliaries now demanded leave to return home.

95 Crusaders retrieve their affairs.

All these heavy losses of the Christians, however, proved in some respects an advantage, as they were thus obliged to lay aside their animosities, which had originally proved the ruin of their affairs. Those who had defended Jerusalem, and most of the other fortresses taken by Saladin, having retreated to Tyre, formed there a very numerous body. This proved the means of preserving that city, and also of re-establishing their affairs for the present. For, having received powerful succours from Europe, they were enabled in 1189 to take the field with 30,000 foot and 2000 horse. Their first attempt was upon Alexandretta; from whence they dislodged a strong party of Mahometans, and made themselves

themselves masters of the place with very little loss. They next laid siege to Ptolemais; of which Saladin had no sooner received intelligence, than he marched to the relief of the place. After several skirmishes with various success, a general engagement ensued, in which Saladin was defeated with the loss of 10,000 men. This enabled the Christians to carry on the siege of Ptolemais with greater vigour; which place, however, they were not able to reduce for the space of two years.

This year the sultan was greatly alarmed by an account that the emperor of Germany was advancing to Constantinople with an army of 260,000 men, in order to assist the other crusaders. This prodigious armament, however, came to nothing. The multitude was so reduced with sickness, famine, and fatigue, that scarce 1000 of them reached the camp before Ptolemais. The siege of that city was continued, though with bad success on the part of the Christians. They were repulsed in all their attacks, their engines were burnt with naphtha, and the besieged always received supplies of provisions in spite of the utmost efforts of the besiegers; at the same time that a dreadful famine and pestilence raged in the Christian camp, which sometimes carried off 200 people a-day.

96 Richard I. of England arrives in Asia.

In 1191, the Christians received powerful succours from Europe. Philip II. of France, and Richard I. of England (from his great courage surnamed *Cœur de Lion*) arrived at the camp before Ptolemais. The latter was esteemed the bravest and most enterprising of all the generals the crusaders had; and the spirits of his soldiers were greatly elated by the thoughts of acting under such an experienced commander. Soon after his arrival, the English sunk a Mahometan ship of vast size, having on board 650 soldiers, a great quantity of arms and provisions, going from Berytus to Ptolemais. Of the soldiers and sailors who navigated this vessel, only a single person escaped; who being taken prisoner by the English, was despatched to the sultan with the news of the disaster. The besieged still defended themselves with the greatest resolution; and the king of England happening to fall sick, the operations of the besiegers were considerably delayed. On his recovery, however, the attacks were renewed with such fury, that the place was every moment in danger of being taken by assault. This induced them to send a letter to Saladin, informing him, that if they did not receive succours the very next day, they would be obliged to submit. As this town was the sultan's principal magazine of arms, he was greatly affected with the account of their distress, especially as he found it impossible to relieve them. The inhabitants, therefore, found themselves under a necessity of surrendering the place. One of the terms of the capitulation was, that the crusaders should receive a very considerable sum of money from Saladin, in consequence of their delivering up the Mahometan prisoners they had in their hands. This article Saladin refused to comply with; and, in consequence of his refusal, Richard caused 3000 of those unfortunate men to be slaughtered at once.

97 Defeats Saladin.

After the reduction of Ptolemais, the king of England, now made generalissimo of the crusaders, took the road to Ascalon, in order to besiege that place; after which, he intended to make an attempt upon Jerusalem itself. Saladin proposed to intercept his passage, and placed himself in the way with an army of 300,000 men. On this occasion was fought one of the greatest battles of that age. Saladin was totally defeated, with the loss of 40,000 men; and Ascalon soon fell into the hands of the crusaders. Other sieges were afterwards carried on with success, and Richard even approached within sight of Jerusalem, when he found, that by reason of the weakened state of his army, and the divisions which prevailed among the officers who commanded it, he should be under the necessity of concluding a truce with the sultan. This was accordingly done in the year 1192; the term was, three years, three months, three weeks, three days, and three hours; soon after which the king of England set out on his return to his own dominions.

98 Mamlouks become masters of Egypt.

99 Account of them.

In 1193 Saladin died, to the inexpressible grief of all true Mahometans, who held him in the utmost veneration. His dominions in Syria and Palestine were shared out among his children and relations into many petty principalities. His son Othman succeeded to the crown of Egypt: but as none of his successors possessed the enterprising genius of Saladin, the history from that time till the year 1250 affords nothing remarkable. At this time the reigning sultan Malek Al Salek was dethroned and slain by the *Mamelucs* or *Mamlouks*, as they are called, a kind of mercenary soldiers who served under him. In consequence of this revolution, the Mamlouks became masters of Egypt, and chose a sultan from among themselves.—These Mamlouks are thought to have been young Turks or Tartars, sold to private persons by the merchants, from whom they were bought by the sultan, educated at his expence, and employed to defend the maritime places of the kingdom. The reason of this institution originally was, that the native Egyptians were become so cowardly, treacherous, and effeminate, from a long course of slavery, that they were unfit for arms. The Mamlouks, on the contrary, made most excellent soldiers; for having no friends but amongst their own corps, they turned all their thoughts to their own profession. According to M. Volney, they came originally from Mount Caucasus, and are distinguished by the flaxen colour of their hair. Here they were found by the crusaders, and were by them called *Mamelucs*, or more correctly *Mamlouks*. The expedition of the Tartars in 1227 proved indirectly the means of introducing them into Egypt. These horrible conquerors, having slaughtered and massacred till they were weary, brought along with them an immense number of slaves of both sexes, with whom they filled all the markets in Asia. The Turks, taking advantage of the opportunity, purchased about 12,000 young men, whom they bred up in the profession of arms, in which they soon attained to great perfection; but becoming mutinous, like the Roman pretorian bands, they turned their arms against their masters, and in 1250 deposed and murdered the caliph, as has been already related.

The Mamlouks having got possession of the government, and neither understanding nor putting a value upon any thing besides the art of war, every species of learning decayed in Egypt, and a great degree of barbarism was introduced. Neither was their empire of long duration, notwithstanding all their martial abilities. The reason of this was, that they were originally only a a small part of the sultan of Egypt's standing forces. As a numerous standing army was necessary in a country where the fundamental maxim of government was, that every native must be a slave, they were at first at a loss how to act; being justly suspicious of all the rest of the army. At last they resolved to buy Christian slaves, and educate them in the same way that they themselves had formerly been. These were commonly brought from Circassia, where the people, though they professed Christianity, made no scruple of selling their children. When they were completed in their military education, these soldiers were disposed of through all the fortresses erected in the country to bridle the inhabitants; and because in their language such a fort was called *Borge*, the new militia obtained the name of *Borgites*. By this expedient the Mamlouks imagined they would be able to secure themselves in the sovereignty. But in this they were mistaken. In process of time, the old Mamlouks grew proud, insolent, and lazy: and the Borgites, taking advantage of this, rose upon their masters, deprived them of the government, and transferred it to themselves about the year 1382.

o
Dn out
by Bor-
gity

The Borgites, as well as the former, assumed the name of *Mamlouks;* and were famous for their valour and ferocity of conduct. They were almost perpetually engaged in wars either foreign or domestic; and their dominion lasted till the year 1517, when they were invaded by Selim the Turkish sultan. The Mamlouks defended themselves with incredible valour; notwithstanding which, being overpowered by numbers, they were defeated in every engagement. The same year, their capital, the city of Cairo, was taken, with a terrible slaughter of those who defended it. The sultan was forced to fly; and, having collected all his force, ventured a decisive battle. The most romantic efforts of valour, however, were insufficient to cope with the innumerable multitude which composed the Turkish army. Most of his men were cut in pieces, and the unhappy prince himself was at last obliged to take shelter in a marsh. He was dragged from his hiding-place, where he had stood up to the shoulders in water, and soon after put to death. With him ended the glory, and almost the existence, of the Mamlouks, who were now everywhere searched for and cut in pieces.

1
Et con-
qud by
Se.

This was another great revolution in the Egyptian affairs: a revolution very little to the advantage of the natives, who may well doubt whether their ancient or modern conquerors have behaved with the greater degree of barbarity. Selim gave a specimen of his government, the very day after his being put in full possession of it, by the death of Tuman Bey the unfortunate sultan above mentioned. Having ordered a theatre to be erected with a throne upon it on the banks of the Nile, he caused all the prisoners, upwards of 30,000 in number, to be beheaded in his presence, and their bodies thrown into the river.

2
Hiorrid
cry.

Notwithstanding this horrid cruelty of Selim, he did not attempt the total extermination of the race of Mamlouks, though this would have been quite agreeable to the maxims of Turkish policy; but in the present case he seems to have recollected, that if he established a pacha in Egypt with the same powers with which he invested those of other parts, he would be under strong temptations to revolt by reason of the distance from the capital. He therefore proposed a new form of government, by which the power being distributed among the different members of the state, should preserve an equilibrium, so that the dependence of the whole should be upon himself. With this view, he chose from among the Mamlouks who had escaped the general massacre a divan, or council of regency, consisting of the pacha and chiefs of the seven military corps. The former was to notify to this council the orders of the Porte, to send the tribute to Constantinople, and provide for the safety of government both external and internal; while, on the other hand, the members of the council had a right to reject the orders of the pacha, or even of deposing him, provided they could assign sufficient reasons. All civil and political ordinances must also be ratified by them. Besides this, he formed the whole body into a republic; for which purpose he issued an edict to the following purpose: "Though, by the help of the Almighty, we have conquered the whole kingdom of Egypt with our invincible armies; nevertheless our benevolence is willing to grant to the 24 sangiacs (A) of Egypt a republican government, with the following conditions.

103
New form
of government
introduced by
Selim.

104
His edict
for a republic.

"I. That our sovereignty shall be acknowledged by the republic; and in token of their obedience, our lieutenant shall be received as our representative: but to do nothing against our will or the republic; but, on the contrary, shall co-operate with it for its welfare on all occasions. Or if he shall attempt to infringe any of its privileges, the republic is at liberty to suspend him from his authority, and to send to our Sublime Porte a complaint against him, &c.

"II. In time of war, the republic shall provide 12,000 troops at its own expence, to be commanded by a sangiac or sangiacs.

"III. The republic shall raise annually and send to our Sublime Porte the sum of 560,000 aslany (B), accompanied by a sangiac, who shall have a satisfactory receipt, &c.

"IV. The same sum to be raised for the use of Medina, and Kiabe or Mecca.

"V. No more troops of Janizaries shall be kept by the republic in time of peace than 14,000; but in time of war they may be increased to oppose our and the republic's enemies.

"VI. The republic shall send annually to our granary, out of the produce of the country, one million of casiz (C) or measures of corn, viz. 600,000 of wheat and 400,000 of barley.

"VII. The republic, fulfilling these articles, shall have a free government over all the inhabitants of Egypt,

---

(A) These sangiacs are the governors of provinces.

(B) Each of these coins is in value about half-a-crown English; and the tribute since that time has been augmented to 800,000 aslany, or about 100,000l. sterling.

(C) Each casiz weighs 25 occa, and each occa is equal to two pounds ten ounces English avoirdupois weight.

Egypt, independent of our lieutenant, but shall execute the laws of the country with the advice of the mollah or high priest under our authority and that of our successors.

"VIII. The republic shall be in possession of the mint as heretofore; but with this condition, that it shall be under the inspection of our lieutenant, that the coin may not be adulterated.

"IX. That the republic shall elect a *skeik bellet* out of the number of beys, to be confirmed by our lieutenant; and that the said sheik bellet shall be our representative, and shall be esteemed by all our lieutenants, and all our officers both of high and low rank, as the head of the republic; and if our lieutenant is guilty of oppression, or exceeds the bounds of his authority, the said sheik bellet shall represent the grievances of the republic to our Sublime Porte: but in case any foreign enemy or enemies disturb the peace of the republic, we and our successors engage to protect it with our utmost power until peace is re-established, without any cost or expence to the republic.

"Given and signed by our *clemency* to the republic of Egypt."

105 The Turkish power now almost entirely lost.

Thus the power of the Mamlouks still continued in a very considerable degree, and by degrees increased so much as to threaten a total loss of dominion to the Turks. During the last 50 years, the Porte having relaxed from its vigilance, such a revolution has taken place, that the Turkish power is now almost reduced to nothing. But in order to understand this, we must consider the way in which the race of Mamlouks is continued or multiplied in Egypt. This is not in the ordinary way, by marriage: on the contrary, M. Volney assures us, that "during 350 years in which there have been Mamlouks in Egypt, not one of them has left subsisting issue: all their children perish in the first or second descent. Almost the same thing holds good with regard to the Turks; and it is observed, that they can only secure the continuance of their families by marrying women who are natives, which the Mamlouks have always disdained. The means by which they are perpetuated and multiplied are the same by which they were first established, viz. by slaves brought from their original country. From the time of the Moguls this commerce has been continued on the banks of the Cuban and Phasis in the same manner as it is carried on in Africa, by the wars among the hostile tribes, and the misery or avarice of the inhabitants, who sell their children to strangers. The slaves thus procured are first brought to Constantinople, and afterwards dispersed through the empire, where they are purchased by the wealthy. When the Turks subdued Egypt (says M. Volney), they should undoubtedly have prohibited this dangerous traffic; their omitting which seems about to dispossess them of their conquest, and which several political errors have long been preparing.

106 Why the children of the Mamlouks and Turks all die in Egypt.

"For a considerable time the Porte had neglected the affairs of this province; and in order to restrain the pachas, had suffered the divan to extend its power till the chiefs of the janizaries and azabs were left without controul. The soldiers themselves, become citizens by the marriages they had contracted, were no longer the creatures of Constantinople; and a change introduced into their discipline still more increased these disorders. At first the seven military corps had one common treasury; and though the society was rich, individuals, not having any thing at their own disposal, could effect nothing. The chiefs, finding their power diminished by this regulation, had interest enough to get it abolished, and obtained permission to possess distinct property, lands, and villages. And as these lands and villages depended on the Mamlouk governors, it was necessary to conciliate them, to prevent their oppressions. From that moment the beys acquired an ascendancy over the soldiers, who till then had treated them with disdain, and this could not but continually increase, since their governments procured them considerable riches. These they employed in creating themselves friends and creatures. They multiplied their slaves; and after emancipating them, employed all their interest to promote them to various employments, and advance them in the army. These upstarts, retaining for their patrons the same superstitious veneration common in the East, formed factions implicitly devoted to their pleasure."

107 Authority usurped by Ibrahim Kiaya.

Thus, about the year 1746, Ibrahim, one of the kiayas (D) of the janizaries, rendered himself in reality master of Egypt; having managed matters so well, that of the 24 beys or sangiacs, eight were of his household. His influence too was augmented by always leaving vacancies in order to enjoy the emoluments himself; while the officers and soldiers of his corps were attached to his interest: and his power was completed by gaining over Rodoan, the most powerful of all the colonels, to his interest. Thus the pacha became altogether unable to oppose him, and the orders of the sultan were less respected than those of Ibrahim. On his death in 1757, his family, i. e. his enfranchised slaves, continued to rule in a despotic manner. Waging war, however, among each other, Rodoan, and several other chiefs were killed; until, in 1766, Ali Bey, who had been a principal actor in the disturbances, overcame his enemies, and for some time rendered himself absolute master of Egypt.

108 History o Ali Bey.

Of this man there are various accounts. The following is that given by M. Volney. He begins with observing, that the private history of the Mamlouks in general must be subject to great uncertainty, by reason of their being generally carried off from their parents at a time of life when they can remember but little or nothing of their parents; and he remarks, that they are likewise unwilling to communicate the little they may happen to remember. It is most commonly supposed, however, that Ali Bey was born among the Abazans, a people of Mount Caucasus; from whom, next to the Circassians, the slaves most valued by the Turks, and other nations who deal in that commodity, are to be obtained.

109 He is bought educate by Ibra Kiaya.

Having been brought to a public sale at Cairo, Ali Bey was bought by two Jew brothers named Isaac and Yousef, who made a present of him to Ibrahim Kiaya.

(D) These were the commanding officers of the janizaries, azabs, &c. who after the first year laid down their employments, and became veterans, with a voice in the divan.

Kiaya. At this time he is supposed to have been about 13 or 14 years old, and was employed by his patron in offices similar to those of the pages belonging to European princes. The usual education was also given him; viz. that of learning to manage a horse well; fire a carbine and pistol; throw the djerid, a kind of dart used in the diversions of that country, and which will be afterwards described. He was also taught the exercise of the sabre, and a little reading and writing. In all the feats of activity just mentioned, he discovered such impetuosity, that he obtained the surname of *Djendali*, or "madman;" and as he grew up, discovered an ambition proportionable to the activity displayed in his youth. About the age of 18 or 20, his patron gave him his freedom; the badge of which among the Turks is the letting the beard grow, for among that people it is thought proper only for women and slaves to want a beard. By his kind patron also he was promoted to the rank of kachef or governor of a district, and at last elected one of the 24 beys. By the death of Ibrahim in 1757, he had an opportunity of satisfying his ambition; and now engaged in every scheme for the promotion or disgrace of the chiefs, and had a principal share in the ruin of Rodoan Kiaya above mentioned. Rodoan's place was quickly filled by another, who did not long enjoy it; and in 1762 Ali Bey, then styled *Sheik-el-Beled*, having got Abdelrahman, the possessor at that time, exiled, procured himself to be elected in his room.

10
He ba-
nis, but
ret s, and
thr off
the rkish
yok

However, he soon shared the fate of the rest, being condemned to retire to Gaza. The place, being under the dominion of a Turkish pacha, was by no means agreeable, for which reason Ali having turned off to another place, kept himself concealed for some time, until in 1766 his friends at Cairo procured his recal. On this he appeared suddenly in that city; and in one night killed four of the beys who were inimical to his designs, banished the rest, and assumed the whole power to himself. Still, however, his ambition was not satisfied; and he determined on nothing less than to throw off his dependence on the Porte altogether, and become sultan of Egypt. With this view he expelled the pacha, refused to pay the accustomed tribute, and in the year 1768 proceeded to coin money in his own name. The Porte being at that time on the eve of a dangerous war with Russia, had not leisure to attend to the proceedings of Ali Bey; so that the latter had an opportunity of going forward with his enterprises very vigorously.

11
Ove omes
an bian
prin

His first expedition was against an Arabian prince named *Hammam;* against whom he sent his favourite Mohammed Bey, under pretence that the former had concealed a treasure entrusted to him by Ibrahim Kiaya, and that he afforded protection to rebels.

2
Pro es to
ma Mec-
ca em-
por of
Ea ndian
con rce.

Having destroyed this unfortunate prince, he next began to put in execution a plan proposed to him by a young Venetian merchant, of rendering Jedda, the port of Mecca, an emporium for all the commerce of India; and even imagined he should be able to make the Europeans abandon the passage to the Indies by the Cape of Good Hope. With this view he fitted out some vessels at Suez; and manning them with Mamlouks, commanded the bey Hassan to sail with them to Jedda, and seize upon it, while a body of cavalry under Mohammed Bey advanced against the town. Both these commissions were executed according to his wish, and Ali became quite intoxicated with his success. Nothing but ideas of conquest now occupied his mind, without considering the immense disproportion between his own force and that of the grand signior. Circumstances, it must be owned, were at that time very favourable to his schemes. The sheik Daher was in rebellion against the Porte in Syria; and the pacha of Damascus had so exasperated the people by his extortions, that they were ready for a revolt.

113
His expedition into Syria.

Having therefore made the necessary preparations, Ali Bey despatched in 1770 about 500 Mamlouks to take possession of Gaza, and thus secure an entrance into Palestine. Osman, the pacha of Damascus, however, no sooner heard of the invasion, than he prepared for war with the utmost diligence, while the troops of Ali Bey held themselves in readiness to fly on the first attack. They were relieved from their embarrassment by Sheik Daher, who hastened to their assistance, while Osman fled without even offering to make the least resistance; thus leaving the enemy masters of all Palestine without striking a stroke. About the end of February 1771, the grand army of Ali Bey arrived; which, by the representation made of it in Europe, was supposed to consist of 60,000 men.

114
Volney's account of his army.

M. Volney, however, informs us, that this army was far from containing 60,000 soldiers; though he allows that there might be two-thirds of that number, who were classed as follows: 1. Five thousand Mamlouks, constituting the whole effective part of the army. 2. Fifteen hundred Arabs from Barbary on foot, constituting the whole infantry of the army. Besides these, the servants of the Mamlouks, each of whom had two, would constitute a body of 10,000 men. A number of other servants would constitute a body of 2000: and the rest of the number would be made up by sutlers and other usual attendants on armies. It was commanded by Mohammed Bey the friend of Ali. "But (says our author) as to order and discipline, these must not be mentioned. The armies of the Turks and Mamlouks are nothing but a confused multitude of horsemen, without uniforms, on horses of all colours and sizes, without either keeping their ranks or observing any regular order." This rabble took the road to Acre, leaving wherever they passed sufficient marks of their rapacity and want of discipline. At Acre a junction was formed with the troops of Sheik Daher, consisting of 1500 Safadians (the name of Sheik Daher's subjects, from *Safad*, a village of Galilee, originally under his jurisdiction). These were on horseback, and accompanied by 1200 Motualis cavalry under the command of Sheik Nasif, and about 1000 Mogrebian infantry. Thus they proceeded towards Damascus, while Osman prepared to oppose them by another army equally numerous and ill regulated: and M. Volney gives the following description of their operations:

115
Their absurd method of carrying on war.

"The reader must not here figure to himself a number of complicated and artificial movements: such as those which, within the last century, have reduced war with us to a science of system and calculation. The Asiatics are unacquainted with the first elements of this conduct. Their armies are mere mobs, their marches ravages, their campaigns inroads, and their battles bloody frays. The strongest or the most adventurous party goes in quest of the other, which frequently flies without making any resistance. If they stand their ground, they engage pell-mell, discharge their carabines, break their spears, and hack each other with their sabres; for

for they have seldom any cannon, and when they have, they are but of little service. A panic frequently diffuses itself without cause; one party flies, the other shouts victory; the vanquished submit to the will of the conqueror, and the campaign often terminates without a battle.

"Such, in a great measure, were the military operations in Syria in the year 1771. The combined army of Ali Bey and Sheik Daher marched to Damascus. The pachas waited for them; they approached, and, on the 6th of June, a decisive action took place: the Mamlouks and Safadians rushed on the Turks with such fury, that, terrified at their courage, they immediately took to flight, and the pachas were not the last in endeavouring to make their escape. The allies became masters of the country, and took possession of the city without opposition, there being neither walls nor soldiers to defend it. The castle alone resisted. Its ruined fortifications had not a single cannon, much less gunners; but it was surrounded by a muddy ditch, and behind the ruins were posted a few musketeers; and these alone were sufficient to check this army of cavalry. As the besieged, however, were already conquered by their fears, they capitulated the third day, and the place was to be surrendered next morning, when, at day-break, a most extraordinary revolution took place.

116
Defection of Ali Bey's general.

This was no less than the defection of Mohammed Bey himself, whom Osman had gained over in a conference during the night. At the moment, therefore, that the signal of surrender was expected, this treacherous general sounded a retreat, and turned towards Egypt with all his cavalry, flying with as great precipitation as if he had been pursued by a superior army. Mohammed continued his march with such celerity, that the report of his arrival in Egypt reached Cairo only six hours before him. Thus Ali Bey found himself at once deprived of all his expectations of conquest; and what was worse, found a traitor whom he durst not punish at the head of his forces. A sudden reverse of fortune now took place. Several vessels laden with corn for Sheik Daher were taken by a Russian privateer; and Mohammed Bey, whom he designed to have put to death, not only made his escape, but was so well attended that he could not be attacked. His followers continuing daily to increase in number, Mohammed soon became sufficiently strong to march towards Cairo; and, in the month of April 1772, having defeated the troops of Ali in a rencounter, entered the city sword in hand, while the latter had scarce time to make his escape with 800 Mamlouks. With difficulty he was enabled to get to Syria by the assistance of Sheik Daher, whom he immediately joined with the troops he had with him. The Turks under Osman were at that time besieging Sidon, but raised the siege on the approach of the allied army, consisting of about 7000 cavalry. Though the Turkish army was at least three times their number, the allies did not hesitate to attack them, and gained a complete victory. Their affairs now began to wear a more favourable aspect; but the military operations were retarded by the siege of Yafa, a place which had revolted; and which, though defended only by a garden wall, without any ditch, held out for eight months. In the beginning of 1773 it capitulated, and Ali Bey began to think of returning to Cairo. For this purpose Sheik Daher had promised to furnish him with succours; and the Russians, with whom he had now contracted an alliance, made him a promise of the like kind. Ali, however, ruined every thing by his own impatience. Deceived by an astrologer, who pretended that the auspicious moment when he was highly favoured by the stars had just arrived, he would needs set out without waiting for the arrival of his allies. He was also farther deceived by a stratagem of Mohammed, who had by force extorted from the friends of Ali Bey letters pressing his return to Cairo, where the people were wearied of his ungrateful slave, and wanted only his presence in order to expel him. Confiding in these promises, Ali Bey imprudently set out with his Mamlouks and 1500 Safadians given him by Daher; but had no sooner entered the desert which separates Gaza from Egypt, than he was attacked by a body of 1000 chosen Mamlouks who were lying in wait for his arrival. They were commanded by a young bey, named *Mourad;* who being enamoured of the wife of Ali Bey, had obtained a promise of her from Mohammed, in case he could bring him her husband's head. As soon as Mourad perceived the dust by which the approach of Ali Bey's army was announced, he rushed upon him, attacked, and took prisoner Ali Bey himself, after wounding him in the forehead with a sabre. Being conducted to Mohammed Bey, the latter pretended to treat him with extraordinary respect, and ordered a magnificent tent to be erected for him; but in three days he was found dead of his wounds, as was given out; though some affirm, perhaps with equal reason, that he was poisoned.

117
He is driven out of Cairo, and with difficulty gets into Syria.

118
Defeats the Turks, and retrieves his affairs.

119
He is ruin
ed by his
own impa-
tience;

120
Is succeed
ed by Mu
hamed B

After the death of Ali Bey, Mohammed Bey took upon him the supreme dignity; but this change of masters proved of very little service to the Egyptians. At first he pretended to be only the defender of the rights of the sultan, remitted the usual tribute to Constantinople, and took the customary oath of unlimited obedience; after which he solicited permission to make war upon Sheik Daher, the ally of Ali Bey. The reason of this request was a mere personal pique; and as soon as it was granted, he made the most diligent preparations for war. Having procured an extraordinary train of artillery, he provided foreign gunners, and gave the command of them to an Englishman named *Robinson.* He brought from Suez a cannon 16 feet long, which had for a considerable time remained useless; and at length, in the month of February 1776, he appeared in Syria with an army equal in number to that which he had formerly commanded when in the service of Ali Bey. Daher's forces, despairing of being able to cope with such a formidable armament, abandoned Gaza, which Mohammed immediately took possession of, and then marched towards a fortified town named Yafa. The history of this siege M. Volney gives as a specimen of the Asiatic manner of conducting operations of that kind. "Yafa (says he), the ancient Joppa, is situated on a part of the coast, the general level of which is very little above the sea. The city is built on an eminence, in the form of a sugar loaf, in height about 130 feet perpendicular. The houses distributed on the declivity, appear rising above each other, like the steps of an amphitheatre. On the summit is a small citadel, which commands the town; the bottom of the hill is surrounded by a wall without a rampart, of 12 or 14 feet high, and two or three in thickness.

121
His expec
tion agai
Sheik
Daher.

122
Accoun
the sieg
Yafa:
specim
the Asi
method
besiegi
towns.

thickness. The battlements on the top are the only tokens by which it is distinguished from a common garden wall. This wall, which has no ditch, is environed by gardens, where lemons, oranges, and citrons, grow in this light soil to a most prodigious size. The city was defended by five or six hundred Safadians and as many inhabitants, who, at the sight of the enemy, armed themselves with their sabres and muskets; they had likewise a few brass cannon, 24 pounders, without carriages; these they mounted as well as they could, on timbers prepared in a hurry; and supplying the place of experience by hatred and courage, they replied to the summons of the enemy with menaces and cannon shot.

"Mohammed, finding he must have recourse to force, formed his camp before the town; but was so little acquainted with the business in which he was engaged, that he advanced within half cannon shot. The bullets, which showered upon the tents, apprizing him of his error, he retreated; and, by making a fresh experiment, was convinced he was still too near. At length he discovered the proper distance, and set up his tent, in which the most extravagant luxury was displayed: around it, without any order, were pitched those of the Mamlouks, while the Barbary Arabs formed huts with the trunks and branches of the orange and lemon trees, and the followers of the army arranged themselves as they could: a few guards were distributed here and there; and without making a single entrenchment, they called themselves encamped.

"Batteries were now to be erected; and a spot of rising ground was made choice of to the south-eastward of the town, where, behind some garden walls, eight pieces of cannon were pointed, at 200 paces from the town; and the firing began, notwithstanding the musquetry of the enemy, who, from the tops of the terraces, killed several of the gunners.

"It is evident that a wall only three feet thick, and without a rampart, must soon have a large breach in it; and the question was not how to mount, but how to get through it? The Mamlouks were for doing it on horseback; but they were made to comprehend that this was impossible; and they consented, for the first time, to march on foot. It must have been a curious sight to see them, with their huge breeches of thick Venetian cloth, embarrassed with their tucked-up *beniches*, their crooked sabres in hand, and pistols hanging at their sides, advancing and tumbling among the ruins of the wall. They imagined that they had conquered every difficulty when this obstacle was surmounted; but the besieged who formed a better judgment, waited till they arrived at the empty space between the city and wall; where they assailed them from the terraces and windows of the houses with such a shower of bullets, that the Mamlouks did not so much as think of setting them on fire, but retired under a persuasion that the breach was utterly impracticable, since it was impossible to enter it on horseback. Morad Bey brought them several times back to the charge, but in vain.

"Six weeks passed in this manner; and Mohammed was distracted with rage, anxiety, and despair. The besieged, however, whose numbers were diminished by the repeated attacks, became weary of defending alone the cause of Daher. Some persons began to treat with the enemy; and it was proposed to abandon the place, on the Egyptians giving hostages. Conditions were agreed upon, and the treaty might be considered as concluded, when, in the midst of the security occasioned by this belief, some Mamlouks entered the town; numbers of others followed their example, and attempted to plunder. The inhabitants defended themselves, and the attack recommenced: the whole army then rushed into the town, which suffered all the horrors of war; men, women, and children, young and old, were all cut to pieces, and Mohammed, equally mean and barbarous, caused a pyramid formed of the heads of these unfortunate sufferers to be raised as a monument of his victory."

123 The town taken and the inhabitants massacred.

By this disaster the greatest terror and consternation were everywhere diffused. Sheik Daher himself fled, and Mohammed soon became master of Acre also. Here he behaved with his usual cruelty, and abandoned the city to be plundered by his soldiers. The French merchants claimed an exemption, and it was procured with the utmost difficulty: nor was even this likely to be of any consequence; for Mohammed, informed that the treasures of Ibrahim kiaya of Daher had been deposited in that place, made an immediate demand of them, threatening every one of the merchants with death if the treasures were not instantly produced. A day was appointed for making the search; but before this came, the tyrant himself died of a malignant fever after two days illness. His death was no sooner known than the army made a precipitate retreat, such as has been already mentioned from Damascus. Sheik Daher continued his rebellion for some time, but was at last entirely defeated, and his head sent to Constantinople by Hassan Pacha the Turkish high-admiral.

124 Death of Mohammed Bey.

125 History of Egypt from that time to the year 1786.

The death of Mohammed was no sooner known in Egypt, than Morad Bey hastened to Cairo in order to dispute the sovereignty with Ibrahim Bey, who had been intrusted with the government on his departure from that place for Syria. Preparations for war were made on both sides; but at last, both parties finding that the contest must be attended with great difficulty, as well as very uncertain in the event, thought proper to come to an accommodation, by which it was agreed that Ibrahim should retain the title of Sheik El Beled, and the power was to be divided between them. But now the beys and others who had been promoted by Ali Bey, perceiving their own importance totally annihilated by this new faction, resolved to shake off the yoke, and therefore united in a league under the title *of the house of Ali Bey*. They conducted their matters with so much silence and dexterity, that both Morad and Ibrahim were obliged to abandon Cairo. In a short time, however, they returned and defeated their enemies though three times their number; but notwithstanding this success, it was not in their power totally to suppress the party. This indeed was owing entirely to their unskilfulness in the art of war, and their operations for some time were very trifling. At last, a new combination having been formed among the beys, five of them were sentenced to banishment in the Delta. They pretended to comply with this order, but took the road of the Desert of the Pyramids, through which they were pursued for three days to no purpose. At last they arrived safe at *Miniah*, a village situated on the Nile, 40 leagues above Cairo.

Here

Here they took up their residence, and being masters of the river, soon reduced Cairo to distress by intercepting its provisions. Thus a new expedition became necessary, and Ibrahim took the command of it upon himself. In the month of October 1783 he set out with an army of 3000 cavalry; the two armies soon came in sight of each other, but Ibrahim thought proper to terminate the affair by negociation. This gave such offence to Morad, who suspected some plot against himself, that he left Cairo. A war betwixt the two rivals was now daily expected, and the armies continued for 25 days in sight of each other, only separated by the river. Negociations took place; and the five exiled beys, finding themselves abandoned by Morad, took to flight, but were pursued and brought back to Cairo. Peace seemed now to be re-established; but the jealousy of the two rivals producing new intrigues, Morad was once more obliged to leave Cairo in 1784. Forming his camp, however, directly at the gates of the city, he appeared so terrible to Ibrahim, that the latter thought proper in his turn to retire to the desert, where he remained till March 1785. A new treaty then took place; by which the rivals agreed to share the power between them, though there was certainly very little probability that such a treaty would be long observed. Since that time we have no accounts of any remarkable transactions in Egypt; nor indeed can we reasonably expect any thing of consequence in a country where matters are managed, as M. Volney expresses himself, by a series of "cabals, intrigues, treachery, and murders."

Of late Egypt has been visited by several travellers, all of whom have published descriptions of the country, its productions, inhabitants, &c. The latest are M. Savary, M. Volney, the baron de Tott, and Mr Bruce; and from the accounts published by those gentlemen the following geographical description is principally compiled.

126 Account of the country.

This country is still divided into two principal parts, called the *Upper* and *Lower Egypt*. According to M. Savary, the former is only a long narrow valley beginning at Syene and terminating at Cairo. It is bounded by two chains of mountains running from north to south, and taking their rise from the last cataract of the Nile. On reaching the latitude of Cairo they separate to the right and left; the one taking the direction of Mount Colzoum, the other terminating in some sand banks near Alexandria; the former being composed of high and steep rocks, the latter of sandy hillocks over a bed of calcareous stone. Beyond these mountains are deserts bounded by the Red sea on the east, and on the west by other parts of Africa; having in the middle that long plain which, even where widest, is not more than nine leagues over. Here the Nile is confined in its course betwixt these insuperable barriers, and during the time of its inundation overflows the country all the way to the foot of the mountains; and Mr Bruce observes that there is a gradual slope from the bed of the river to those mountains on both sides. The baron de Tott says, that the mountains four leagues from the Nile, and facing Cairo, "are only a ridge of rocks of about 40 or 50 feet high, which divide Egypt from the plains of Libya; which ridge accompanies the course of the river, at a greater or lesser distance, and seems as if only intended to serve as a bank to the general inundation."

Lower Egypt, according to M. Savary, comprehends all the country between Cairo, the Mediterranean, the isthmus of Suez and Libya. "This immense plain (says he) presents on the borders of its parching sands a strip of lands cultivated along the canals of the river, and in the middle a triangular island to which the Greeks gave the name of *Delta;* at the top of the angle of which the baron de Tott informs us the rocks of Libya and the coasts of Arabia open and recede from each other towards the east and west, parallel to the Mediterranean. This great extent of country, from the kingdom of Barca to Gaza, is either overflowed by the river, or capable of being so; which thus fertilizes in a high degree a tract of country seemingly devoted to perpetual barrenness on account of the want of rain and the heat of the climate."

127 Coast of E gypt extremely low.

According to the testimonies of both Mr Bruce and M. Volney, the coast of Egypt is so extremely low, that it cannot be discovered at sea till the mariners come within a few leagues of it. In ancient times the sailors pretended to know when they approached this country, by a kind of black mud brought up by their sounding line from the bottom of the sea; but this notion, though as old as the days of Herodotus, has been discovered to be a mistake by Mr Bruce; who found the mud in question to arise while the vessel was opposite to the deserts of Barca. All along the coast of Egypt a strong current sets to the eastward.

128 Of the fe tility of a cient and modern Egypt.

In former times Egypt was much celebrated for its fertility; and there is great reason to believe, that were the same pains bestowed upon the cultivation of the ground, and the distribution of the waters of the Nile in a proper manner, the same fertility would still be found to remain. The cause of decrease in the produce of Egypt we shall describe in the words of M. Savary. "The canals," says he, speaking of the Delta, "which used to convey fertility with their waters, are now filled. The earth no longer watered, and continually exposed to the burning ardour of the sun, is converted into a barren sand. In those places where formerly were seen rich fields and flourishing towns, on the Pelusiac, the Tarictic, and the Mendesian branches, which all strike out from the canal of Damietta, nothing is to be found at this day but a few miserable hamlets, surrounded by date trees and by deserts. These once navigable canals are now no more than a vain resemblance of what they were: they have no communication with the lake Menzall, but what is merely temporary, on the swelling of the Nile; they are dry the remainder of the year. By deepening them by removing the mud deposited by the river since the Turks have made themselves masters of Egypt, the country they pass through would be again fertilized, and the Delta recover a third of its greatness."

129 Savary accoun the for tion of Delta.

Concerning this island it has been the opinion of a great many, even from very ancient times, that it was produced by the mud brought down by the inundations of the Nile: and this opinion we find adopted in the strongest manner by M. Savary. His account of the supposed rise of the Delta, and indeed of the greatest part of Egypt, is to the following purpose. In

In those early ages where history has not fixed any epoch, a certain people descended from the mountains near the cataracts into the valley overflowed by the Nile, and which was then an uninhabitable morass overgrown with reeds and canes. In what manner, or from what motive, these people were induced to descend from their ancient habitations to such a place, or how they found means to penetrate into a morass which he expressly tells us was *impenetrable*, we are not informed, neither is it to our present purpose to inquire. At that time, however, the sea bathed the feet of those mountains where the pyramids are built, and advanced far into Libya. It covered also part of the isthmus of Suez, and every part of what we now call the Delta formed a great gulf. After many ages the Egyptians, by what means is unknown, at least not specified by our author (though they ought to have been so, as the country it seems was then overflowed not only by the river but by the ocean), formed canals to carry off the stagnant waters of the Nile; opposed strong dykes to its ravages; and, tired of dwelling in the caverns of rocks, built towns and cities upon spots elevated either by nature or art. Already the river was kept within its bounds, the habitations of men were out of the reach of its inundations, and experience had taught the people to foresee and announce them. One of the kings of Egypt undertook to change the course of the river. After running 250 leagues between the barriers already mentioned, meeting with an unsurmountable obstacle to the right, it turned suddenly to the left; and taking its course to the southward of Memphis, it spread its waters through the sands of Libya. The prince we speak of caused a new bed to be dug for it to the east of Memphis; and by means of a large dyke obliged it to return between the mountains, and discharge itself into the gulf that bathes the rock on which the castle of Cairo is built. The ancient bed of the river was still to be seen in the time of Herodotus, and may even be traced at this day across the deserts, passing to the westward of the lakes of natrum. The Arabs still bestow upon it the name of *Bahr Belama*, " or sea without water," and it is now almost choked up. To the labours of this monarch Egypt is indebted for the Delta. A reflux of the sea was occasioned by the enormous weight of the waters of the Nile, which precipitated themselves into the bottom of the gulf. Thus the sands and mud carried along with them were collected into heaps; and thus the Delta, at first very inconsiderable, rose out of the sea, of which it repelled the limits. It was a gift of the river, and it has since been defended from the attacks of the ocean by raising dykes around it. Five hundred years before the Trojan war, according to Herodotus, the Delta was in its infancy; eight cubits of water being then sufficient to overflow it. Strabo tells us, that boats passed over it from one extremity to the other; and that its towns, built upon artificial eminences, resembled the islands of the Egean sea. At the time that Herodotus visited this country, 15 cubits were necessary to cover all the Lower Egypt; but the Nile then overflowed the country for the space of two days journey to the right and left of the island. Under the Roman empire 16 cubits performed the same effect. When the Arabs came to have the dominion, 17 cubits were requisite; and at this day 18 are necessary to produce a plentiful crop; but the inundation stops at Cairo and the neighbouring country, without being extended over the Lower Egypt. Sometimes, however, the Nile rises to 22 cubits; and the cause of this phenomenon is the mud for so many years accumulated on the island. Here, in the space of 3284 years, we see the Delta elevated 14 cubits. Our author wrote in 1777, and informs us that he twice made the tour of the island during the time of the inundation. " The river (says he) flowed in full streams in the great branches of Rosetta and Damietta, as well as in those which pass through the interior part of the country; but did not overflow the lands, except in the lower parts, where the dykes were pierced for the purpose of watering the plantations of rice. We must not, however, imagine, as several travellers pretend, that this island will continue to rise, and that it will become unfruitful. As it owes its increase to the annual settling of the mud conveyed thither by the Nile, when it ceases to be overflowed it will no longer increase in height, for it is demonstrated that culture is not sufficient to raise land.

" It is natural to imagine that the Delta has increased in length as well as in height; and of this we may look upon the following fact to be a remarkable proof. Under the reign of Psammiticus, the Milesians, with 30 vessels, landed at the mouth of the Bolbitine branch of the Nile, now called that of *Rosetta*, where they fortified themselves. There they built a town called *Metelis*, the same as *Faoüe*, which, in the Coptic vocabularies, has preserved the name of *Messil.* This town, formerly a sea-port, is now nine leagues distant from the sea; all which space the Delta has increased in length from the time of Psammiticus to the present. Homer, in his Odyssey, puts the following words in the mouth of Menelaus. ' In the stormy sea which washes Egypt there is an island called *Pharos.* Its distance from the shore is such, that a vessel with a fair wind may make the passage in a day.' From the way in which he speaks of this island in other places, also, we may suppose that the island of Pharos, in his time, was not less than 20 leagues distant from the Egyptian coast, though now it forms the port of Alexandria; and this sentiment is confirmed by the most ancient writers.

" What prodigious changes great rivers occasion on the surface of the globe! How they elevate, at their mouths, islands which become at length large portions of the continent! It is thus that the Nile has formed almost all the Lower Egypt, and created out of the waters the Delta, which is 90 leagues in circumference. It is thus that the Meander, constantly repelling the waves of the Mediterranean, and gradually filling up the gulf into which it falls, has placed in the middle of the land the town of Miletus, formerly a celebrated harbour. It is thus that the Tigris and the Euphrates, let loose from the Armenian hills, and sweeping with them in their course the sands of Mesopotamia, are imperceptibly filling up the Persian gulf."

130
Mr Bruce's reasons for the contrary opinion.

These are the reasons assigned by M. Savary for thinking that the Delta, as well as the greatest part of the Lower Egypt, had been produced by the Nile; but this opinion is violently contested by other travellers, particularly Mr Bruce, who has given a pretty long dissertation upon it, as well as many occasional

sional remarks through the course of his work. He begins with observing, 1. That the country of Egypt is entirely a valley bounded by rugged mountains; whence it might seem natural to imagine that the Nile, overflowing a country of this kind, would be more ready to wash away the soil than add to it. 2. It is observed by Dr Shaw, and the same is confirmed by our author, that there is a gentle slope from the middle of the valley to the foot of the mountains on each side; so that the middle, in which is the channel of the Nile, is really higher than any other part of the valley. Large trenches are cut across the country from the channel of the river, and at right angles with it, to the foot of the mountains. 3. As the river swells, the canals become filled with water, which naturally descending to the foot of the mountains, runs out at the farther end, and overflows the adjacent level country. 4. When the water, having attained the lowest ground, begins to stagnate, it does not acquire any motion by reason of the canal's being at right angles with the channel of the Nile, unless in the case of excessive rains in Ethiopia, when the water by its regurgitation again joins the stream. In this case, the motion of the current is communicated to the whole mass of waters, and every thing is swept away by them into the sea. 5. It has been the opinion of several authors, that there was a necessity for measuring the height of the inundation on account of the quantity of mud brought down annually by the waters, by which the landmarks were so covered that the proprietors could not know their own grounds after the river subsided. But whatever might be the reason of this covering of the landmarks in ancient times, it is certain that the mud left by the Nile could not be so in the time of Herodotus, or during any period of time assigned by that historian; for he assigns only one foot of increase of soil throughout Egypt in an hundred years from the mud left by the river; the increase during one year, therefore, being only the hundredth part of a foot, could not cover any landmark whatever. Besides, the Egyptian lands are at this day parted by huge blocks of granite, which frequently have gigantic heads at the end of them: and these could not, at the rate mentioned by Herodotus, be covered in several thousand years. 6. The Nile does not now bring down any great quantity of mud; and it is absurd to suppose that it can at present bring down as much as it did soon after the creation, or the ages immediately succeeding the deluge. Throughout Abyssinia, according to the testimony of our author, the channel of every torrent is now worn to the bare rock, and almost every rivulet runs in a hard stony bed, all the loose earth being long ago washed away; so that an annual and equable increase of the earth from the sediment of the waters is impossible. 7. Our author made a great number of trials of the water of the Nile during the time of its inundation in different places. At Basboch, when just coming down from the cultivated parts of Abyssinia, and before it enters Sennaar, the sediment is composed of fat earth and sand, and its quantity is exceedingly small. At the junction of the Nile and Astaboras the quantity of sediment is very little augmented; consisting still of the same materials, but now mostly sand. At Syene the quantity of sediment was almost nine times greater than before; but was now composed almost entirely of sand, with a very small quantity of black earth. The conclusion of our author's experiments, however, is different from what we should have been led to expect from those just mentioned. "The experiment at Rosetta (says he) was not so often repeated as the others: but the result was, that in the strength of the inundation the sediment consisted mostly of sand; and, towards the end, was much the greater part earth. I think these experiments conclusive, as neither the Nile coming fresh from Abyssinia, nor the Atbara, though joined by the Mareb, likewise from the same country, brought any great quantity of soil from thence."

8. Our author goes on to observe, that had the Nile brought down the quantities of mud which it has been said to do, it ought to have been most charged with it at Syene; as there it contained the whole that was to be conveyed by it into Egypt. Instead of this, however, the principal part of the sediment at this place was sand; and this is very naturally accounted for from the vast quantities of sand taken up by the winds in the deserts between Gooz and Syene. Here our traveller frequently saw vast pillars of this kind of sand, which is so fine and light as to form an impalpable powder, traversing the desert in various directions. Many of these were driven upon the river; and when it became calm in the evening, fell down into it entirely; thus affording materials for many sandy islands to be met with in the Nile.

9. Mr Bruce adopts the opinion of those who suppose that there has been a continual decrease of water since the creation of the world. In this case, therefore, if the land of Egypt had been continually increasing in height while the water that was to cover it decreased; there must have been frequent famines on account of the want of a sufficient inundation. But so far is this from being the case, that, according to the testimony of several Arabian MSS. there had not, when Mr Bruce was in Egypt, been one scarce season from the lowness of the inundation for 34 years; though during the same space they had three times experienced famine by too great an abundance of water, which carried away the millet.

10. If there had been such an increase of land as Herodotus and others suppose, it must now have been very perceptible in some of the most ancient public monuments. This, however, is by no means the case. The base of every obelisk in Upper Egypt is to this day quite bare and visible. Near Thebes there are still extant two colossal statues, plainly designed for nilometers, and which ought by this time to have been almost covered with earth; but notwithstanding the length of time these have remained there, they are still bare to the very base.

131 Opinio various thors c cerning rise of Nile i cient t

The strongest arguments which the advocates for the increase of land in Egypt can make use of is, that the measures by which the quantity of inundation is determined are smaller now than in former times; and these small measures are said to have been introduced by the Saracens. On this Mr Bruce very justly observes, that such an expedient could not have answered any good purpose; as no decrease of the measure could have augmented the quantity of corn produced by the ground. M. Savary observes, that, to render his calculation concerning the growth of land in Egypt absolutely exact, it would be necessary to determine the

the precise length of the Greek, Roman, and Arabian cubit; and even to know the different alterations which that measure had undergone among those people: But this nicety he thinks needless, looking upon the general fact to be fully established by what he had said before. Mr Bruce, however, has treated the subject with much greater accuracy. He observes, that from the situation of Canopus, the distance betwixt Egypt and Cyprus, and the extension of the land to the northward, it appears that no addition of any consequence had been made to it for 3000 years past. The only argument left for the increase of land therefore must be taken from the nilometer. The use of this instrument was to determine the quantity of inundation, that so it might be known whether the crop would be sufficient to enable the people to pay the taxes exacted of them by the sovereign or not. The first step was to know what space of ground was overflowed in a given number of years; and this being determined by mensuration, the next thing was to ascertain the produce of the ground upon an average. Thus becoming acquainted with the greatest and least crops produced, together with the exact extent of ground overflowed, they were furnished with all the necessary principles for constructing a nilometer; and nothing now remained but to erect a pillar in a proper place, and divide it exactly into cubits. This was accordingly done; the pillar was first divided into cubits, and these again were subdivided into digits. The first division of this kind was undoubtedly that mentioned in Scripture, and called the *cubit of a man;* being the length of the arm from the middle of the round bone in the elbow to the point of the middle finger; a measure still in use among all rude nations. As no standard could be found by which this measure might be exactly determined, authors have differed very much concerning the true length of the cubit when reduced to our feet and inches. Dr Arbuthnot reckons two cubits mentioned in Scripture; one of them containing one foot nine inches and $\frac{888}{1000}$ of an inch; the other one foot and $\frac{824}{1000}$ of a foot; but Mr Bruce is of opinion that both of these are too large. He found, by mensuration, the Egyptian cubit to be exactly one foot five inches and three-fifths of an inch; and Herodotus mentions, that in his time the cubit used for determining the increase of the Nile was the Samian cubit, about 18 of our inches. The latter also informs us, that in the time of Moeris, the minimum of increase was 8 cubits, at which time all Egypt below the city of Memphis was overflowed; but that in his time 16 or at least 15 cubits were necessary to produce the same effect. But to this account Mr Bruce objects, that Herodotus could have no certain information concerning the nilometer, because he himself says that the priests, who alone had access to it, would tell him nothing of the matter. Herodotus also informs us, that in the time of Moeris, great lakes were dug to carry off the waters of the inundation; and this superfluous quantity Mr Bruce supposes to have been conveyed into the desert for the use of the Arabs, and that by such a vast drain the rise of the water on the nilometer would undoubtedly be diminished. But even granting that there was such a difference between the rise of the water in the time of Moeris and in that of Herodotus, it does not appear that any thing like it has appeared ever since. Strabo, who travelled into Egypt 400 years after the time of Herodotus, found that eight cubits were then the minimum, as well as in the time of Moeris. From some passages in Strabo, however, it appears that it required a particular exertion of industry to cause this quantity of water produce a plentiful crop; but there is not the least reason to suppose, that the very same industry was not necessary in the time of Moeris; so that still there is not any increase of land indicated by the nilometer. About 100 years afterwards, when the emperor Adrian visited Egypt, we are informed from unquestionable authority, that 16 cubits were the minimum when the people were able to pay their tribute; and in the fourth century, under the emperor Julian, 15 cubits were the standard; both which accounts correspond with that of Herodotus. Lastly, Procopius, who lived in the time of Justinian, informs us, that 18 cubits were then requisite for a minimum.

132
No increase of land in these ages can reasonably be supposed;

From these accounts, so various and discordant, it is obvious that no certain conclusion can be drawn. It is not indeed easy to determine the reason of this difference in point of fact. The only conjecture we can offer is, that as it appears that by proper care a smaller quantity of water will answer the purpose of producing a plentiful crop, so it is not unreasonable to suppose that at different periods the industry of the people has varied so much as to occasion the disagreement in question. This would undoubtedly depend very much upon their governor; and indeed Strabo informs us that it was by the care of the governor Petronius, that such a small quantity of water was made to answer the purpose. The conclusion drawn by Mr Bruce from the whole of the accounts above related, is, that from them it is most probable that no increase of land has been indicated by the nilometer from the time of Moeris to that of Justinian.

133
nor in more modern times.

On the conquest of Egypt by the Saracens, their barbarous and stupid caliph destroyed the nilometer, causing another to be built in its stead, and afterwards fixed the standard of paying tribute considerably below what it had usually been. The Egyptians were thus kept in continual terror, and constantly watched the new nilometer to observe the gradual increase or decrease of the water. On this he ordered the new nilometer to be destroyed, and another to be constructed, and all access to it to be denied to the people. Which prohibition is still continued to Christians; though our author found means to get over this obstacle, and has given a figure of the instrument itself. That the people might not, however, be supposed to remain in total ignorance of their situation, he commanded a proclamation to be daily made concerning the height of the water, but in such an unintelligible manner that nobody was made any wiser; nor, according to our author, is the proclamation understood at this day. From his own observations, however, Mr Bruce concludes, that 15 cubits are now the minimum of inundation, and as this coincides with the accounts of it in the times of Herodotus and Adrian, he supposes with great probability, that the same quantity of water has been necessary to overflow this country from the earliest accounts to the present time.

It now remains only to take notice of what is said by M. Savary concerning the former distance of the island of Pharos from the land to which it is now joined.

134
M. Savary's opinion concerning the isle of Pharos refuted by M. Volney.

With regard to his other assertions concerning the city of Metelis having been once a sea port, M. Volney proves that he has quoted Strabo unfairly, and consequently no stress is to be laid upon them. The principal, indeed the only, evidence which therefore remains, is the passage already quoted from Homer, viz. that "the island of Pharos is as far distant from one of the mouths of the Nile as a vessel can sail in one day before the wind." "But (says M. Volney) when Homer speaks of the distance of this island, he does not mean its distance from the shore opposite, as that traveller (M. Savary) has translated him, but from the land of Egypt and the river Nile. In the second place, by a day's sail we must not understand that indefinite space which the vessels, or rather the boats of the ancient Greeks, could pass through in a day; but an accurate and determined measure of 540 stadia. This measure is ascertained by Herodotus, and is the precise distance between Pharos and the Nile, allowing, with M. d'Anville, 27,000 toises to 540 stadia. It is therefore far from being proved, that the increase of the Delta or of the continent was so rapid as has been represented; and, if we were disposed to maintain it, we should still have to explain how this shore, which has not gained half a league from the days of Alexander, should have gained eleven in the far shorter period from the time of Menelaus to that conqueror. The utmost extent of the encroachment of this land upon the sea, however, may be learned from the words of Herodotus; who informs us, that "the breadth of Egypt, along the sea coast, from the gulf of Plinthine to the lake Serbonis near Mount Casius, is 3600 stadia; and its length from the sea to Heliopolis 1500 stadia." Allowing therefore the stadium of Herodotus to be between 50 and 51 French toises, the 1500 stadia just mentioned are equal to 76,000 toises; which at the rate of 57,000 to a degree, gives one degree and near 20 minutes and a half. But from the astronomical observations of M. Niebuhr, who travelled for the king of Denmark in 1761, the difference of latitude between Heliopolis, now called *Matarea*, and the sea, being one degree 29 minutes at Damietta, and one degree 24 minutes at Rosetta, there is a difference on one side of three minutes and a half, or a league and a half encroachment; and eight minutes and a half, or three leagues and a half, on the other."

Thus the dispute concerning the augmentation of the land of Egypt by the Nile seems to be absolutely decided; and the encroachments of it on the sea so trifling, that we may justly doubt whether they exist, or whether we are not entirely to attribute the apparent differences to those which certainly take place betwixt the ancient and modern mensuration. M. Volney gives a very particular description of the face of the country; but takes notice of the inconveniences under which travellers labour in this country, by which it is rendered extremely difficult to say any thing certain with regard to the nature of the soil or mineral productions. These arise from the barbarity and superstition of the people, who imagine all the Europeans to be magicians and sorcerers, who come by their magic art to discover the treasures which the genii have concealed under the ruins. So deep rooted is this opinion, that no person dares walk alone in the fields, nor can he find any one willing to accompany him; by which means he is confined to the banks of the river, and it is only by comparing the accounts of various travellers that any satisfactory knowledge can be acquired.

135
Volney's account the face the cou try.

According to this author, the entrance into Egypt at Rosetta presents a most delightful prospect, by the perpetual verdure of the palm trees on each side, the orchards watered by the river, with orange, lemon, and other fruit trees, which grow there in vast abundance; and the same beautiful appearance is continued all the way to Cairo. As we proceed farther up the river, he says, that nothing can more resemble the appearance of the country than the marshes of the Lower Loire, or the plains of Flanders: instead, however, of the numerous trees and country houses of the latter, we must imagine some thin woods of palms and sycamores, with a few villages of mud-walled cottages built on artificial mounds. All this part of Egypt is very low and flat, the declivity of the river being so gentle, that its waters do not flow at a greater rate than one league in an hour. Throughout the country nothing is to be seen but palm trees, single or in clumps, which become more rare in proportion as you advance; with wretched villages composed of huts with mud walls, and a boundless plain, which at different seasons is an ocean of fresh water, a miry morass, a verdant field, or a dusty desert; and on every side an extensive and foggy horizon, where the eye is wearied and disgusted. At length, towards the junction of the two branches of the river, the mountains of Cairo are discovered on the east; and to the south-west three detached masses appear, which from their triangular form are known to be the pyramids. We now enter a valley which turns to the southward, between two chains of parallel eminences. That to the east, which extends to the Red sea, merits the name of a mountain from its steepness and height, as well as that of a desert from its naked and savage appearance. Its name in the Arabic language is *Mokattam*, or the *hewn mountain*. The western is nothing but a ridge of rock covered with sand, which has been very properly termed a *natural mound* or *causeway*. In short, that the reader may at once form an idea of this country, let him imagine on one side a narrow sea and rocks; on the other, immense plains of sand; and in the middle, a river, flowing through a valley of 150 leagues in length and from three to seven wide, which at the distance of 30 leagues from the sea separates into two arms; the branches of which wander over a soil almost free from obstacles and void of declivity.

From comparing his own observations with those of other travellers, our author concludes, that the basis of all Egypt from *Asouan* (the ancient Syene) to the Mediterranean, is a continued bed of calcareous stone of whitish hue, and somewhat soft, containing the same kind of shells met with in the adjacent seas, and which forms the immense quarries extending from Saouadi to Manfalout for the space of more than 25 leagues, according to the testimony of Father Sicard.

13
Reyni

As this country has been more recently visited by men of eminent abilities and profound research, who appear to have examined every object that presented itself with a philosopher's eye, we beg leave to add to the testimonies of the authors already mentioned, the substance of the French general Reynier's account of the face of the country. He informs us, that the barriers by which Egypt is inclosed must be strong, because they have been planted by the hand of nature. It

It is separated from Asia by deserts of considerable extent; and should an hostile army attempt to approach it on that side, it would have to take its route through marshy grounds below its general level, and presenting to the traveller little else than brackish water. Its flat shore towards the Mediterranean, and the mouths of the Nile gorged up with mounds of sand, present to an enemy very few places which will be found proper for the debarkation of troops. Immense deserts constitute its natural boundaries on the west, on which account it has nothing to dread but the incursions of the Arabs from Barbary. A desert also separates Egypt from the Red sea, which gives no flattering invitations to an enemy to invade it from that quarter, the two ports of that sea being destitute of resources, and Egypt itself being the only country from which a hostile army could procure provisions and camels, sufficient to enable it to cross the desert.

In Upper Egypt, a chain of mountains present themselves to the eye of the traveller on either side of the Nile. The valley between these mountains, through which the course of the river is directed, is nearly five leagues broad, which the periodical inundations of the river completely cover. This valley alone is inhabited, and susceptible of cultivation. The eastern chain of mountains, by which the Nile is separated from the Red sea, surpasses that on the west in respect of height, terminating by precipices towards the valley, assuming in different places the appearance of an immense wall, broken irregularly by narrow valleys, which have owed their origin to the sudden and temporary torrents of winter, and serve for passes over these stupendous mountains. The western chain, by which the valley of the Nile is separated from that of Ouasis, has in general a gradual and gentle declivity, although it becomes more abrupt towards Siout, and is steep from the angle formed by the Nile towards Hennh, till it reaches Syene, at which place the mountains have a more considerable height, affording but a narrow passage to the river.

The distance between these two chains of mountains is increased as you approach Cairo, the eastern chain terminating near the extremity of the Red sea, without the appearance of any junction with the Arabian mountains, which have a similar termination. The western chain declines towards Fayoum, taking a north-west direction near Grand Cairo, and forming the Mediterranean coast in a direction to the west. Lower Egypt lies between these two great chains of mountains and the sea, which has most probably been formed, at least in a great measure, by the slime or mud which the river Nile deposits, as it is intersected by its branches, and a vast number of canals.

The seven branches by which the Nile anciently emptied itself into the Mediterranean, are at present reduced to two, viz. those of Damietta and Rosetta: There are now no vestiges of the other five, except a canal or two, which are only navigable during a part of the year. It is not improbable, that when all the branches of the Nile were entire and distinct, each of them contained about the same quantity of water. The cutting of canals to effect the equilibrium of the water, the channels of which were afterwards neglected, would diminish the quantum of water in one branch and increase it in another. The salt water mingling with the fresh, would destroy the fecundity of the ground in some places, and thus induce the inhabitants to search for habitations where they might find the earth more fertile.

It has already been observed, that the principal part of Lower Egypt owes its existence to the desposition of mud or earth by the Nile, which also formed the banks at the different mouths of that river. The mud of the Nile would first cover the low ground nearest to its bed or channel, and the increase of land from the deposition of mud would be more gradual in its progress in distant parts, from which circumstance would arise the formation of lakes. These in their turn would be gradually filled up by the land growing out of the deposited mud of the river, which of consequence would increase the boundaries of Lower Egypt, by taking from the sea; but as it is natural for the sea to resist such encroachments, it is probable that the ground formed by the deposited mud of the Nile will no longer continue to increase in one direction without diminishing in another. The experience of centuries past has fully evinced, that the sea has actually taken more from the extent of Egypt than has been compensated by the mud of the Nile. By the simple operation of natural causes it may be safely concluded, that if nature and art do not co-operate; if the water is permitted to increase, and the channels of the different branches are allowed to be augmented, the sea will continue to snatch new lands from the inhabitants, which appears to be the inevitable doom of Egypt, while it continues in the hands of a people who are ignorant and uncultivated.

A large proportion of the land formerly watered by the branches of the Nile, anciently denoted the Pelusiac, Tanitic, and Mendesian branches, is now the bed of Lake Menzaleh. Lake Bourlos is not far from the mouth of what was formerly called the Sebennitic branch, and Lake Maadieh is near the mouth of the ancient Canopic. Lake Mareotis was at too great a distance from the Nile to be filled up with the mud which it deposits, the waters of which were diverted from the lake, by a canal which had been cut for the conveyance of water to the city of Alexandria; and having no communication with the sea, its waters of consequence were gradually evaporated. It still, however, contained a moving sand and a brackish mud, which receiving the rain in winter, and a small portion of the waters from the Nile by the canals of Bahireh, it exhibits the appearance of a marsh during the greater part of the year. There are also a few lakes which owe their origin to the redundant waters of the Nile, diffusing themselves over hollow places in which they are confined, and only disappear by the gradual process of evaporation.

In addition to the branches and chief canals already mentioned, there are numerous canals in Lower Egypt by which it is intersected. These convey the waters of the inundation, which dykes in different districts serve to retain. By these waters the more elevated grounds are fertilized, and other cantons in succession, after which they are poured into the lakes, or are lost in the sea. The swelling of this remarkable river commences about the summer solstice, reaching its utmost extent in the autumnal equinox; and after appearing for a few days in all its native majesty, it gradually begins

begins to subside. In point of time there is a difference of fifteen days, and sometimes twice that period, with respect to the rise and fall of the Nile; but it may be affirmed in general, that Lower Egypt cannot be safely passed during any more of the year than from the beginning of February to the end of August. At this time the great branches alone contain water, on which passage boats are always to be met with.

It is obvious, from this succinct account of the general face of the country, that no invading army could carry on any military operations in Lower Egypt during more than seven months in the year. It may perhaps be admitted with truth, that the confines of the desert might be traversed during the five remaining months; but the villages in that direction are ill qualified to grant those necessary supplies to an army which, after crossing the desert, must be in want of every thing. No communication could be kept open from the desert with the interior, from September to December inclusive. At this period, therefore, an enemy could not carry on any military operations in the interior but by water. Nor would an army destined to defend Egypt find itself free from very considerable embarrassment during the continuance of the inundation; for as a considerable part of its movements would unavoidably be made on that element, they would be from the nature of things both tedious and difficult.

137
Mr Bruce's account of the deserts, marble mountains, &c.

Mr Bruce has given us a particular account of the sources from whence were derived the vast quantities of marble met with in the remains of ancient buildings in this country. These he discovered during his journey from Kenne to Cosseir on the Red sea, before he took his expedition to Abyssinia. He gives a most dismal idea of the deserts through which he passed. What houses he met with were constructed like those M. Volney mentions, of clay, being no more than six feet in diameter, and about ten in height. The mountains were the most dreary and barren that can be imagined: and the heat of the sun so great, that two sticks rubbed together only for half a minute would take fire and flame. In these burning regions no living creature was to be met with, even the poisonous serpents and scorpions not being able to find subsistence. The first animal he saw was a species of ants in a plain called *Hamra* from the purple colour of its sand; and it was remarkable that these insects were of the same colour with the sand itself. No water was anywhere to be met with on the surface; though at a place called *Legeta* there were some draw-wells, the water of which was more bitter than soot itself. At Hamra the porphyry mountains and quarries begin, the stone of which is at first soft and brittle; but the quantity is immense, as a whole day was taken up in passing by them. These porphyry mountains begin in the latitude of nearly 24 degrees, and continue along the coast of the Red sea to about 22° 30′, when they are succeeded by the marble mountains; these again by others of alabaster, and these last by basaltic mountains. From the marble mountains our author selected twelve kinds, of different colours, which he brought along with him. Some of the mountains appeared to be composed entirely of red and others of green marble, and by their different colours afforded an extraordinary spectacle. Not far from the porphyry mountains the cold was so great, that his camels died on his return from Abyssinia though the thermometer stood no lower than 42 degrees.

Near to Cosseir he discovered the quarries whence the ancients obtained those immense quantities of marble with which they constructed so many wonderful works. The first place where the marks of their operations were very perceptible, was a mountain much higher than any they had yet passed, and where the stone was so hard that it did not even yield to the blows of a hammer. In this quarry he observed that some ducts or channels for conveying water terminated; which, according to him, shows that water was one of the means by which these hard stones were cut. In four days, during which our author travelled among these mountains, he says, that he had "passed more granite, porphyry, marble, and jasper, than would build Rome, Athens, Corinth, Syracuse, Memphis, Alexandria, and half a dozen such cities." It appeared to him that the passages between the mountains, and which he calls *defiles*, were not natural but artificial openings; where even whole mountains had been cut out, in order to preserve a gentle slope towards the river. This descent our author supposes not to be above one foot in 50; so that the carriages must have gone very easily, and rather required something to retard their velocity than any force to pull them forward. Concerning the mountains in general, he observes, that the porphyry is very beautiful to the eye, and is discovered by a fine purple sand without any gloss. An unvariegated marble of a green colour is generally met with in the same mountain; and where the two meet the marble becomes soft for a few inches, but the porphyry retains its hardness. The granite has a dirty brown appearance, being covered with sand: but on removing this, it appears of a gray colour with black spots, with a reddish cast all over it. The granite mountains lie nearer to the Red sea, and seem to have afforded the materials for Pompey's pillar. The redness above mentioned seems to go off on exposure to the air; but re-appears on working or polishing the stone farther. The red marble is next to the granite, though not met with in the same mountain. There is also a red kind with white veins, and vast quantities of the common green serpentine. Some samples of that beautiful marble named *Isabella* were likewise observed; one of them of that yellowish cast called *quaker colour*, the other of the bluish kind named *dove colour*. The most valuable kind is that named *verde antico*, which is found next to the Nile in the mountains of serpentine. It is covered by a kind of blue flaky stone, somewhat lighter than a slate, more beautiful than most kinds of marble, and when polished having the appearance of a volcanic lava. In these quarters the verde antico had been uncovered in patches of about 20 feet square. There were small pieces of African marble scattered about in several places, but no rocks or mountains of it; so that our author conjectures it to lie in the heart of some other kind. The whole is situated on a ridge with a descent to the east and west; by which means it might easily be conveyed either to the Nile, or Red sea, while the hard gravel and level ground would readily allow the heaviest carriages to be moved with very little force.

Travellers have talked of an emerald mine in these deserts; but from the researches of Mr Bruce, it does not

not appear to have any existence. In the Red sea indeed, in the latitude of 25° 3′, at a small distance from the south-western coast, there is an island called the *Mountain of Emeralds;* but none of these precious stones are to be met with there. Here, as well as on the continent, there were found many pieces of a green pellucid substance; but veined, and much softer than rock crystal, though somewhat harder than glass. A few yards up the mountain he found three pits, which are supposed to have been the mines whence the ancients obtained the emeralds; but though many pieces of the green substance above mentioned were met with about these pits, no signs of the true emerald could be perceived. This substance, however, he conjectures to have been the *smaragdus* of the Romans. In the mountains of Cosseir, as well as in some places of the deserts of Nubia, our author found some rocks exactly resembling petrified wood.

9 Sto of a s ap- peance.

The only metal said by the ancients to be produced in Egypt is copper. On the road to Suez are found great numbers of those stones called *Egyptian flints* and *pebbles*, though the bottom is a hard, calcareous, and sonorous stone. Here also M. Volney tells us, that the stones above mentioned, and which resemble petrified wood, are to be met with. These, he says, are in the form of small logs cut slanting at the ends, and might easily be taken for petrifactions, though he is convinced that they are real minerals.

0 Sal kes.

F. Sicard mentions two lakes, from the water of which is produced annually a great quantity of salt containing much mineral alkali: and M. Volney informs us, that the whole soil of this country is impregnated with salt; so that, upon digging to some depth in the ground, we always meet with brackish water impregnated in some degree with the mineral alkali as well as with common salt. The two lakes mentioned by Sicard are situated in the desert to the west of the Delta; and are three or four leagues in length, and about a quarter of a league in breadth, with a solid and stony bottom. For nine months in the year they are without water; but in the winter time there oozes out of the earth a reddish violet-coloured water, which fills the lakes to the height of five or six feet. This being evaporated by the return of the heat, there remains a bed of salt two feet thick and very hard, which is broken in pieces with iron bars; and no less than 30,000 quintals are procured every year from these lakes. So great is the propensity of the Egyptian soil to produce salt, that even when the gardens are overflowed for the sake of watering them, the surface of the ground, after the evaporation and absorption of the water, appears glazed over with salt. The water found in the wells contains mineral alkali, marine salt, and a little nitre. M. Volney is of opinion, that the fertile mould of Egypt, which is of a blackish colour, differs essentially from that of the other parts; and is derived from the internal parts of Ethiopia along with the waters of the Nile. This seems to contradict what he had before advanced against M. Savary concerning the increase of the land of Egypt by means of the waters of this river: but there is no reason at all to suppose this kind of earth to be of a foreign origin; it being always the result of vegetation and cultivation. Even the most barren and sandy spots in the world, if properly watered, and such vegetables planted in them as would grow there, in time would be covered with this black earth as well as others: and of this kind of artificial formation of soil, travellers give us a remarkable instance in the garden of the monks at Mount Sinai, where the country is naturally as barren as in any place of the world. "The monks of Sinai (says Dr Shaw), in a long process of time, have covered over with dung and the sweepings of their convent near four acres of naked rocks: which produce as good cabbage, roots, salad, and all kinds of pot-herbs, as any soil and climate whatsoever. They have likewise raised olive, plum, almond, apple, and pear trees, not only in great numbers, but of excellent kinds. The pears particularly are in such esteem at Cairo, that there is a present of them sent every year to the bashaw and persons of the first quality. Neither are their grapes inferior in size and flavour to any whatsoever: it being fully demonstrated, by what this little garden produces, how far an indefatigable industry can prevail over nature; and that several places are capable of culture and improvement which were intended by nature to be barren, and which the lazy and slothful have always suffered to be so."

Veg ble mou of Egy not orig lly deri from Ethi a.

142 Natural fertility of Egypt not diminished.

From this general account of the country, we may reasonably conclude, that the natural fertility of Egypt is not diminished in modern times, provided the same pains were taken in the cultivation of it as formerly; but this is not to be expected from the present degenerate race of inhabitants. "The Delta (says M. Savary) is at present in the most favourable state for agriculture. Washed on the east and west by two rivers formed by the division of the Nile, each of which is as large and more deep than the Loire, intersected by innumerable rivulets; it presents to the eye an immense garden, all the different compartments of which may be easily watered. During the three months that the Thebais is under water, the Delta possesses fields covered with rice, barley, vegetables, and winter fruits. It is also the only part of Egypt where the same field produces two crops of grain within the year, the one of rice, the other of barley."

143 Method of purifying and cooling the water in Egypt.

The only cause of all this fertility is the Nile, without which the whole country would soon become an uninhabitable desert, as rain falls very seldom in this part of the world. It flows with a very gentle stream through the flat country, and its waters are very muddy, so that they must have time to settle, or even require filtration before they can be drunk. For purifying the water, the Egyptians, according to M. Volney, use bitter almonds, with which they rub the vessel containing it, and then the water becomes light and good; but on what principle this ingredient acts we cannot pretend to determine. Unglazed earthen vessels filled with water are kept in every apartment; which by a continual evaporation through their porous substance, render the contained fluid very cool even in the greatest heats. The river continues muddy for six months: and during the three which immediately precede the inundation, the stream being reduced to an inconsiderable depth, becomes heated, green, fetid, and full of worms. The Egyptians in former times paid divine honours to the Nile, and still hold it in great veneration. They believe its waters to be very nourishing, and that they are superior

rior to any in the world; an opinion very excusable in them, as they have no other, and large draughts of cold water are among their highest luxuries.

144 Of the inundation of the Nile.

This river, swelled by the rains which fall in Abyssinia, begins to rise in Egypt about the month of May; but the increase is inconsiderable till towards the end of June, when it is proclaimed by a public crier through the streets of Cairo. About this time it has usually risen five or six cubits; and when it has risen to 16, great rejoicings are made, and the people cry out *Waffah Allah*, that is, that God has given them abundance. This commonly takes place about the latter end of July, or at farthest before the 20th of August; and the sooner it takes place, so much the greater are the hopes of a good crop. Sometimes, though rarely, the necessary increase does not take place till later. In the year 1705, it did not swell to 16 cubits till the 19th of September; the consequence of which was that the country was depopulated by famine and pestilence.

We may easily imagine that the Nile cannot overflow the whole country of itself in such a manner as to render it fertile; for which reason there are innumerable canals cut from it across the country, it has already been observed, by which the water is conveyed to distant places, and almost every town or village has one of these canals. In those parts of the country where the inundation does not reach, and where more water is required than it can furnish, as for watering of gardens, they must have recourse to artificial means for raising it from the river. In former times they made use of Archimedes's screw; but that is now disused, and in place of it they have chosen the Persian wheel. This is a large wheel turned by oxen, having a rope hung with several buckets which fill as it goes round, and empty themselves into a cistern at the top. Where the banks of the river are high, they frequently make a bason in the side of them, near which they fix an upright pole, and another with an axle across the top of that, at one end of which they hang a great stone, and at the other a leathern bucket; this bucket being drawn down into the river by two men, is raised by the descent of the stone, and emptied into a cistern placed at a proper height. This kind of machine is used chiefly in the upper parts of the country, where the raising of water is more difficult than in places near the sea. When any of the gardens or plantations want water, it is conveyed from the cisterns into little trenches, and from thence conducted all round the beds in various rills, which the gardener easily stops by raising the mould against them with his foot, and diverts the current another way as he sees occasion.

145 Nilometer described.

The rise of the inundation is measured, as has already been observed, by an instrument adapted for the purpose, and called *mikeas*, which we translate *nilometer*. Mr Bruce informs us, that this is placed between Geeza and Cairo, on the point of an island named *Rhoda* about the middle of the river, but somewhat nearer to Geeza. It is a round tower with an apartment, in the middle of which is a cistern neatly lined with marble. The bottom of this cistern reaches to that of the river, and there is a large opening by which the water has free access to the inside. The rise of the water is indicated by an octagonal column of blue and white marble, ou which are marked 20 peeks or cubits of 22 inches each. The two lowermost of these have no subdivisions; but each of the rest is divided into 24 parts called *digits*; the whole height of the pillar being 36 feet 8 inches.

146 Of the canals by which the water is conveyed, &c.

When the river has attained its proper height, all the canals are opened, and the whole country laid under water. During the time of the inundation a certain vortical motion of the waters takes place: but notwithstanding this, the Nile is so easily managed, that many fields lower than the surface of its waters are preserved from injury merely by a dam of moistened earth not more than eight or ten inches in thickness. This method is made use of particularly in the Delta when it is threatened with a flood.

As the Nile does not always rise to a height sufficient for the purposes of agriculture, the former sovereigns of Egypt were at vast pains to cut proper canals in order to supply the deficiency. Some of these are still preserved, but great numbers are rendered useless through the indolence or barbarity of their successors. Those which convey the water to Cairo, into the province of Fayoom, and to Alexandria, are best taken care of by government. The last is watched by an officer appointed for that purpose, whose office it is to hinder the Arabs of Bachria, who receive this superfluous water, from turning it off before Alexandria be provided for, or opening it before the proper time, which would hinder the increase of the river. In like manner, that which conveys the water to Fayoom is watched, and cannot be opened before that of Cairo, which is called the *Canal of Trajan*. A number of other canals, only taken care of by those who derive advantage from them, proceed from that arm of the Nile which runs to Damietta, and fertilize the province of Sharkia; which, making part of the isthmus of Suez, is the most considerable of Egypt, and the most capable of a great increase of cultivation. The plains of Gaza which lie beyond, and are possessed by the Arabs, would be no less fertile, were it not for the excessive inclination these people have to destroy, so that they make war even with the spontaneous productions of the earth. A number of other canals run through the Delta; and the vestiges of those which watered the provinces to the eastward and westward, show that in former times these were the best cultivated parts of Egypt. "We may also presume (says the baron de Tott), from the extent of the ruins of Alexandria, the construction of the canal, and the natural level of the lands which encompass the lake Mareotis, and extend themselves westward to the kingdom of Barca, that this country, at present given up to the Arabs, and almost desert, was once sufficiently rich in productions of every kind to furnish the city of Alexander with its whole subsistence."

147 Air and climate of Egypt.

The air and climate of Egypt are extremely hot, not only from the height of the sun, which in summer approaches to the zenith, but from the want of rain and from the vicinity of those burning and sandy deserts which lie to the southward. In the months of July and August, according to M. Volney, Reaumur's thermometer stands, even in the most temperate apartments, at the height of 24 or 25 degrees above the freezing point; and in the southern parts it is said to rise still higher. Hence, he says, only two seasons should be distinguished in Egypt, the cool and the hot, or spring and summer. The latter continues for the greatest part of of the year, viz. from March to November or even longer: for by the end of February the sun is intolerable to a European at nine o'clock in the morning. During the whole of this season the air seems to be inflamed, the sky sparkles, and every one sweats profusely, even without the least exercise, and when covered with the lightest dress. This heat is tempered by the inundation of the Nile, the fall of the night dews, and the subsequent evaporation; so that some of the European merchants, as well as the natives, complain of the cold in winter. The dew we speak of does not fall regularly throughout the summer, as with us; the parched state of the country not affording a sufficient quantity of vapour for this purpose. It is first observed about St John's day (June 24th), when the river has begun to swell, and consequently a great quantity of water is raised from it by the heat of the sun, which being soon condensed by the cold of the night air, falls down in copious dews.

It might naturally be imagined, that as for three months in the year Egypt is in a wet and marshy situation, the excessive evaporation and putrefaction of the stagnating waters would render it very unhealthy. But this is by no means the case. The great dryness of the air makes it absorb vapours of all kinds with the utmost avidity; and these rising to a great height, are carried off by the winds either to the southward or northward, without having time to communicate any of their pernicious effects. This dryness is so remarkable in the internal parts of the country, that flesh meat exposed to the open air does not putrefy even in summer, but soon becomes hard and dry like wood. In the deserts there are frequently dead carcases thus dried in such a manner, and become so light, that one may easily lift that of a camel with one hand. In the maritime parts, however, this dryness of the air is not to be expected. They discover the same degree of moisture which usually attends such situations. At Rosetta and Alexandria, iron cannot be exposed to the air for 24 hours without rusting. According to M. Volney, the air of Egypt is also strongly impregnated with salts: for which opinion he gives the following reason: "The stones are corroded by natrum (mineral alkali or soda), and in moist places long crystallizations of it are to be found, which might be taken for saltpetre. The wall of the Jesuits garden at Cairo, built with earth and bricks, is everywhere covered with a crust of this natrum as thick as a crown piece: and when this garden has been overflowed by the waters of the kalidj (canal), the ground, after they have drained off, appears sparkling on every side with crystals, which certainly were not brought thither by the water, as it shows no sign of salt either to the taste or by distillation."—But whatever may be the quantity of salt contained in the earth, it is certain that M. Volney's opinion of its coming thither from the air cannot be just. The salt in question is excessively fixed, and cannot be dissipated into the air without the violent heat of a glasshouse furnace; and even after this has been done, it will not remain diffused through the atmosphere, but quickly falls back again. No experiments have ever shown that any salt was or could be diffused in the air, except volatile alkali, and this is now known to be formed by the union of two permanently elastic fluids; and it is certain that a saline air would quickly prove fatal to the animals who breathed it. The abundance of this kind of salt in Egypt therefore only shows, that by some unknown operation the heat of the sun forms it from the two ingredients of earth and water, though we do not yet understand the manner, nor are able to imitate this natural operation.

148
Why exotic plants will not thrive in Egypt.

To this saline property of the earth M. Volney ascribes the excessive quickness of vegetation in Egypt, which is so great, that a species of gourd called *kara* will, in 24 hours, send forth shoots of four inches in length; but for the same reason, in all probability, it is that no exotic plant will thrive in Egypt. The merchants are obliged annually to send to Malta for their garden seeds; for though the plants thrive very well at first, yet if the seed of them is preserved, and sown a second year, they always come up too tall and slender.

149
Cause of the dews in Egypt.

By reason of the great dryness of the air, Egypt is exempted from the phenomena of rain, hail, snow, thunder, and lightning. Earthquakes are also seldom heard of in this country; though sometimes they have been very fatal and destructive, particularly one in the year 1112. In the Delta it never rains in summer, and very seldom at any other time. In 1761, however, such a quantity of rain unexpectedly fell, that a great number of houses, built with mud walls, tumbled entirely down by being soaked with the water, to which they were unaccustomed. In the Higher Egypt the rain is still less frequent; but the people, sensible of the advantages which accrue from it, always rejoice when any falls, however insufficient to answer the purpose. This deficiency of rain is supplied by the inundation and dews already mentioned. The latter proceed, as has already been said, partly from the waters of the inundation, and partly from the sea. At Alexandria, after sunset, in the month of April, the clothes exposed to the air on the terraces are soaked with them as if it had rained. These dews are more or less copious according to the direction of the wind. They are produced in the greatest quantity by the westerly or northerly winds, which blow from the sea; but the south and south-east winds, blowing over the deserts of Africa and Arabia, produce none.

150
Remarkable regularity of the winds.

The periodical return of winds from a certain quarter is a very remarkable phenomenon in this country. When the sun approaches the tropic of Cancer, they shift from the east to the north; and, during the month of June, they always blow from the north or north-west. They continue northerly all the month of July, varying only sometimes towards the east, and sometimes the contrary way. About the end of this month, and during the whole of August and September, they blow directly from the north, and are but of a moderate strength, though somewhat weaker in the night than in the day. Towards the end of September they return to the east, though they do not absolutely fix on that point, but blow more regularly from it than any other except the north. As the sun approaches the southern tropic, they become more variable and tempestuous, blowing most commonly from the north, north-east, and west, which they continue to do throughout the months of December, January, and February; and, during that season, the vapours raised from the Mediterranean condense into a mist, or even sometimes into rain. Towards the end of February, and in the succeeding month, they more frequently blow from the south than from any other quarter. During some part of the month of March and in that of April, they blow from the south, south-east, and south-west; sometimes from the north and east, the latter becoming most prevalent about the end of that month, and continuing during the whole of May.

151
Rains in Abyssinia and in Armenia occasioned by two opposite currents of air.

It is to the long continuance of the north winds, formerly called the *Etesian winds*, that Egypt probably owes its extreme dryness, as well as part of the inundation by which it is fertilized. From the month of April to July, there appear to be two immense currents in the atmosphere, the under one blowing from the north, and the upper from the south. By the former the vapours are raised from the Mediterranean and southern parts of Europe, where they are carried over Abyssinia, dissolving there in immense deluges of rain; while by the latter the superfluous vapours, or those raised from the country of Abyssinia itself, are carried northward toward the sources of the Euphrates. Here the clouds coming from the south, descending into the lower part of the atmosphere, dissolve in like manner into rain, and produce an inundation of the Euphrates similar to that of the Nile, and immediately succeeding it. Mr Bruce had an opportunity of ascertaining this fact in the month of June 1768; for at that time, while on a voyage from Sidon to Alexandria, he observed great numbers of thin white clouds moving rapidly from the south, and in direct opposition to the Etesian winds.

152
Of hot winds.

Besides the ordinary winds here spoken of, Egypt is infested with the destructive blasts common to all warm countries which have deserts in their neighbourhood. These have been distinguished by various names, such as *poisonous winds*, *hot winds of the desert*, *Samiel*, *the wind of Damascus*, *Kamsin*, and *Simoom*. In Egypt they are denominated "winds of 50 days," because they most commonly prevail during the 50 days preceding and following the equinox; though, should they blow constantly during one half of that time, an universal destruction would be the consequence. Of these travellers have given various descriptions. M. Volney says, that the violence of their heat may be compared to that of a large oven at the moment of drawing out the bread. They always blow from the south; and are undoubtedly owing to the motion of the atmosphere over such vast tracts of hot sand, where it cannot be supplied by a sufficient quantity of moisture. When they begin to blow, the sky loses its usual serenity, and assumes a dark, heavy, and alarming aspect, the sun himself laying aside his usual splendour, and becoming of a violet colour. This terrific appearance seems not to be occasioned by any real haze or cloud in the atmosphere at that time, but solely to the vast quantity of fine sand carried along by those winds, and which is so excessively subtile that it penetrates everywhere. The motion of this wind is always rapid, but its heat is not intolerable till after it has continued for some time. Its pernicious qualities are evidently occasioned by its excessive avidity of moisture. Thus it dries and shrivels up the skin; and by doing the same to the lungs, will in a short time produce suffocation and death. The danger is greatest to those of a plethoric habit of body, or who have been exhausted by fatigue; and putrefaction soon takes place in the bodies of such as are destroyed by it. Its extreme dryness is such, that water sprinkled on the floor evaporates in a few minutes; all the plants are withered and stripped of their leaves; and a fever is instantly produced in the human species by the suppression of perspiration. It usually lasts three days, but is altogether insupportable if it continue beyond that time. The danger is greatest when the wind blows in squalls, and to travellers who happen to be exposed to its fury without any shelter. The best method in this case is to stop the nose and mouth with an handkerchief. Camels, by a natural instinct, bury their noses in the sand, and keep them there till the squall is over. The inhabitants, who have an opportunity of retiring to their houses, instantly shut themselves up in them, or go into pits made in the earth, till the destructive blast be over.

The description of a blast of this kind which overtook Mr Bruce in the desert of Nubia is still more terrible than that just given from M. Volney. We have already mentioned something of the pillars of moving sand raised by the winds in the desert. These were observed by our traveller on this occasion in all their terrific majesty. Sometimes they appeared to move slowly; at other times with incredible swiftness, so that they could not have been avoided by the fleetest horse. Sometimes they came so near, that they threatened destruction to the whole company. Frequently the tops, when arrived at an immense height, so that they were lost in the clouds, suddenly separated from the bodies, and dispersed themselves in the air; and sometimes the whole column broke off near the middle, as if it had received a cannon shot; and their size was such, that at the distance of about three miles, they appeared ten feet in diameter. Next day they appeared of a smaller size, but more numerous, and sometimes approached within two miles of the company. The sun was now obscured by them, and the transmission of his rays gave them a dreadful appearance resembling pillars of fire. This was pronounced by the guide to be a sign of the approaching *Simoom* or hot wind; and he directed, that when it came, the people should fall upon their faces and keep their mouths on the sand, to avoid the drawing in this pernicious blast with their breath. On his calling out that the Simoom was coming, Mr Bruce turned for a moment to the quarter from whence it came, which was the south-east. It appeared like a haze or fog of a purple colour, but less bright than the purple part of the rainbow; seemingly about 20 yards in breadth, and about 12 feet high from the ground. It moved with such rapidity, that before he could turn about and fall upon his face, he felt the vehement heat of its current upon his face; and even after it passed over, which was very quickly, the air which followed was of such a heat as to threaten suffocation. Mr Bruce had unfortunately inspired some part of the pernicious blast; by which means he almost entirely lost his voice, and became subject to an asthmatic complaint, from which he did not get free for two years. The same phenomenon occurred twice more on their journey through this desert. The second time, it came from the south a little to the east: but it now seemed to have a shade of blue along with the purple, and its edges were less perfectly defined; resembling rather a thin smoke, and having

ving about a yard in the middle tinged with blue and purple. The third time, it was preceded by an appearance of sandy pillars more magnificent than any they had yet observed; the sun shining through them in such a manner as to give those which were nearest a resemblance of being spangled with stars of gold. The simoom which followed had the same blue and purple appearance as before, and was followed by a most suffocating wind for two hours, which reduced our travellers to the lowest degree of weakness and despondency. It was remarkable that this wind always came from the south-east, while the sandy pillars, which prognosticated its approach, affected to keep to the westward, and to occupy the vast circular space inclosed by the Nile to the west of their route, going round by Chagre towards Dongola. The heaps of sand left by them when they fell, or raised by the whirlwinds which carried them up, were 12 or 13 feet high, exactly conical, tapering to a fine point, and their bases well proportioned.

153 he in- bitants gypt.

The inhabitants of Egypt may now be distinguished into four distinct races of people.

I. The *Arabs*, who may be subdivided into three classes. 1. The posterity of those who settled here immediately after the conquest of the country by Amrou Ebn Al As, the caliph Omar's general. 2. The *Magrebians*, or Western Arabs, who at different times have migrated from the countries to the westward of Egypt, and are descended from the Saracen conquerors of Mauritania. 3. The *Bedouins*, or Arabs of the desert, known to the ancients by the name of *Scenites*, or dwellers in tents. The first of these classes are now found among the husbandmen and artizans; and are distinguished from the others by being of a more robust habit of body, as well as of a larger stature than the others. They are in general five feet four inches high; and many of them attain two or three inches more, and are muscular without being fleshy. Their countenances are almost black, but their features are not disagreeable; and as those of the country do not ally themselves in marriage but with the people of their own tribe, their faces have all a strong resemblance to each other. This is not the case with such as live in towns, by reason of their promiscuous marriages. The second class are more numerous in the Said, where they have villages and even distinct sovereigns of their own. Like the former, they apply themselves to agriculture and mechanical occupations. The Bedouins pass their lives among the rocks, ruins, and sequestrated places where they can find water; sometimes uniting in tribes and living in low smoky tents, and shifting their habitations from the desert to the banks of the river and back again, as best suits their conveniency. Their time of inhabiting the desert is the spring; but after the inundation they take up their residence in Egypt, in order to profit by the fertility of the country. Some farm lands in the country, which they cultivate, but change annually. In general, all these Bedouins are robbers, and are a great terror to travellers as well as to the husbandmen; but though their number is estimated at not less than 30,000, they are dispersed in such a manner that they cannot attempt any thing of consequence.

II. The *Copts* are descendants of those inhabitants of Egypt whom the Arabs subdued, and who were composed of original Egyptians, Persians and Greeks. M. Volney is of opinion that their name of Copts is only an abbreviation of the Greek word *Aigouptios*, an Egyptian. They are principally to be met with in the Said, though some also inhabit the Delta. They have all a yellowish dusky complexion, puffed-up visage, swoln eyes, flat noses, and thick lips; and in fact the exact countenance of a mulatto. M. Volney, from a view of the sphynx, and finding its features to be such as is just now described, concludes, that the ancient Egyptians were real negroes; which he thinks is likewise confirmed by a passage in Herodotus, where he concludes, that the inhabitants of Colchis were descended from the Egyptians, "on account of the blackness of their skins and frizzled hair." M. Volney also remarks, that the countenance of the negroes is such as exactly represents that state of contraction assumed by our faces when strongly affected by heat. The eye-brows are knit, the cheeks rise, the eye-lids are contracted, and the mouth distorted; and this state of contraction to which the features of the negroes are perpetually exposed in the hot climates they inhabit, is become particularly characteristic. Excessive cold and snow produces the same effect; and hence this kind of countenance is also common among the Tartars; while, in the temperate climates, the features are proportionably lengthened, and the whole countenance expanded.

The Copts profess the Christian religion, but follow the heresy of the Eutychians, whence they have been persecuted by the Greeks; but having at last got the better of their adversaries, they are become the depositaries of the registers of the lands and tribes. At Cairo they are called *writers;* and are the intendants, secretaries, and collectors for government. The head of their class is writer to the principal chief; but they are all hated by the Turks, to whom they are slaves, as well as by the peasants whom they oppress. Their language bears a great resemblance to the Greek; but they have five letters in their alphabet, as well as a number of words in their language, which may be considered as the remains of the ancient Egyptian. These are found to bear a near resemblance to the dialects of some of the neighbouring nations, as the Arabic, Ethiopian, Syriac, &c. and even of those who lived on the banks of the Euphrates. The language of the Copts, however, has fallen into disuse for upwards of 300 years. On the conquest of the country by the Saracens, the latter obliged the people to learn their language; and about the year 722 the use of the Greek tongue was prohibited throughout the whole of their empire: the Arabic language then of course became universal; while the others, being only met with in books, soon became totally neglected. The true Coptic, therefore, though there is a translation of the scriptures and many books of devotion written in it, is understood by nobody, not even the monks and priests.

III. The *Turks*, who have the title of being masters of Egypt, but are chiefly to be met with at Cairo, where they possess the religious and military employments. Formerly they possessed also the posts under government; but these are now occupied by the fourth race of inhabitants, viz.

IV. The *Mamlouks*. Of the origin of these we have already given some account: we have only, therefore,

fore, to relate some of the most remarkable particulars concerning their constitution and government, manners, &c.

These people, as has already been mentioned, are the real masters of Egypt; and in order to secure themselves in the possession of the country, they have taken several precautions. One of the principal of these is the degradation of the two military corps of azabs and janizaries, both of which were formerly very formidable. They have been able to effect this only in consequence of the corrupt and wretched government of the Turks; for before the revolt of Ibrahim Kiaya, the Turkish troops, which ought to have consisted of 40,000, were reduced to less than half that number through the avarice and malversation of their officers. Their degradation was completed by Ali Bey; who having first displaced all the officers who gave him any umbrage, left their places vacant, and so reduced the consequence of the whole, that the azabs and janizaries are now only a rabble of vagabonds, who dread the Mamlouks as much as the meanest of the populace. The principal body of the Mamlouks reside at Cairo; but many of them are dispersed through the country, in order to keep up their authority, collect the tribute, and oppress the people: yet it should seem very easy for the Porte to dispossess them of this usurped authority, as their number is supposed not to exceed 8500, including among these a great many youth under 20 years of age.

154
Absurd dress and accoutrements of the Mamlouks.

The Mamlouks are all horsemen; and as war is accounted the only honourable employment among them, it is reckoned disgraceful to walk on foot, none but cavalry being accounted soldiers. The other inhabitants are allowed only the use of mules and asses; and the same mark of indignity is imposed upon Europeans; though by proper management and liberal presents, this may be got over. In the year 1776 Lord Algernoun Percy, afterwards Lord Louvaine, and the earl of Charlemount, obtained permission to ride upon horseback. The Mamlouks, however, are not incited to this continual appearance on horseback merely by their supposed superiority to the rest of the inhabitants; it is rendered necessary by their dress, which is extremely unwieldy and cumbersome. It consists of a wide shirt of thin yellowish-coloured cotton; over which is a gown of Indian linen, or some of the light stuffs of Damascus or Aleppo. Over this is a second covering of the same form and wideness, with sleeves reaching down to the ends of the fingers. The former covering is called *antari*, and the latter *caftan*. The caftan is usually made of silk or some finer stuff than the under garments; and both of them are fastened by a long belt, which divides the whole dress into two bundles. Over all these they have a third, named *djouha*, consisting of cloth without lining, and made nearly similar to the others, but that the sleeves are cut in the elbow. This coat is lined, sometimes even in summer, with fur; and as if all this was not sufficient, they have an outer covering called the *beniche*, which is the cloak or robe of ceremony; and so completely covers the body, that even the ends of the fingers are not to be seen. Thus, when the beniche and other accoutrements are on, the whole body appears like a long sack, with a bare neck and bald head covered with a turban thrust out of it. This turban is called a *kaouk*; and is of a cylindrical form, yellow, and turned up on the outside with a roll of muslin artificially folded up. On their feet they have a sock of yellow leather reaching up to the heels, slippers without any quarters, which consequently are always ready to be left behind in walking. Lastly, to complete this extraordinary dress, they have a kind of pantaloon or trowsers, long enough to reach up to the chin, and so large that each of the legs is big enough to contain the whole body; but that they may walk more at their ease under such a number of impediments, they tie all the loose parts of their dress with a running sash. "Thus swaddled (says M. Volney), we may imagine the Mamlouks are not very active walkers; and those who are not acquainted by experience with the prejudices of different countries, will find it scarcely possible to believe that they look on this dress as exceedingly commodious. In vain we may object that it hinders them from walking, and encumbers them unnecessarily on horseback; and that in battle a horseman once dismounted is a lost man. They reply, *It is the custom*, and every objection is answered."

In the accoutrements of their horses, the Mamlouks are almost equally absurd. The saddle is a clumsy piece of furniture, weighing with the saddle-cloths not less than 25 pounds; while the weight of the stirrups is never less than 9 or 10 pounds, nay, frequently exceeds 13. On the back part of the saddle rises a trussequin about eight inches in height, while a pummel before projects four or five inches, in such a manner as to endanger the breast of the horseman if he should happen to stoop. Instead of a stuffed frame, they have three thick woollen coverings below the saddle; the whole being fastened by a surcingle, which, instead of a buckle, is tied with leather thongs in very complicated knots, and liable to slip. Instead of a crupper they have a large martingale which throws them upon the horses shoulders. The stirrups are made of copper, longer and wider than the foot, having circular edges an inch high in the middle, and gradually declining toward each end. The edges are sharp, and used instead of spurs, by which means the poor animal's sides are much wounded. The weight of the furniture has already been mentioned; and is the more ridiculous as the Egyptian horses are very small. The bridle is equally ill contrived, and greatly injures the horse's mouth, especially by reason of the violent method they have of managing the animal. Their usual way is to put the horse to a full gallop, and suddenly stop him when at full speed. Thus checked by the bit, he bends in his hind legs, stiffens the fore ones, and moves along as if he scarce had joints in his body: yet, notwithstanding all those disadvantages, our author acknowledges that they are vigorous horsemen, having a martial appearance which pleases even strangers.

155
Their a
educatio
&c.

In the choice of their arms they have shown themselves more judicious. Their principal weapon is an English carbine about 30 inches long; but so large in the bore, that it can discharge 10 or 12 balls at a time, which can scarcely fail of doing great execution even from the most unskilful hand. Besides two large pistols carried in the belt, they have sometimes a heavy mace at the bow of the saddle for knocking down their enemy; and by the shoulder belt they suspend a crooked sabre measuring 24 inches in a straight line from the hilt

hilt to the point, but 30 at least in the curve. The reason of the preference given to the crooked blade is, that the effect of a straight one depends merely on the force with which it falls, and is confined to a small space, but that of a crooked one is continued longer by the action of the arm in retiring. The Mamlouks commonly procure their sabres from Constantinople, or other parts of Europe; but the beys rival each other in those of Persia, and such as are fabricated of the ancient steel of Damascus. For these they frequently pay as high as 40l. or 50l. sterling; but though it must be allowed that the edge of these weapons is exquisitely keen, yet they have the defect of being almost as brittle as glass. The whole education and employment of the Mamlouks consists in the exercise of these weapons, or what is conducive to it; so that we should imagine they might at last become altogether irresistible. Every morning the greater part of them exercise themselves in a plain near Cairo, by firing their carbines and pistols in the most expeditious manner, having an earthen vessel for a mark to shoot at; and the person who breaks it is highly applauded by the beys who attend in order to encourage them. Here also they exercise themselves in the use of the sabre, as well as of the bow and arrows; though they do not any longer make use of these last in their engagements. Their favourite diversion is throwing the *djerid;* a word properly signifying a reed, but which is generally made use of to signify any staff thrown by the hand after the manner of the Roman pilum. In this exercise they make use of the branches of the palm-tree fresh stripped. These branches, which have the form of the stalk of an artichoke, are about four feet long, and weigh five or six pounds. With these the cavaliers enter the lists, riding full speed, and throwing them afterwards at each other from a considerable distance. As soon as the assailant has thrown his weapon, he turns his horse, and his antagonist pursues in his turn. The diversion, however, frequently turns out very serious, as some are capable of throwing these weapons with force sufficient to wound their antagonists mortally. Ali Bey was particularly dexterous at this kind of sport, and frequently killed those who opposed him. All these military exercises, however, are by no means sufficient to render the Mamlouks formidable in the field. In their engagements they have neither order, discipline, nor even subordination; so that their wars are only scenes of robbery, plunder, and tumultuary encounters, which begin very often suddenly in the streets of Cairo without the least warning. If the contention happens to be transferred to the country, it is still carried on in the same manner. The strongest or most daring party pursues the other. If they are equal in courage, they will perhaps appoint a field of battle, and that without the least regard to the advantages of situation, but fighting in platoons, with the boldest champions at the head of each. After mutual defiances, the attack begins, and every one chooses out his man. After discharging their fire-arms, if they have an opportunity they attack with their sabres; and such as happen to be dismounted are helped up again by their servants; but if nobody happens to be near, the servants will frequently kill them for the sake of the money they carry about them. Of late, however, the ordinary Mamlouks, who are all slaves to the rest, seem convinced that their patrons are the persons principally interested; for which reason they reasonably enough conclude that they ought to encounter the greatest dangers. Hence they generally leave them to carry on the dispute by themselves; and being always sure of finding a master who will employ them, they generally return quietly to Cairo until some new revolution takes place.

56
Are not formidable in war.

157
Their expensive way of living.

The mode of living among the Mamlouks is exceedingly expensive, as may easily be conceived from what has already been related. There is not one of them who does not cost above 100l. sterling annually, and many of them upwards of 200l. At every return of the fast of Ramadan, their masters must give them a new suit of French and Venetian clothes, with stuffs from India and Damascus. Frequently they require new horses and harness: they must likewise have pistols and sabres from Damascus, with gilt stirrups, and saddles and bridles plated with silver. The chiefs are distinguished from the vulgar by the trinkets and precious stones they wear; by riding Arabian horses of 200l. or 300l. value, wearing shawls of Cashmire in value from 25l. to 50l. each, with a variety of pelisses, the cheapest of which costs above 20l. Even the European merchants have given into this kind of extravagance; so that not one of them looks upon his wardrobe to be decently furnished unless it be in value 500l. or 600l.

158
Their bad character.

Anciently it was customary for the women to adorn their heads with sequins; but this is now rejected as not sufficiently expensive. Instead of these, diamonds, emeralds, and rubies, are now substituted; and to these they add French stuffs and laces. In other respects the character of the Mamlouks is almost the worst that can be imagined. Without affection, tie, or connection with each other or with the rest of mankind, they give themselves up without controul to the most enormous vices; and, according to M. Volney, they are at once ferocious, perfidious, seditious, base, deceitful, and corrupted by every species of debauchery, not excepting even the unnatural vice; of which he tells us not one is free, this being the very first lesson each of them receives from his master, all being originally slaves, as has already been mentioned.

159
Miserable state of the Egyptians.

As these are the present governors of Egypt, we may easily judge that the condition of the common people cannot be very agreeable. The greater part of the lands indeed are in the hands of the Mamlouks, beys, and professors of the law, the property of all others being very precarious. Contributions are to be paid, or damages repaired, every moment; and there is neither right of succession nor inheritance for real property, but every thing must be purchased from government. The peasants are allowed nothing but what is barely sufficient to sustain life. They cultivate rice and corn indeed, but are not at liberty to use either. The only food allowed them is dora or Indian millet, from which they make a kind of tasteless bread; and of this, with water and raw onions, consists all their fare throughout the year. They esteem themselves happy, therefore, if along with these they can sometimes procure a little honey, cheese, sour milk, or a few dates. They are very fond of flesh meat and fat; neither of which, however, they have an opportunity of tasting except at extraordinary festivals. Their ordinary

dinary dress consists of a shirt of coarse blue linen, and a clumsy black cloak; with a sort of black bonnet over their heads; and over all they wear a long red woollen handkerchief. Their arms, legs, and breasts, are naked, and most of them do not even wear drawers. They live in mud-walled huts of the most miserable construction, where they are exposed to the inconveniences of smoke, heat, and unwholesome air; to all which are to be added the continual fears they live in of being robbed by the Arabs, oppressed by the Mamlouks, or some other grievous calamity. The only conversation is concerning the intestine troubles and misery of the country, murders, bastinadoes, and executions. Here sentence of death is executed without the least delay or form of trial. The officers who go the rounds in the streets either by night or day, are attended by executioners, who carry along with them leathern bags for receiving the heads they cut off in these expeditions. Even the appearance of guilt is not necessary to incur a capital punishment; for frequently nothing more is requisite than the possession of wealth, or being supposed to possess it. In this case the unfortunate person is summoned before some bey; and when he makes his appearance, a sum of money is demanded of him. If he denies that he possesses it, he is thrown on his back, and receives two or three hundred blows on the soles of the feet, nay perhaps is put to death without any ceremony. The only security of those who possess any wealth in this country therefore is, to preserve as great an appearance of poverty as possible.

160 Diseases prevalent in this country.

Though the climate of Egypt is far from being unhealthy; yet there are not a few diseases which seem to be peculiar to it, and to have their origin either from the constitution of the atmosphere, or the manner of living of the inhabitants. One of these till lately has been supposed to be the plague; which opinion we find supported by Dr Mead, who has endeavoured to assign a natural reason why it should take its origin in this country. But it is now universally agreed, that the plague never originates in the interior parts of Egypt, but always begins at Alexandria, passing successively from thence to Rosetta, Cairo, Damietta, and the rest of the Delta. It is likewise observed, that its appearance is always preceded by the arrival of some vessel from Smyrna or Constantinople; and that if the plague has been very violent in either of these cities, the danger of Egypt is the greater. On proper inquiry, it is found to be really a native of Constantinople; from whence it is exported by the absurd negligence of the Turks, who refuse to take any care to prevent the spreading of the infection. As they sell even the clothes of the dead without the least ceremony, and ships laden with this pernicious commodity are sent to Alexandria, it is no wonder that it should soon make its appearance there. As soon as it has reached Cairo, the European merchants shut themselves up with their families in their *khans* or lodgings, taking care to have no further communication with the city. Their provisions are now deposited at the gate of the khan, and are taken up by the porter with iron tongs; who plunges them into a barrel of water provided for the purpose. If they have occasion to speak to any person, they take care to keep at such a distance as to avoid touching or even breathing upon each other. By these precautions they certainly escape the general calamity, except by accident; and it not long ago happened that the disease was conveyed by a cat into the dwellings of the French merchants in Cairo; by which two were infected, and one died. In this manner they were imprisoned for three or four months, without any other amusement than walking on their terraces in the evenings, cards, or conversation with one another. There is a remarkable difference betwixt the plague at Constantinople and in Egypt. In the former it is most violent in summer; and in the latter in winter, ending there always in the month of June. It is also remarkable, that the water-carriers of Egypt, whose backs are constantly wet from the nature of their occupation, never have the plague. It appears in Egypt every fourth or fifth year, when it makes such ravages as would depopulate the country, were it not for the vast concourse of strangers which arrive here every year from all parts of the Turkish empire.

A malady which seems in reality to be peculiar to Egypt is blindness. This is so common at Cairo, as M. Volney informs us, that out of 100 people whom he has met on the street, he might reckon 20 quite blind; 10 without the sight of one eye; and 20 others with their eyes red, purulent, or blemished. Almost every one, says he, wears a fillet, a token of an approaching or convalescent ophthalmy. In considering the causes of this disorder, he reckons the sleeping upon terraces to be a principal one. The south wind, he says, cannot be the cause; otherwise the Bedouins would be equally subject to it with the Egyptians themselves: but what is with the greatest probability to be assigned as the cause, according to our author, is the very poor and little nutritive food which the natives are obliged to use. "The cheese, sour-milk, honey, confection of grapes, green fruits, and raw vegetables (says he), which are the ordinary food of the people, produce in the stomach a disorder which physicians have observed to affect the sight; the raw onions, especially, which they devour in great quantities, have a peculiar heating quality, as the monks of Syria made me remark on myself. Bodies thus nourished, abound in corrupted humours, which are constantly endeavouring a discharge. Diverted from the ordinary channels, by habitual perspiration, these humours fly to the exterior parts, and fix themselves where they find the least resistance. They therefore naturally attack the head, because the Egyptians, by shaving it once a-week, and covering it with a prodigiously hot head-dress, principally attract to it the perspiration; and if the head receives ever so slight an impression of cold on being uncovered, this perspiration is suppressed, and falls upon the teeth, or still more readily on the eyes as being the tenderest part. It will appear the more probable that the excessive perspiration of the head is a principal cause, when we reflect that the ancient Egyptians, who went bare-headed, are not mentioned by physicians as being so much afflicted with ophthalmies; though we are informed by historians that some of the Pharaohs died blind. The Arabs of the desert also, who cover the head but little, especially when young, are also very little subject to them." In this country blindness is often the consequence of the small-pox, a disorder very frequent and very fatal among

among the Egyptians; and no doubt the more dangerous on account of their absurd method of treating it, of which it is needless to enter into any discussion in this place. They are not unacquainted with inoculation; but seem not to be sensible of its advantages, as they very seldom practise it.

To the same cause, viz. unwholesome food, M. Volney ascribes the general deformity of the beggars, and the miserable appearance of the children; which he says are nowhere so wretched. "Their hollow eyes, pale and puffed faces, swollen bellies, meagre extremities, and yellow skins, make them always seem as if they had not long to live. Their ignorant mothers pretend that this is the effect of the *evil eye* of some envious person, who has bewitched them; and this ancient prejudice is still general in Turkey: but the real cause is the badness of their food. In spite of the talismans, therefore, an incredible number of them perish; nor is any city more fatal to the population of the neighbouring country than Grand Cairo.

The venereal disease, which, for reasons best known to themselves, the inhabitants call the *blessed evil*, is so general at Cairo, that one half of the inhabitants are infected. It is extremely difficult to cure, though the symptoms are comparatively very mild, insomuch that people who are infected with it will frequently live to the age of 80; but it is fatal to children born with the infection, and exceedingly dangerous to such as emigrate to a colder climate.

Besides these, there are two uncommon diseases met with in Egypt, viz. a cutaneous eruption which returns annually; and a swelling of the testicles, which often degenerates into an enormous hydrocele. The former comes on towards the end of June or beginning of July, making its appearance in red spots and pimples all over the body, occasioning a very troublesome itching. The cause of this distemper, in M. Volney's opinion, is the corruption of the waters of the Nile, which towards the end of April become very putrid, as has already been observed. After this has been drunk for some time, the waters of the inundation, which are fresh and wholesome, tend to introduce some change in the blood and humours; when a cutaneous eruption is the natural consequence.

The hydrocele most commonly attacks the Greeks and Copts; and is attributed to the quantity of oil they make use of, as well as to their frequent hot-bathing. Our author remarks, that "in Syria as well as in Egypt, constant experience has shown, that brandy distilled from common figs, or from the fruit of the sycamore tree, as well as from dates and the fruit of the nopal, has a most immediate effect on the testicles, which it renders hard and painful the third or fourth day after it has been drunk; and if the use of it be not discontinued, the disorder degenerates into a confirmed hydrocele. Brandy distilled from dried raisins has not the same effect: this is always mixed with aniseeds; and is very strong, being distilled three times. The Christians of Syria and the Copts of Egypt make great use of it; the latter especially drink whole bottles of it at their supper. I imagined this an exaggeration; but I have myself had ocular proofs of its truth, though nothing could equal my astonishment that such excesses do not produce instant death, or at least every symptom of the most insensible drunkenness."

In the spring season malignant fevers prevail in this country; concerning which our author mentions no remarkable particular, but that eggs are a kind of poison, and that bleeding is very prejudicial. He recommends a vegetable diet, and the bark in very large quantity.

161 Commerce of Cairo considerable.

Notwithstanding the oppression which the Egyptians labour under, a very considerable trade is carried on from Cairo. This flourishing state of commerce in the midst of the most desperate barbarity and despotism is owing to three causes. 1. That all the commodities consumed in Egypt are collected within the walls of that city. 2. That the Mamlouks and all the people of property reside in that place, and there spend their whole revenues. 3. By the situation of this city it is a centre of circulation; corresponding with Arabia and India, by the Red sea; with Abyssinia and the interior parts of Africa, by the Nile; and with Europe and the Turkish empire by means of the Mediterranean. A caravan comes here annually from Abyssinia, bringing from 1000 to 1200 slaves, with gum, ivory, gold dust, ostrich-feathers, parrots, and monkeys.—Another, which sets out from the extreme parts of Morocco, takes in pilgrims for Mecca from all that country as far south as the mouth of the river Senegal. It consists of no fewer than three or four thousand camels; and, passing along the coasts of the Mediterranean, collects likewise the pilgrims from Algiers, Tripoli, and Tunis, arriving at last at Alexandria by the way of the desert. Proceeding thence to Cairo, it joins the Egyptian cavavan; and then setting out both together, they take their journey to Mecca, from whence they return in one hundred days; but the Morocco pilgrims, who have still 600 leagues to go, are upwards of a year in returning. The commodities they bring along with them are, India stuffs, shawls, gums, perfumes, pearls, and principally coffee. Besides the profits of this merchandise, considerable sums arise from the duties paid by pilgrims, and the sums expended by them.

The caravans above mentioned are not the only means by which these commodities are brought to Cairo. They arrive also at Suez, to which port the southerly winds bring in the month of May six or eight and twenty sail of vessels from Jedda. Small caravans likewise arrive from time to time from Damascus with silk and cotton stuffs, oils and dried fruits. During the proper season there are also a number of vessels in the road of Damietta, unloading hogsheads of tobacco from Latakia, vast quantities of which are consumed in this country. For this commodity rice is taken in exchange; while other vessels bring clothing, arms, furs, passengers, and wrought silk from Constantinople. There are other vessels which come from Marseilles, Leghorn, and Venice, with cloths, cochineal, Lyons stuffs and laces, grocery ware, paper, iron, lead, Venetian sequins, and German dahlers. These are conveyed to Rosetta in barks called by M. Volney *djerm*, but which seem to be the same mentioned by Mr Bruce under the name of *canja*, and which are particularly described by him. He informs us, that there is a peculiarity in the form of this vessel which makes it useful for navigating the river Nile; and that is, that the keel

162 Vessels which navigate the Nile described.

keel is not straight, but a portion of a parabola, whose curve is almost insensible to the eye. Hence, as sandbanks are very common in the Nile, and vessels are apt to strike them when the water becomes low, the middle of the canja will be aground while the extremities are afloat, and thus by means of oars and other assistance, it is always possible to get clear; but were the keel straight, this would be altogether impossible, by reason of the vast sails those vessels carry, which would urge them on with too much force to be recovered. The accommodation on board these vessels is much better than what could be expected: but they are liable to the depredations of robbers, who either swim under water in the day-time, or upon goats skins during the night: though these seldom attack any boats where there are Europeans, whom they dread on account of their skill in fire arms.

From so many sources we need not wonder that the commerce of Cairo should be in a very flourishing state. In 1783, according to the report of the commissioner-general of the customs, it amounted to no less than 6,250,000l.; but notwithstanding this show of wealth, the trade carried on at Cairo contributes very little to the enriching of the people. This will readily appear, when we consider, that great part of the coffee and other merchandise brought from India is exported to foreign countries, the value being paid in goods from Turkey and other European countries; while the country consumption consists entirely, or mostly, in articles of luxury already finished, and the produce given in return is mostly in raw materials.

163
Of cutting through the isthmus of Suez.

Schemes have frequently been projected of enlarging the commerce of Egypt by cutting through the isthmus of Suez, and thus joining the Mediterranean and Red seas by a canal. This is looked upon by M. Volney as impracticable. He owns, indeed, that no objection can arise from the distance, which is not more than 18 or 19 leagues; neither does any obstacle arise from mountains, or the inequality of levels, the whole being a sandy barren plain. The difficulty, which he considers as insuperable, proceeds from the nature of the corresponding coasts of the Mediterranean and Red seas; both of which are low and sandy, where the waters form lakes, shoals, and morasses, so that ships cannot come within a considerable distance of either; and it would be scarce possible to cut a permanent canal amidst these shifting sands: not to mention, that the shore is destitute of harbours, which must be entirely the work of art. The country, besides, has not a drop of fresh water, which it would therefore be necessary to bring as far as from the Nile. The best method of effecting this junction, therefore, is by means of the river itself; and for this the ground is perfectly well calculated. This has been already done by several Egyptian princes, particularly Sesostris; and the canal is said to have been 170 feet wide, and deep enough for large vessels. After the Grecian conquest it was renewed by the Ptolemies, then by Trajan, and lastly by the Arabs. Part of it still remains, running from Cairo to the north-east of the *Berket-el-Hadj*, or Lake of the Pilgrims, where it loses itself. At present the commerce with Suez is only carried on by means of caravans, which set out towards the end of April or beginning of May, or in the months of July and August; waiting the arrival of the vessels, and setting out on their departure. The caravans are very numerous; that with which M. Volney travelled consisting of 5000 or 6000 men and 3000 camels. The country is as desert and barren as possible, without a single tree or the smallest spot of verdure; so that every necessary for those who accompany the caravan must be carried on the backs of the camels, wood and water not excepted.

The custom-houses of Egypt are in the hands of the Christians of Syria. Formerly they were managed by Jews; but these were completely ruined by the extortions of Ali Bey in 1769. The Syrian Christians came from Damascus somewhat more than 50 years ago; and having by their economy and industry gained possession of the most important branches of commerce, they were at length enabled to farm the custom-houses, which is an office of great consequence. There were at first only three or four families of them; but their number has since increased to more than 500, and they are reckoned very opulent.

164
Low state of the arts and learning.

From what has already been said concerning the state of the Egyptians, we may naturally conclude, that the arts and all kinds of learning are at a very low ebb among them. Even the most simple of the mechanical professions are still in a state of infancy. The work of their cabinet-makers, gun smiths, and locksmiths, is extremely clumsy. There are manufactures of gunpowder and sugar; but the quality of both is very indifferent. The only thing in which they can be said to arrive at any degree of perfection is the manufacture of silk stuffs; though even these are far less highly finished than those of Europe, and likewise bear a much higher price. One very extraordinary art indeed is still extant among the Egyptians, and appears to have existed in that country from the most remote antiquity; and that is, a power of enchanting the most deadly serpents in such a manner, that they shall allow themselves to be handled, nay even hurt in the severest manner, without offering to bite the person who injures them. Those who have this art are named PSYLLI; to which article we refer for an account of what has been said on the subject by ancient and modern travellers.

165
War in Egypt.

The long and bloody war to which the revolution of France gave rise, induced the government of that country to leave no measure unattempted, by which the grandeur, independence, and commerce of Great Britain might be as much injured as possible, if not utterly destroyed. The conquest of Egypt was therefore projected, as a preparatory step towards the subjugation of the East Indies, to be effected by reaching the Indian ocean through the isthmus of Suez. This was a daring, a desperate undertaking; and no military character of which France could boast, was considered as equal to its successful execution but the hero of Marengo. He accordingly embarked at Toulon, as commander in chief of the army of the east, which amounted to about 40,000 men, and having compelled Malta to surrender in the course of his voyage, he steered for the coast of Egypt, and arriving at Alexandria on the first of July 1798, he carried it by assault on the evening of the 5th.

166
Alexand
taken b
the Fre

It is well known that while Bonaparte continued in Italy, he strictly prohibited his troops from committing acts of rapine and plunder, of which, however, they were

were guilty at Alexandria, and consequently it is to be presumed that the commander in chief could not then prevent it. If he could, he was unquestionably blind to his own interest not to do so, since nothing was more unlikely to conciliate the affections of the Egyptians. Cairo next surrendered to the victors on the 23d of the same month. The French general attacked one of the enemy's posts at Lambabe on the 25th, when 300 of the enemy were killed; but this was only a prelude to the memorable battle of the Pyramids, which was fought on the following day, and seemed for the present to decide the fate of Egypt. The Mamlouks lost 2000 men; and 400 camels, together with their baggage and 50 pieces of cannon, fell into the hands of the conquerors. Thus far Bonaparte appeared to be the favourite of fortune, by whom he was never to be deserted; but he soon found that the race is not always to the swift, or the battle to the strong. He experienced a reverse of an irreparable nature; and as it does not appear that he entertained the smallest apprehension of it, it gave a trait of ferocity to his subsequent conduct which he had never before exhibited.

167
le of
Nile.

Admiral Nelson appeared off the mouth of the Nile on the 1st of August, with a naval force equal to that of the French admiral; and although the fleet of the latter was so stationed and defended as to render an attack extremely hazardous, the British hero was determined to attempt it; and in this he succeeded to the utmost of his wishes. He captured nine sail of the line belonging to the enemy, L'Orient, the admiral's flag ship of 120 guns, having blown up during the desperate and bloody engagement. The loss on the part of the French must have been immense, since Gantheaume mentions 3100 made prisoners, whom the British commander returned: of this number there were 800 wounded. The British had about 202 killed, besides sixteen officers, and 678 wounded.

After Grand Cairo surrendered to the French, Bonaparte formed his victorious army into three divisions, one of which was commanded by General Desaix, whose destination was Upper Egypt, in pursuit of the flying Mamlouks; the second division he left for the defence of Cairo, and marched in person at the head of the third in pursuit of Ibrahim Bey, who had taken his route towards Syria with a rich caravan. To render abortive, if possible, the designs of Bonaparte, Britain formed an alliance with the Sublime Porte, and the chief preparations for carrying the concerted plan into effect, were made in Syria, under the care and direction of the pacha Djezzar. The frontiers of Egypt towards Syria were to be attacked by an army from Asia Minor, the operations of which were to be favoured by making a strong diversion towards the mouths of the Nile, and by various assaults in Upper Egypt with the remains of Mourad Bey's army. Sir Sidney Smith left Portsmouth to superintend the execution of this extensive plan, and grant every assistance in his power by the maritime force under his command.

In the mean time care was taken to block up the harbour of Alexandria with four sail of the line and five frigates, under the command of Commodore Hood, as he had found it impracticable to burn or destroy the French fleet of transports, without the assistance of a land force sufficient to attack Alexandria. Of the light vessels which had been sent him by the combined fleet of Turks and Russians the commodore had made no use; and he also found the report to be without foundation, that the vessels in the old port belonging to the French, were burnt. It was in order to destroy the preparations of the pacha Djezzar, and disconcert the plans of Sir Sidney Smith, that General Bonaparte thought of leaving Egypt and marching into Syria. The result of this expedition, as we have already hinted, was fatal to the French interest, although Bonaparte perhaps never undertook an enterprise with more rational expectations of ultimate success.

168
Acre defended by Sir Sidney Smith.

The town of Jaffa, (anciently Joppa), was obstinately defended, but at last surrendered to the superior tactics of European soldiers. From this place the French general marched with his army in three divisions against St Jean d'Acre, which put an effectual period to his hitherto triumphant career. The pacha was powerfully encouraged by Sir Sidney Smith to make an obstinate resistance to the attack of Bonaparte; and to animate him still more with the hopes of being able to hold out, and force the assailants in the issue to raise the siege, he sent him a French engineer of distinguished merit, by whose instrumentality Sir Sidney Smith had been enabled to effect his escape from prison. Although the fortress was completely repaired by Colonel Philipeaux (the name of the engineer), yet it is more than probable that it could not have long held out against the skill and intrepidity of Bonaparte, if his heavy artillery had not been intercepted by the British on their way from Damietta and Rosetta. After a desperate and bloody siege of about 61 days continuance, the French commander was obliged to abandon the hope of making Acre surrender. In the course of his retreat back again to Egypt, Bonaparte's army ravaged the whole country, burnt the harvests, destroyed the defences of the different ports, the magazines, and every resource of which the Turks might have availed themselves in approaching the frontiers of Egypt. He reached Grand Cairo in 26 days after raising the siege of Acre.

Sir Sidney Smith, with indefatigable zeal and activity, continued to execute the remaining parts of the plan of operations against Egypt, which was seconded by the increasing zeal of the Turks in the prosecution of the same design. The troops destined to make an attack upon Alexandria were assembled in the different ports in the island of Rhodes, by Seid Mustapha Pacha, the enterprise being conducted by European officers. The combined fleet of Turkey and Britain only waited the arrival of a convoy, previous to their sailing for Egypt, which the captain pacha, who then lay at anchor in the Dardanelles, was to dispatch to Rhodes. During the absence of General Bonaparte, no method had been left unattempted, in order to ruin the interest of the French, and kindle a spirit of rebellion in the minds of the people. This plan succeeded to a certain extent, but the presence of Bonaparte restored tranquillity. His army no doubt suffered extremely in its march to Syria; but with such zeal and activity did he turn his attention to the re-establishment of its organization, that it was in a condition to undertake active operations in the short period of three weeks, although, according to very high authority, it had been completely buried in the burning sands of the desert.

While Bonaparte was in the vicinity of the pyramids,

mids, intended to pursue Mourad Bey in his retreat to Fayoum, he received intelligence from Alexandria, that a Turkish fleet of 100 sail had come to anchor in the bay of Aboukir, from which 3000 troops had landed on the shore of the peninsula, and carried the fort of Aboukir by assault. He accordingly gave direction to his officers to march their forces towards the place of landing, and the first rendezvous of the army was appointed to be at Rhamanieh, situated on the left side of the Nile. The advanced guard under the command of General Murat, took the route to Gizeh, and General Menou's moveable column, together with the park of artillery and the staff, formed a conjunction at Rhamanieh on the 20th of July. After the French army quitted its post at the village of Birket, it assembled at the wells between Alexandria and Aboukir; and Bonaparte fixed his head quarters at the former place.

The Turkish army was about 15,000 strong, and receiving daily reinforcements. When Bonaparte came in sight of it, he instantly formed his columns to attack it, and General d'Estaing carried the intrenched height of the enemy, by which their right was supported, at the point of the bayonet. Their two wings were cut off from retreating by General Murat, who marched up to the centre of the enemy with a body of cavalry. By this manœuvre 2000 men perished by water, or were killed by the fire of the republicans. As Bonaparte found that the chief strength of the Turkish army was at the centre, he changed his position as the nature of the ground rendered it necessary. By a variety of experienced movements, in which the French lost several brave officers, the Turks were at length thrown into the utmost confusion, retreated in every direction, and threw themselves into the sea. The majority of them were at too great a distance from the vessels, to be saved in this manner from a watery grave. After this battle, the fort of Aboukir was summoned to surrender, which was defended with the most desperate fury, as the Turks had no idea of capitulating with arms in their hands. General Menou conducted the siege with great vigour and address, and after bombarding it for eight days, till it exhibited nothing but a heap of ruins, the son of the pacha and 2000 men laid down their arms, and were made prisoners of war. In the fort the republicans found 1800 men killed, and 300 wounded. It is said that Sir Sidney Smith witnessed this melancholy reverse of fortune on the part of the Turks, without having it in his power, as at Acre, to grant them relief, or to animate them by his courageous example.

169 Bonaparte returns to France.

The next day Bonaparte returned to Alexandria where he learned the dismal situation of French affairs on the continent of Europe, particularly in Italy and on the Rhine, and the violent commotions which were agitating the interior of France. This determined him to quit Egypt, and return to his own country, full of the idea of vesting in his own person the sovereign authority, to which he has at length attained, both in name and reality. General Berthier alone was his confidential friend, to whom he communicated his future designs. Admiral Gantheaume was ordered to get ready two frigates with the utmost expedition, without informing that officer what was to be their destination, and brought with him Generals Lasnes, Marmont, Murat, and Andreossi, together with Monge and Berthollet of the institute; Bessieres and his guides received sealed notes, which were not to be opened till a certain day, and certain hour, and at a particular point of the sea-shore. They were found to contain orders for immediate embarkation; and another packet which was to be opened on the day after the sailing of the frigates, contained the nomination of General Kleber to the chief command, and Desaix to that of Upper Egypt.

By dispatches from General Kleber subsequent to the departure of Bonaparte, it appears that Mourad Bey having dropt down the Nile to El-Ganayur, was repulsed by a division of the army of Upper Egypt, under the command of General Morand. Being overtaken in his flight by this division, his camp was surprised at Samahout, a vast number of Mamlouks were entirely cut off; 200 camels with spoils, 100 horses, and a prodigious quantity of military implements, fell into the hands of the republicans, and it was with the utmost difficulty that the bey effected his escape. Thus signally defeated, Mourad wandered through the inhospitable deserts of Upper Egypt, in search of an asylum and the means of subsistence. As this man was such an indefatigable enemy to the French, Desaix resolved to exterminate him if possible, and for this purpose two columns of infantry mounted on dromedaries were immediately organized, the one commanded by Desaix in person, and the other by Adjutant-general Boyer, who came up with Mourad on the 19th of October in the desert of Sediman, after a forced march of three days. The Mamlouks fought with determined valour and intrepidity, animated with the hopes of gaining possession of the dromedaries. Their attack was met with such vigour on the part of the republicans, that the Mamlouks and Arabs were soon put to flight, and pursued back to the deserts by their intrepid conquerors.

On the 24th of September, a Turkish fleet of 18 vessels came to anchor before Damietta, which was so rapidly increased by constant reinforcements, that it amounted to 53 about the end of the subsequent month. The naval commander of this fleet was Sir Sidney Smith on board the Tyger. On the 1st of November 4000 Turks effected a landing, who were attacked by General Verdier at the head of 1000 men, and lost, in this apparently unequal contest, no fewer than 300 men killed, 800 prisoners, including Ismael Bey, the second in command, 32 stand of colours, and five pieces of cannon. After a number of subsequent battles and inferior skirmishes which the republicans fought with various success, they seemed willing to evacuate Egypt upon certain conditions, which met with the approbation of Sir Sidney Smith; but they were afterwards rejected by a species of policy for which it is difficult to account, and fresh obstacles were thrown in the way of the proposed evacuation. This was an event much to be desired by the republicans, according to the opinion of some, while the French denied that the necessity of such a measure ever existed. According to them, they had still 20,000 effective men in that quarter of the globe, and liberally shared in the affections of the inhabitants, by whom they were assisted.

The gallant and experienced Kleber, who succeeded Bonaparte gypt. Egypt.

170 assassina- of eber. Bonaparte in the chief command of the *army of the East*, was treacherously assassinated by a janissary, while presenting the general with a memorial for his perusal, on which the chief command devolved on Menou, but not till some other generals, and Reynier in particular, had refused to accept of it. Suspicions fell heavily on General Menou, who, it was supposed, had hired the assassin, as it was well known that a variance subsisted between Kleber and Menou; but it is only doing justice to the latter to declare, that the dying assertions of the murderer sufficiently evinced the contrary. He was most probably hired by the grand vizier himself; but who advised the vizier to the adoption of such an infamous, cowardly measure, we must leave to our readers to find out. The assassin was impaled alive, his right hand burnt off, and his body left to be devoured by birds of prey. Three sheiks who were privy to his designs, but did not divulge them, were beheaded.

Lieutenant Wright was dispatched to Cairo by Sir Sidney Smith, with propositions respecting the evacuation of Egypt to General Menou, whose answer the combined powers expected with anxiety, as the grand vizier was determined to advance against the enemy at the head of 30,000 men, should Menou evince himself determined not to evacuate Egypt. He soon gave them to understand that no overtures of accommodation which they could make to him would be received. He accordingly recommenced hostilities, and marched against Syria with the principal part of his army; a measure which proved abortive under the auspices of Bonaparte, by the prompt and gallant exertions of Sir Sidney Smith. Menou strongly fortified Alexandria, Damimietta, and Rosetta, and not only finished the lines which Colonel Bromley had begun at Aboukir, but made to these several important additions, putting every place into such a state of defence as seemed to bid defiance to any attack from the Turks.

In the mean time Britain was not idle, but active in the organization of an army destined to invade Egypt, and compel the French troops to evacuate that country, which was too contiguous to her inestimable possessions in the East Indies; and the command of it was given to that gallant and highly respectable officer, the late general Sir Ralph Abercromby, who appeared off Aboukir in the beginning of March, 1801. The weather proving unfavourable for some days, Sir Ralph did not begin to land his troops till the 8th, at an early hour in the morning. The French having marched from Alexandria, took their station on the heights of Aboukir, to prevent the landing of the British forces. An action soon commenced between the hostile armies, which lasted for two hours, but the republicans were obliged to retreat, having only 4000 men to oppose to three times that number. The loss of the French on this occasion was estimated at 3000, and that of the British about 1500 men, in killed, wounded, and prisoners.

71 T British ur crom- ctori- t A- ir.

After this, few actions of importance occurred till the memorable 21st of March, on which day a battle was fought about four miles from Alexandria. A false attack on the left of the British army was the commencement of hostilities, but the French were still more anxious to turn the right of their opponents, which they attempted in vain. With the same success they made an attack upon the central division. About 200 prisoners fell into the hands of the British; but as their cavalry was much inferior to that of the enemy, whose retreat was also covered by cannon on the opposite hills, they could not pursue their advantages. The loss of the British at this time was very considerable, but the most irreparable part of it was the loss of the commander in chief, who was mortally wounded on the 21st, and died on the 28th of the same month. He was succeeded by General Hutchinson, the second in command, to whom was committed the completion of the plans which his worthy predecessor had concerted. He attacked the French on the the 19th of May, near Rhamanieh, and forced them to retire towards Cairo. He had 4000 British troops under his command, and an equal number of Turks under the captain pacha. He then directed his route towards Cairo, from which the army of the grand vizier was distant only four leagues, in a north-east direction. A reinforcement of 3000 British troops reached Aboukir about the 6th of May.

By the advice of Colonel Murray and some other British officers then in the camp of the grand vizier, his highness obtained a victory over 4600 French, with 9000 chosen troops, not encumbered with the women and useless attendants so commonly met with in the camps of eastern generals. The whole of Damietta soon fell into the hands of the allies, and the successor of Mourad Bey declared in favour of the British, joining Sir J. Hutchinson with 1500 cavalry, that kind of force of which the British commander stood in greatest need. In a short time after, the French evacuated Cairo, which was taken possession of by the combined Turkish and British army. Alexandria still held out, but Menou was at length, however, obliged to surrender, and thus the whole of Egypt was in possession of the allies. War having been declared against Russia in 1807, a British force under General Fraser was dispatched from Sicily, and took possession of Alexandria, after a very trifling resistance, on the 21st of March. Two attempts to take Rosetta, however, having failed, with the loss of 1000 men, and a large Turkish force approaching Alexandria, the British commander thought it prudent to evacuate the place. The embarkation took place in September the same year. Since that period the situation of Egypt has been greatly improved by the vigorous government of the Pacha Ali.

For a description of these stupendous monuments, the pyramids, see the article PYRAMIDS. See also the article EGYPT in the SUPPLEMENT.

E tians, etia.

EGYPTIANS, or GYPSIES. See GYPSIES.

EHRETIA, a genus of plants belonging to the pentandria class. See BOTANY *Index*.

Ehrharta, Ehud.

EHRHARTA, a genus of plants belonging to the hexandria class. See BOTANY *Index*.

EHUD, the son of Gera, a Benjamite, a man left-handed,

handed, who delivered Israel from the oppression of Eglon king of Moab, under whom they served for 18 years. See EGLON. It being customary for the Israelites to send a present or tribute to the king of Moab; in the year of the world 2579, being the last year of their servitude, Ehud was appointed to carry it, who having a design either to free his country from this oppression, or perish in the attempt, had for this purpose provided himself with a dagger which had two edges, and which he had concealed on his right side, (Judges iii. 15. &c.). After he had delivered the present, pretending he had something of great importance to communicate to the king, he obtained a private audience of him; when taking his opportunity, he stabbed him with the poniard to the heart, and so shutting the door after him, had time to make his escape; for as the king was a very corpulent man, his attendants supposed that he was either reposing or easing himself, and therefore forbore to enter his apartment until Ehud was quite gone. As soon as he came to Mount Ephraim, he gathered together the Israelites that lay nearest him, acquainted them with what he had done; and then securing the fords of Jordan that none of them might escape, he fell upon the Moabites, and subdued them.

EIA, or EY, in our old writers, is used for an island. Hence the names of places ending in *ey*, denote them to be islands. Thus, Ramsey, the isle of rams; Shepey, the isle of sheep, &c.

EIA is also sometimes used for water; and hence the names of places near waters or lakes terminate in *ey*.

EJACULATOR, in *Anatomy*, a name applied to two muscles of the penis, from their office in the ejection of the seed. See ANATOMY, *Table of the Muscles*.

EICETÆ, called also HEICETÆ and HICETÆ, heretics of the seventh century, who made profession of the monastic life.—From that passage in Exodus where Moses and the children of Israel are said to have sung a song in praise of the Lord, after they had passed the Red sea, wherein their enemies had perished; the Eicetæ concluded, that they must sing and dance to praise God aright: and as Mary the prophetess, sister of Moses and Aaron, took a drum in her hand, on the same occasion, and all the women did the like, to testify their joy, by playing, beating, and dancing; the Eicetæ, the better to imitate their conduct herein, endeavoured to draw women to them to make profession of the monastic life, and assist in their mirth.

EICK. See BRUGES.

EIDER-DUCK. See ANAS, ORNITHOLOGY *Index*.

EIDER-Down, the down of the eider-duck. The eider-duck plucks off the down from its breast for the purpose of making its nest, which, after being robbed by those who collect the down, is renewed by the bird till its breast is quite bare.

EJECTA, a term used by lawyers for a woman deflowered or cast from the virtuous.

EJECTION, in the animal economy, the evacuation, or discharging any thing through some of the emunctories, as by stool, vomit, &c.

EJECTION, in *Scots Law*, is the turning out the possessor of any heritable subject by force; and is either *legal* or *illegal*. Legal ejection is where a person having no title to possess, is turned out by the authority of law. Illegal ejection is one person's violently turning another out of possession without lawful authority.

EJECTMENT, in *English Law*, a writ or action which lies for the lessee for years, on his being ejected or put out of his land, before the expiration of his term, either by the lessor or a stranger. It may also be brought by the lessor against the lessee, for rent in arrears, or holding over his term, &c. Ejectment of late years is become an action in the place of many real actions, as writs of right, formedons, &c. which are very difficult, as well as tedious and expensive; and this is now the common action for trial of titles, and recovering of lands, &c. illegally held from the right owner; yet where entry is taken away by discents, fines, recoveries, disseisins, &c. an ejectment shall not be brought; whereby we find that all titles cannot be tried by this action.

The method of proceeding in the action of ejectment is to draw up a declaration, and feign therein a lease for three, five, or seven years, to him that would try the title; and also feign a casual ejector or defendant; and then deliver the declaration to the ejector, who serves a copy of it on the tenant in possession, and gives notice at the bottom for him to appear and defend his title; or that he the feigned defendant will suffer judgment by default, whereby the true tenant will be turned out of possession: to this declaration the tenant is to appear at the beginning of next term by his attorney, and consent to a rule to be made defendant, instead of the casual ejector, and take upon him the defence, in which he must confess lease, judgment, entry, and auster, and at the trial stand upon the title only: but in case the tenant in possession does not appear, and enter into the said rule in time, after the declaration served, then, on affidavit being made of the service of the declaration, with the notice to appear as aforesaid, the court will order judgment to be entered against the casnal ejector by default; and thereupon the tenant in possession, by writ *habere facias possessionem*, is turned out of his possession. On the trial in ejectment, the plaintiff's title is to be set forth from the person last seised in fee of the lands in question, under whom the lessor claims down to the plaintiff, proving the deeds, &c. and the plaintiff shall recover only according to the right which he has at the time of bringing his action. And here, another who hath title to the land, upon a motion made for that purpose, may be defendant in the action with the tenant in possession, to defend his title; for the possession of the lands is primarily in question, and to be recovered, which concerns the tenant, and the title thereto is tried collaterally, which may concern some other.

EKRON, a city and government of the Philistines. It fell by lot to the tribe of Judah, in the first division made by Joshua (xv. 45.), but afterwards it was given to the tribe of Dan (*id.* xix. 43.). It was situated very near the Mediterranean, between Ashdod and Jamnia. Ekron was a powerful city, and it does not appear by history that the Jews were ever sole peaceable possessors of it: the Ekronites were the first who said that it was necessary to send back the ark of the God of Israel, in order to be delivered from those calamities which the presence of it brought upon their country, (1 Sam. v. 10.). The idol Baalzebub was principally adored at Ekron (2 Kings, i. 2. &c.).

ELÆAGNUS, Oleaster, or *Wild Olive;* a genus of plants, belonging to the tetrandria class. See Botany *Index*.

ELÆOCARPUS, a genus of plants belonging to the polyandria class. See Botany *Index*.

ELÆOTHESIUM, in antiquity, the anointing room, or place where those who were to wrestle or had bathed anointed themselves. See Gymnasium.

ELAIS, a genus of plants belonging to the natural order of *Palmæ*. See Botany *Index*.

ELAM, in *Ancient Geography*, a country frequently mentioned in Scripture, and lying to the south-east of Shinar. In the time of Daniel (viii. 2.) Susiana seems to have been part of it; and before the captivity, it does not appear that the Jews called Persia by any other name. Elymæ and Elymais are often mentioned by the ancients. Ptolemy, though he makes Elymais a province of Media, yet he places the Elymæ in Susiana, near the sea coast. Stephanus takes it to be a part of Assyria; but Pliny and Josephus more properly of Persia, whose inhabitants this latter tells us sprang from the Elamites. The best commentators agree, that the Elamites, who were the ancestors of the Persians, were descended from Elam the son of Shem. It is likewise allowed that the most ancient among the inspired writers constantly intend Persia, when they speak of Elam and the kingdom of Elam. Thus, not to detain the reader with unnecessary quotations, when the prophet Jeremiah (xlix. 39.), after denouncing many judgments against this country, adds these words, "But it shall come to pass in the latter days, that I will bring again the captivity of Elam, saith the Lord," he is always understood to mean the restoration of the kingdom of the Persians by Cyrus, who subdued the Babylonians, as they before had subdued the Persians.

ELAPHEBOLIA, in Grecian antiquity, a festival in honour of Diana the huntress. In the celebration a cake was made in the form of a deer (ελαφος), and offered to the goddess. It owed its institution to the following circumstance: When the Phocians had been severely beaten by the Thessalians, they resolved, by the persuasion of one Deiphantus, to raise a pile of combustible materials, and burn their wives, children, and effects, rather than submit to the enemy. This resolution was unanimously approved by the women, who decreed Deiphantus a crown for his magnanimity. When every thing was prepared, before they fired the pile, they engaged their enemies, and fought with such desperate fury, that they totally routed them, and obtained a complete victory. In commemoration of this unexpected success, this festival was instituted to Diana, and observed with the greatest solemnity.

ELAPHEBOLIUM, in Grecian antiquity, the ninth month of the Athenian year, answering to the latter part of February and beginning of March. It consisted of 30 days; and took its name from the festival elaphebolia, kept in this month, in honour of Diana the huntress, as mentioned in the preceding article.

ELASMIS, in *Natural History*, an old term applied to talcs, composed of small plates in form of spangles; and either single, and not farther fissile; or, if complex, only fissile to a certain degree, and that in somewhat thick laminæ.—Of these talcs there are several varieties, some with large and others with small spangles, which differ also in colour and other peculiarities.

ELASTIC, in *Natural Philosophy*, an appellation given to all bodies endowed with the property of elasticity. See Elasticity.

Elastic Fluids. See Air, Electricity, Gas, and *Elastic Vapours* below.

Elastic Resin. See Caoutchouc.

Elastic Vapours are such as may, by any external mechanical force, be compressed into a smaller space than what they originally occupied; restoring themselves, when the pressure is taken off, to their former state with a force exactly proportioned to that with which they were at first compressed. Of this kind are all the aerial fluids without exception, and all kinds of fumes raised by means of heat, whether from solid or fluid bodies.

Of these, some retain their elasticity only when a considerable degree of heat is applied to them or the substance which produces them; while others remain elastic in every degree of cold, either natural or artificial, that has yet been observed. Of the former kind are the vapours of water, spirit of wine, mercury, sal ammoniac, and all kinds of sublimable salts; of the latter, those of muriatic acid gas, hydrogen gas, nitrous gas, common air, &c.

The elastic force with which any one of these fluids is endowed has not yet been calculated, as being ultimately greater than any obstacle we can put in its way. Thus, if we compress the atmospherical air, we shall find that for some little time it will easily yield to the force we apply; but every succeeding moment the resistance will become stronger, and a greater and greater force must be applied in order to compress it farther. As the compression goes on, the vessel containing the air becomes hot; but no power whatever has yet been able to destroy the elasticity of the contained fluid in any degree; for upon removing the pressure, it is always found to occupy the very same space that it did before. The case is the same with aqueous steam, to which a sufficient heat is applied to keep it from condensing into water. This will yield to a certain degree: but every moment the resistance becomes greater, until at last it will overcome any obstacles whatever. An example of the power of this kind of steam we have every day in the steam engine; and the vapours of other matters, both solid and fluid, have frequently manifested themselves to be endowed with an equal force. Thus the force of the vapours of spirit of wine has occasioned terrible accidents when the worm has been stopped, and the head of the still absurdly tied down to prevent an explosion; the vapours of mercury have burst an iron box; and those of sal ammoniac, volatile salts, nitrous acid, marine acid, phosphorus, &c. have all been known to burst the chemical vessels which confined them with great force, in such a manner as to endanger those who stood near them. In short, from innumerable observations, it may be laid down as an undoubted fact, that there is no substance whatever capable of being reduced into a state of vapour, but what in that state is endowed with an elastic force ultimately superior to any obstacle we can throw in its way.

It hath been a kind of desideratum among philosophers to give a satisfactory reason for this astonishing

ing power of elasticity in vapour, seemingly so little capable of accomplishing any great purpose when in an unconfined state. As air is that fluid in which, from the many experiments made upon it by the air-pump and otherwise, the elastic property has most frequently been observed, the researches of philosophers were at first principally directed towards it. The causes they assigned, however, were very inadequate; being founded upon an hypothesis concerning the form of the particles of the atmosphere itself, which they supposed to be either rolled up like the springs of watches, or that they consisted of a kind of elastic flakes. This was followed by another hypothesis concerning their substance, which was imagined to be perfectly elastic, and so strong that they could not be broken by any mechanical power whatever; and thus they thought the phenomenon of the elasticity of the air might be explained. But an insuperable difficulty still attended their scheme, notwithstanding both these suppositions: for it was observed, that the elastic power of the air was augmented not only in proportion to the quantity of pressure it was made to endure, but in proportion to the degree of heat applied to it at the time. Sir Isaac Newton was aware of this difficulty; and justly concluded, that the phenomena of the air's elasticity could not be solved on any other supposition but that of a repulsive power diffused all around each of its particles, which became stronger as they approached, and weaker as they removed from each other. Hence the common phenomena of the air-pump and condensing-engine received a satisfactory explanation; but still it remained to account for the power shown in the present case by heat, as it could not be denied that this element had a very great share in augmenting the elasticity of the atmosphere, and seemed to be the only cause of elasticity in other vapours. It does not appear that Sir Isaac entered into this question, but contented himself with attributing to heat the property of increasing repulsion, and ascribing this to another unexplored property called *rarefaction*. Thus matters stood till the great discovery made by Dr Black, that some bodies have the power of absorbing in an unknown manner the element in question, and parting with it afterwards, so that it flows out of the body which had absorbed it with the very same properties that it had before absorption. Hence many phenomena of heat, vapours and evaporation, were explained in a manner much more satisfactory than had ever been attempted or even expected before. One of these was that remarkable property of metals becoming hot by hammering; during which operation, in the Doctor's opinion, the element of heat is squeezed out from between the particles of the metal, as water is from the pores of a sponge by pressing it between the fingers. Of the same nature is the phenomenon above mentioned, that air when violently compressed becomes hot, by reason of the quantity of more subtle element squeezed out from among the particles. In this manner it appears that heat and the repulsive power of Sir Isaac Newton are the very same; that by diminishing the heat of any quantity of air, its elasticity is effectually diminished, and it will of itself shrink into a smaller space as effectually as by mechanical pressure. In one case have we what may be called ocular demonstration of the truth of this doctrine, viz. that by throwing the focus of a strong burning lens upon a small quantity of charcoal *in vacuo*, the whole will be converted into inflammable air, having even a greater power of elasticity than common air in an equal degree of heat. Here there is nothing else but heat or light to produce the elastic power, or cause the particles of charcoal which before *attracted* now to repel each other. In another case we have evidence equally strong, that the element of heat by itself, without the presence of that of light, is capable of producing the same effect. Thus when a phial of ether is put into the receiver of an air pump, and surrounded by a small vessel of water, the ether boils violently, and is dissipated in vapour, while the water freezes, and is cooled to a great degree. The dissipation of this vapour shows that it has an elastic force; and the absorption of the heat from the water shows, that this element not only *produces* the elasticity, but actually enters into the substance of the vapour itself; so that we have not the least reason to conclude that there is any other repulsive power by which the particles are kept at a distance from one another than the substance of the heat itself. In what manner it acts, we cannot pretend exactly to explain, without making hypotheses concerning the form of the minute particles of matter, which must always be very uncertain. All known phenomena, however, concur in rendering the theory just now laid down extremely probable. The elasticity of the steam of water is exactly proportioned to the degree of heat which flows into it from without; and if this be kept up to a sufficient degree, there is no mechanical pressure which can reduce it into the state of water. This, however, may very easily be done by abstracting a certain portion of the latent heat it contains; when the elastic vapour will become a dense and heavy fluid. The same thing may be done in various ways with the permanently elastic fluids. Thus the purest dephlogisticated air, when made to part with its latent heat by burning with iron, is converted into a gravitating substance of an unknown nature, which adheres strongly to the metal. If the decomposition is performed by means of inflammable air, both together unite into an heavy, aqueous, or acid fluid: if by mixture with nitrous air, still the heat is discernible, though less violent than in the two former cases. The decomposition indeed is slower, but equally complete, and the deplogisticated air becomes part of the nitrous acid, from which it may be again expelled by proper means: but of these means heat must always be one; for thus only the elasticity can be restored, and the air be recovered in its proper state. The same thing takes place in fixed air, and all other permanently elastic fluids capable of being absorbed by others. The conclusion therefore which we can only draw from what data we have concerning the composition of elastic vapours is, that all of them are formed of a terrestrial substance, united with the element of heat in such a manner that part of the latter may be squeezed out from among the terrestrial particles; but in such a manner, that as soon as the pressure is taken off, the surrounding fluid rushes in, and expands them to their original bulk: and this expansion or tendency to it will be increased in proportion to the degree of heat, just as the expansion of a sponge would be exceedingly augmented, if we could contrive to convey a stream of water into

into the heart of it, and make the liquid flow out with violence through every pore in the circumference. In this case, it is evident that the water would act as a *power of repulsion* among the particles of the sponge, as well as the fire does among the particles of the water, charcoal, or whatever other substance is employed. Thus far we may reason from analogy; but in all probability the internal and essential texture of these vapours will for ever remain unknown. Their obvious properties, as well as some of their more latent operations in many cases, are treated of under CHEMISTRY.

It has been imagined by some, that the artificial elastic fluids have not the same mechanical property with common air, viz. that of occupying a space inversely proportional to the weights with which they are pressed: but this is found to be a mistake. All of them likewise have been found to be non-conductors of electricity, though probably not all in the same degree. Even aqueous vapour, when intimately mingled with any permanently elastic fluid, refuses to conduct this fluid, as is evident from the highly electrical state of the atmosphere in very dry weather, when we are certain that aqueous vapour must abound very much, and be intimately mixed with it. The colour of the electric spark, though it may be made visible in all kinds of permanently elastic vapours, is very different in different fluids. Thus in inflammable and alkaline air it is red or purple, but in fixed air it appears white.

ELASTICITY, or *ELASTIC Force*, that property of bodies wherewith they restore themselves to their former figure, after any external pressure.

The cause or principle of the important property elasticity, or springiness, is variously assigned. The Cartesians account for it from the materia subtilis making an effort to pass through pores that are too narrow for it. Thus, say they, in bending or compressing, a hard elastic body, e. g. a bow, its parts recede from each other on the convex side, and approach on the concave: consequently the pores are contracted or straitened on the concave side; and if they were before round, are now, for instance, oval: so that the materia subtilis, or matter of the second element, endeavouring to pass out of those pores thus straitened, must make an effort, at the same time, to restore the body to the state it was in when the pores were more patent and round, i. e. before the bow was bent: and in this consists its elasticity.

Other later and more wary philosophers account for elasticity much after the same manner as the Cartesians; with this only difference, that in lieu of the subtile matter of the Cartesians, these substitute ETHER, or a fine etherial medium that pervades all bodies.

Others, setting aside the precarious notion of a materia subtilis, account for elasticity from the great law of nature ATTRACTION, or the cause of the COHESION of the parts of solid and firm bodies. Thus, say they, when a hard body is struck or bent, so that the component parts are moved a little from each other, but not quite disjointed or broke off, or separated so far as to be out of the power of that attractive force whereby they cohere; they must certainly, on the cessation of the external violence, spring back to their former natural state.

Others resolve elasticity into the pressure of the atmosphere; for a violent tension or compression, though not so great as to separate the constituent particles of bodies far enough to let in any foreign matter, must yet occasion many little vacuola between the separated surfaces; so that upon the removal of the force they will close again by the pressure of the aerial fluid upon the external parts. See ATMOSPHERE.

Lastly, others attribute the elasticity of all hard bodies to the power of resilition in the air included within them: and so make the elastic force of the air the principle of elasticity in all other bodies.

The ELASTICITY of Fluids is accounted for from their particles being all endowed with a centrifugal force; when Sir Isaac Newton, prop. 23. lib. 2. demonstrates, that particles, which naturally avoid or fly off from one another by such forces as are reciprocally proportioned to the distances of their centre, will compose an elastic fluid, whose density shall be proportional to its compressions; and *vice versa*, if any fluid be composed of particles that fly off and avoid one another, and hath its density proportional to its compression, then the centrifugal forces of those particles will be reciprocally as the distances of their centres.

ELASTICITY of the Air, is the force wherewith that element dilates itself, upon removing the force whereby it was before compressed. See AIR and ATMOSPHERE.

The elasticity or spring of the air was first discovered by Galileo. Its existence is proved by this experiment of that philosopher: An extraordinary quantity of air being introduced by means of a syringe into a glass or metal ball, till such time as the ball, with this accession of air, weighs considerably more in the balance than it did before; upon opening the mouth thereof, the air rushes out, till the ball sink to its former weight. From hence we argue, that there is just as much air gone out, as compressed air had been crowded in. Air, therefore, returns to its former degree of expansion, upon removing the force that compressed or resisted its expansion; consequently it is endowed with an elastic force. It must be added, that as the air is found to rush out in every situation or direction of the orifice, the elastic force acts every way, or in every direction.

The elasticity of the air makes a considerable article in PNEUMATICS.

The cause of the elasticity of the atmosphere hath been commonly ascribed to a repulsion between its particles; but this can give us only a very slight idea of the nature of its elasticity. The term *repulsion*, like that of *attraction*, requires to be defined; and, in all probability, will be found in most cases to be the effect of the action of some other fluid. Thus, we find, that the elasticity of the atmosphere is very considerably affected by heat. Supposing a quantity of air heated to such a degree as is sufficient to raise Fahrenheit's thermometer to 212, it will then occupy a considerable space. If it is cooled to such a degree as to sink the thermometer to 0, it will shrink up into less than half the former bulk. The quantity of repulsive power therefore acquired by the air, while passing from one of these states to the other, is evidently owing to the heat added to or taken away from it. Nor have we any reason to suppose that the quantity of elasticity or repulsive power it still possesses is owing to any other thing than the fire contained in it. The supposing repulsion to be a primary cause, independent of all others, hath given rise to many erroneous theories, and been one very great mean of embarrassing philosophers in their accounting for the phenomena of ELECTRICITY.

ELATE, a genus of plants belonging to the natural order of *Palmæ*. See BOTANY *Index*.

ELATER, a genus of insects belonging to the order of *Coleoptera*. See ENTOMOLOGY *Index*.

ELATERIUM, a genus of plants belonging to the monœcia class. See BOTANY *Index*.

ELATERIUM, Ελατηριον, in *Pharmacy*, a violently purgative medicine, prepared from the wild cucumber.

ELATH, or ELOTH, a port of Idumæa, situated upon the Red sea, which David in his conquest of Edom took (2 Sam. viii. 14.), and there established a trade to all parts of the world. His son, we see, built ships in Elath, and sent them from thence to Ophir for gold, (2 Chr. viii. 17, 18.). It continued in the possession of the Israelites about 150 years, till in the time of Joram, the Edomites recovered it (1 Kings viii. 20.); but it was again taken from them by Azariah, and by him left to his son, (2 Kings xiv. 22.). His grandson Ahaz, however, lost it again to the king of Syria (ib. xvi. 6.); and the Syrians had it in their hands a long while, till, after many changes under the Ptolemies, it came at length into the possession of the Romans.

ELATINE, a genus of plants belonging to the octandria class. See BOTANY *Index*.

ELATOSTEMA, a genus of plants belonging to the monœcia class. See BOTANY *Index*.

ELBA, an island in the Mediterranean, near the coast of Tuscany, rendered celebrated by the temporary residence of Bonaparte in 1814. It is about 60 miles in circuit, and contains 12,000 inhabitants. See ELBA, SUPPLEMENT.

ELBE, a large river in Germany, which, rising on the confines of Silesia, runs through Bohemia, Saxony, and Brandenburg; and afterwards dividing the duchy of Luxemburg from that of Mecklenburg, as also the duchy of Bremen from Holstein, it falls into the German ocean, about 70 miles below Hamburg. It is navigable for great ships higher than any river in Europe.

ELBING, a city of Polish Prussia, in the palatinate of Marienburg, situated in E. Long. 20. 0. N. Lat. 54. 15. on a bay of the Baltic sea, called the *Frischaff*, near the mouth of the Vistula. The town is large, populous, and very well built. It is divided into two parts, called the old and new town, which are both of them very well fortified. The old town has a handsome tower, with a good college. The place has a considerable trade, especially in cheese, butter, and corn. It is seated in a champaign level like Holland, very fruitful and populous. The inhabitants are partly Lutherans and partly Roman Catholics.

ELBOW, the outer angle made by the flexure or bend of the arm. That eminence whereon the arm rests, called by us *elbow*, is by the Latins called *cubitus*, and the Greeks αγκων, and by others ολεκρανον.

ELBOW is also used by architects, masons, &c. for an obtuse angle of a wall, building, or road, which diverts it from its right line.

ELCESAITES, in church history, ancient heretics, who made their appearance in the reign of the emperor Trajan, and took their name from their leader Elcesai. The Elcesaites kept a mean between the Jews, Christians, and Pagans; they worshipped but one God, observed the Jewish sabbath, circumcision, and the other ceremonies of the law. They rejected the Pentateuch, and the prophets: nor had they any more respect for the writings of the apostles, particularly those of St Paul.

ELDERS, or SENIORS, in Jewish history, were persons the most considerable for age, experience, and wisdom. Of this sort were the 70 men whom Moses associated to himself in the government of his people: such, likewise, afterwards, were those who held the first rank in the synagogue, as presidents.

In the first assemblies of the primitive Christians, those who held the first place were called *elders*. The word *presbyter*, often used in the New Testament, is of the same signification: hence the first councils of Christians were called *presbyteria*, or *councils of elders*.

ELDERS is also a denomination still retained in the Presbyterian discipline. The elders are officers, who, in conjunction with the pastors, or ministers, and deacons, compose the consistories or kirk-sessions, meeting to consider, inspect, and regulate, matters of religion and discipline. They are chosen from among the people, and are received publicly with some degree of ceremony. In Scotland, there is an indefinite number of elders in each parish; generally about 12. See *KIRK-Sessions* and PRESBYTERY.

ELDER. See SAMBUCUS, BOTANY *Index*.

ELEA, or ELIS, in *Ancient Geography*, a district of Peloponnesus, situated between Achaia and Messenia, reaching from Arcadia quite to the west or Ionian sea: so called from ELIS, a cognominal town. See ELIS.

ELEATIC PHILOSOPHY, among the ancients, a name given to that of the STOICS, because taught at Ελεα, in Latin *Velia*, a town of the Lucani.

The founder of this philosophy, or of the Eleatic sect, is supposed to have been Xenophanes, who lived about the 56th Olympiad, or between 500 or 600 years before Christ. This sect was divided into two parties, which may be denominated *metaphysical* and *physical*, the one rejecting, and the other approving, the appeal to fact and experiment. Of the former kind were Xenophanes, Parmenides, Melissus, and Zeno of Elea. They are supposed to have maintained principles not very unlike those of Spinoza; they held the eternity and immutability of the world: that whatever existed was only one being; that there was neither any generation or corruption; that this one being was immoveable and immutable, and was the true God; and whatever changes seemed to happen in the universe, they considered as mere appearances and illusions of sense. However, some learned men have supposed, that Xenophanes and his followers, speaking metaphysically, understood by the universe, or the one being, not the material world, but the originating principle of of all things, or the true God, whom they expressly affirm to be incorporeal. Thus Simplicius represents them as merely metaphysical writers, who distinguished between things natural and supernatural; and who made the former to be compounded of different principles. Accordingly, Xenophanes maintained, that the earth consisted of air and fire; that all things were produced out of the earth, and the sun and stars out of clouds, and that there were four elements. Parmenides also distinguished between the doctrine concerning metaphysical objects, called *truth*, and that concerning physical or corporeal things, called *opinion*; with respect to the former there was one immoveable principle; but in the latter two that were moveable, viz. fire and earth, or heat and cold; in which particulars Zeno agreed with him. The other branch of the Eleatic sect were the atomic philosophers, who formed their system from an attention to the phenomena of nature; of these the most considerable were Leucippus, Democritus, and Protagoras.

ELECAMPANE. See INULA, BOTANY *Index*.

ELECT, (from *eligo*, "I choose") CHOSEN, in the Scriptures, is applied to the primitive Christians; in which sense, the elect are those chosen and admitted to the favour and blessing of Christianity.

ELECT, in some systems of theology, is a term appropriated to the saints, or the predestinated: in which sense the elect are those persons who are said to be predestinated to glory as the end, and to sanctification as the means.

ELECT is likewise applied to archbishops, bishops, and other officers, who are chosen, but not yet consecrated, or actually invested with their office or jurisdiction.

The emperor is said to be elect before he is inaugurated and crowned; a lord mayor is elect, before his predecessor's mayoralty is expired, or the sword is put in his hands.

ELECTION, the choice that is made of any thing or person, whereby it is preferred to some other. There seems this difference, however, between choice and election, that election has usually a regard to a company or community, which makes the choice; whereas choice is seldom used but when a single person makes it.

ELECTION, in British polity, is the people's choice of their representatives in parliament. (See PARLIAMENT.) In this consists the exercise of the democratical part of our constitution: for in a democracy there can be no exercise of sovereignty but by suffrage, which is the declaration of the people's will. In all democracies, therefore, it is of the utmost importance to regulate by whom, and in what manner, the suffrages are to be given. And the Athenians were so justly jealous of this prerogative, that a stranger, who interfered in the assemblies of the people, was punished by their laws with death; because such a man was esteemed guilty of high treason, by usurping those rights of sovereignty to which he had no title. In Britain, where the people do not debate in a collective body, but by representation, the exercise of this sovereignty consists in the choice of representatives. The laws have therefore very strictly guarded against usurpation or abuse of this power, by many salutary provisions; which may be reduced to these three points, 1. The qualifications of the electors. 2. The qualifications of the elected. 3. The proceedings at elections.

B kst. C nent.

(1.) As to the qualifications of the electors. The true reason of requiring any qualification, with regard to property, in voters, is to exclude such persons as are in so mean a situation, that they are esteemed to have no will of their own. If these persons had votes, they would be tempted to dispose of them under some undue influence or other. This would give a great, an artful, or a wealthy man, a larger share in elections than is consistent with general liberty. If it were probable that every man would give his vote freely, and without influence of any kind; then, upon the true theory and genuine principles of liberty, every member of the community, however poor, should have a vote in electing those delegates to whose charge is committed the disposal of his property, his liberty, and his life. But since that can hardly be expected in persons of indigent fortunes, or such as are under the immediate dominion of others, all popular states have been obliged to establish certain qualifications; whereby some, who are suspected to have no will of their own, are excluded from voting, in order to set other individuals, whose will may be supposed independent, more thoroughly upon a level with each other.

And this constitution of suffrages is framed upon a wiser principle with us, than either of the methods of voting, by centuries, or by tribes, among the Romans. In the method by centuries, instituted by Servius Tullius, it was principally property, and not numbers, that turned the scale: in the method by tribes, gradually introduced by the tribunes of the people, numbers only were regarded, and property entirely overlooked. Hence the laws passed by the former method had usually too great a tendency to aggrandize the patricians or rich nobles; and those by the latter had too much of a levelling principle. Our constitution steers between the two extremes. Only such are entirely excluded as can have no will of their own: there is hardly a free agent to be found, but what is entitled to a vote in some kind or other in the kingdom. Nor is comparative wealth, or property, entirely disregarded in elections; for though the richest man has only one vote at one place, yet, if his property be at all diffused, he has probably a right to vote at more places than one, and therefore has many representatives. This is the spirit of our constitution; not that we assert it is in fact quite so perfect as we have endeavoured to describe it; for if any alteration might be wished or suggested in the present form of parliaments, it should be in favour of a more complete representation of the people.

But to return to the qualifications; and first those of electors for knights of the shire. 1. By statute 8 Hen. VI. c. 7. and 10 Hen. VI. c. 2. (amended by 14 Geo. III. c. 58.) the knights of the shire shall be chosen of people, whereof every man shall have freehold to the value of forty shillings by the year within the county; which (by subsequent statutes) is to be clear of all charges and deductions, except parliamentary and parochial taxes. The knights of shires are the representatives of the landholders, or landed interest of the kingdom: their electors must therefore have estates in lands or tenements within the county represented.

sented. These estates must be freehold, that is, for term of life at least; because beneficial leases for long terms of years were not in use at the making of these statutes, and copyholders were then little better than villains, absolutely dependent upon their lords. This freehold must be of 40 shillings annual value; because that sum would then, with proper industry, furnish all the necessaries of life, and render the freeholder, if he pleased, an independent man: For Bishop Fleetwood, in his *Chronicon Preciosum*, written at the beginning of the last century, has fully proved 40 shillings in the reign of Henry VI. to have been equal to twelve pounds per annum in the reign of Queen Anne; and, as the value of money is very considerably lowered since the bishop wrote, we may fairly conclude, from this and other circumstances, that what was equivalent to 12 pounds in his days, is equivalent to 20 at present. The other less important qualifications of the electors for counties in England and Wales may be collected from the statutes cited below (A); which direct, 2. That no person under 21 years of age shall be capable of voting for any member. This extends to all sorts of members as well for boroughs as counties; as does also the next, viz. 3. That no person convicted of perjury, or subornation of perjury, shall be capable of voting in any election. 4. That no person shall vote in right of any freehold, granted to him fraudulently, to qualify him to vote. Fraudulent grants are such as contain an agreement to reconvey, or to defeat the estate granted; which agreements are made void, and the estate is absolutely vested in the person to whom it is so granted. And, to guard the better against such frauds, it is further provided, 5. That every voter shall have been in the actual possession, or receipt of the profits, of his freehold to his own use for 12 kalendar months before; except it came to him by descent, marriage, marriage settlement, will, or promotion to a benefice or office. 6. That no person shall vote in respect of an annuity or rent-charge, unless registered with the clerk of the peace 12 kalender months before. 7. That in mortgaged or trust estates, the person in possession, under the above-mentioned restrictions, shall have the vote. 8. That only one person shall be admitted to vote for any one house or tenement, to prevent the splitting of freeholds. 9. That no estate shall qualify a voter, unless the estate has been assessed to some land-tax aid, at least 12 months before the election. 10. That no tenant by copy of court-roll shall be permitted to vote as a freeholder. Thus much for the electors in counties.

As for the electors of citizens and burgesses, these are supposed to be the mercantile part or trading interest of this kingdom. But as trade is of a fluctuating nature, and seldom long fixed in a place, it was formerly left to the crown to summon, *pro re nata*, the most flourishing towns to send representatives to parliament. So that as towns increased in trade, and grew populous, they were admitted to a share in the legislature. But the misfortune is, that the deserted boroughs continued to be summoned, as well as those to whom their trade and inhabitants were transferred; except a few which petitioned to be eased of the expence, then usual, of maintaining their members: four shillings a-day being allowed for a knight of the shire, and two shillings for a citizen or burgess; which was the rate of wages established in the reign of Edward III. Hence the members for boroughs now bear above a quadruple proportion to those for counties; and the number of parliament men is increased since Fortescue's times, in the reign of Henry VI. from 300 to upwards of 500, exclusive of those for Scotland. The universities were, in general, not empowered to send burgesses to parliament; though once, 28 Edw. I. when a parliament was summoned to consider of the king's right to Scotland, there were issued writs, which required the university of Oxford to send up four or five, and that of Cambridge two or three, of their most discreet and learned lawyers for that purpose. But it was King James I. who indulged them with the permanent privilege to send constantly two of their own body; to serve for those students who, though useful members of the commnnity, were neither concerned in the landed nor the trading interest: and to protect in the legislature the rights of the republic of letters. The right of election in boronghs is various, depending entirely on the several charters, customs, and constitutions of the respective places; which has occasioned infinite disputes; though now, by statute 2 Geo. II. c. 24. the right of voting for the future shall be allowed according to the last determination of the house of commons concerning it; and, by statute 3 Geo. III. c. 15. no freeman of any city or borough (other than such as claim by birth, marriage, or servitude) shall be intitled to vote therein, unless he hath been admitted to his freedom 12 kalender months before.

(2.) Next, as to the qualifications of persons to be *elected* members of the house of commons. Some of these depend upon the law and cnstom of parliaments, declared by the house of commons; others upon certain statutes. And from these it appears, 1. That they must not be aliens born or minors. 2. That they must not be any of the 12 judges, because they sit in the lords' house; nor of the clergy, for they sit in the convocation; nor persons attainted of treason, or felony, for they are unfit to sit anywhere. 3. That sheriffs of counties, and mayors and bailiffs of boroughs, are not eligible in their respective jurisdictions, as being returning officers; but that sheriffs of one county are eligible to be knights of another. 4. That, in strictness, all members ought to have been inhabitants of the places for which they are chosen; but this, having been long disregarded, was at length entirely repealed by statute 14 Geo. III. c. 58. 5. That no persons concerned in the management of any duties or taxes created since 1692, except the commissioners of the treasury, nor any of the officers following (viz. commissioners of prizes, transports, sick and wounded, wine licenses, navy, and victualling; secretaries or receivers of prizes; comptrollers of the army accounts; agents for regiments; governors of plantations, and their

---

(A) 7 and 8 Will. III. c. 25. 10 Ann. c. 23. 2 Geo. II. c. 21. 18 Geo. II. c. 18. 31 Geo. II. c. 14. 3 Geo. III. c. 24.

their deputies; officers of Minorca or Gibraltar; officers of the excise and customs; clerks or deputies in the several offices of the treasury, exchequer, navy, victualling, admiralty, pay of the army or navy, secretaries of state, salt, stamps, appeals, wine-licenses, hackney-coaches, hawkers, and pedlars), nor any persons that hold any new office under the crown created since 1705, are capable of being elected or sitting as members. 6. That no person having a pension under the crown during pleasure, or for any term of years, is capable of being elected or sitting. 7. That if any member accepts an office under the crown, except an officer in the army or navy accepting a new commission, his seat is void; but such member is capable of being re-elected. 8. That all knights of the shire shall be actual knights, or such notable esquires and gentlemen as have estates sufficient to be knights, and by no means of the degree of yeomen. This is reduced to a still greater certainty, by ordaining, 9. That every knight of a shire shall have a clear estate of freehold or copyhold to the value of 600l. per annum, and every citizen and burgess to the value of 300l.: except the eldest sons of peers and of persons qualified to be knights of shires, and except the members for the two universities; which somewhat balances the ascendant which the boroughs have gained over the counties, by obliging the trading interest to make choice of landed men: and of this qualification the member must make oath, and give in the particulars in writing, at the time of his taking his seat. But, subject to these standing restrictions and disqualifications, every subject of the realm is eligible of common right: though there are instances, wherein persons in particular circumstances have forfeited that common right, and have been declared ineligible *for that parliament*, by a vote of the house of commons, or *for ever*, by an act of the legislature. But it was an unconstitutional prohibition which was grounded on an ordinance of the house of *lords*, and inserted in the *king's* writs, for the parliament holden at Coventry, 6 Hen. IV. that no apprentice or other man of the law should be elected a knight for the shire therein: in return for which, our law-books and historians have branded this parliament with the name of *parliamentum indoctum*, or the lack-learning parliament; and Sir Edward Coke observes, with some spleen, that there was never a good law made thereat.

(3.) The third point, regarding elections, is the method of proceeding therein. This is also regulated by the law of parliament, and the several statutes referred to in the margin below (B); all which we shall blend together, and extract out of them a summary account of the method of proceeding to elections.

As soon as the parliament is summoned, the lord chancellor (or if a vacancy happens during the sitting of parliament, the speaker, by order of the house, and without such order if a vacancy happens by death in the time of a recess for upwards of 20 days) sends his warrant to the clerk of the crown in chancery; who thereupon issues out writs to the sheriff of every county for the election of all the members to serve for that county, and every city and borough therein. Within three days after the receipt of this writ, the sheriff is to send his precept, under his seal, to the proper returning officers of the cities and boroughs, commanding them to elect their members: and the said returning officers are to proceed to election within eight days from the receipt of the precept, giving four days notice of the same; and to return the persons chosen, together with the precept, to the sheriff.

But elections of knights of the shire must be proceeded to by the sheriffs themselves in person, at the next county-court that shall happen after the delivery of the writ. The county-court is a court held every month or oftener by the sheriff, intended to try little causes not exceeding the value of 40s. in what part of the county he pleases to appoint for that purpose: but for the election of knights of the shire, it must be held at the most usual place. If the county-court falls upon the day of delivering the writ, or within six days after, the sheriff may adjourn the court and election to some other convenient time, not longer than 16 days, nor shorter than 10: but he cannot alter the place, without the consent of all the candidates; and, in all such cases, 10 days public notice must be given of the time and place of the election.

And, as it is essential to the very being of parliament that elections should be absolutely free, therefore all undue influences upon the electors are illegal, and strongly prohibited. For Mr Locke ranks it among those breaches of trust in the executive magistrate, which, according to his notions, amount to a dissolution of the government, "if he employs the force, treasure, and offices of the society to corrupt the representatives, or openly to pre-engage the electors, and prescribe what manner of persons shall be chosen: For thus to regulate candidates and electors, and new model the ways of election, what is it (says he) but to cut up the government by the roots, and poison the very fountain of public security?" As soon, therefore, as the time and place of election, either in counties or boroughs, are fixed, all soldiers quartered in the place are to remove, at least one day before the election, to the distance of two miles or more; and not to return till one day after the poll is ended. Riots likewise have been frequently determined to make an election void. By vote also of the house of commons, to whom alone belongs the power of determining contested elections, no lord of parliament, or lord-lieutenant of a county, hath any right to interfere in the election of commoners; and, by statute, the lord warden of the cinque-ports shall not recommend any members there. If any officer of the excise, customs, stamps, or certain other branches of the revenue, presumes to intermeddle in elections, by persuading any voter or dissuading him, he forfeits 100l. and is disabled to hold any office.

(B) 7 Hen. IV. c. 15. 8 Hen. VI. c. 7. 23 Hen. VI. c. 14. 1 W. & M. st. 1. c. 2. 2 W. and M. st. 1. c. 7. 5 and 6 W. & M. c. 20. 7 W. III. c. 4. 7 and 8 W. III. c. 7. and c. 25. 10 and 11 W. III. c. 7. 12 and 13 W. III. c. 10. 6 Ann. c. 23. 9 Ann. c. 5. 10 Ann. c. 19. and c. 33. 2 Geo. II. c. 24. 8 Geo. II. c. 30. 18 Geo. II. c. 18. 19 Geo. II. c. 28. 10 Geo. III. c. 16. 11 Geo. III. c. 42. 14 Geo. III. c. 15.

Thus are the electors of one branch of the legislature secured from any undue influence from either of the other two, and from all external violence and compulsion. But the greatest danger is that in which themselves co-operate, by the infamous practice of bribery and corruption. To prevent which it is enacted, that no candidate shall, after the date (usually called the *teste*) of the writs, or after the vacancy, give any money or entertainment to his electors, or promise to give any, either to particular persons, or to the place in general, in order to his being elected; on pain of being incapable to serve for that place in parliament. And if any money, gift, office, employment, or reward be given, or promised to be given, to any voter, at any time, in order to influence him to give or withhold his vote, as well he that takes as he that offers such bribe forfeits 500l. and is for ever disabled from voting and holding any office in any corporation; unless, before conviction, he will discover some other offender of the same kind, and then he is indemnified for his own offence. The first instance that occurs of election bribery, was so early as 13 Eliz. when one Thomas Longe (being a simple man, and of small capacity to serve in parliament) acknowledged that he had given the returning officer and others of the borough for which he was chosen four pounds to be returned member, and was for that premium elected. But for this offence the borough was amerced, the member was removed, and the officer fined and imprisoned. But as this practice hath since taken much deeper and more universal root, it hath occasioned the making of these wholesome statutes; to complete the efficacy of which, there is nothing wanting but resolution and integrity to put them in strict execution.

Undue influence being thus guarded against, the election is to be proceeded to on the day appointed; the sheriff or other returning officer first taking an oath against bribery, and for the due execution of his office. The candidates likewise, if required, must swear to their qualification, and the electors in counties to theirs; and the electors both in counties and boroughs are also compellable to take the oath of abjuration, and that against bribery and corruption. And it might not be amiss, if the members elected were bound to take the latter oath as well as the former; which, in all probability, would be much more effectual than administering it only to the electors.

The election being closed, the returning officer in boroughs returns his precept to the sheriff, with the persons elected by the majority: and the sheriff returns the whole, together with the writ for the county and the knights elected thereupon, to the clerk of the crown in chancery; before the day of meeting, if it be a new parliament, or within 14 days after the election, if it be an occasional vacancy; and this under penalty of 500l. If the sheriff does not return such knights only as are duly elected, he forfeits, by the old statues of Henry VI. 100l.; and the returning officer in boroughs, for a like false return, 40l.; and they are besides liable to an action, in which double damages shall be recovered, by the latter statutes of King William: and any person bribing the returning officer shall also forfeit 300l. But the members returned by him are the sitting members, until the house of commons, upon petition, shall adjudge the return to be false and illegal. The form and manner of proceeding upon such petition are now regulated by statute 10 Geo. III. c. 16. (amended by 11 Geo. III. c. 42. and made perpetual by 14 Geo. III. c. 15.), which directs the method of choosing by lot a select committee of 15 members, who are sworn well and truly to try the same, and a true judgment to give, according to the evidence.

ELECTION of Scots Peers. See LORDS.

ELECTION of Ecclesiastical Persons. Elections for the dignities of the church ought to be free, according to the stat. 9 Ed. II. cap. 14. If any persons, that have a voice in elections, take any reward for an election in any church, college, school, &c. the election shall be void. And if any persons of such societies resign their places to others for reward, they incur a forfeiture of double the sum; and both the parties are rendered incapable of the place. Stat. 31 Eliz. cap. 6.

ELECTION of a Verderor of the Forest (electione viridariorum forestæ), in *Law*, a writ that lies for the choice of a verderor, where any of the verderors of the forest are dead, or removed from their offices. This writ is directed to the sheriff, and the verderor is to be elected by the freeholders of the county in the same manner as coroners. New. Nat. Brev. 366.

ELECTION is also the state of a person who is left to his own free will, to take or do either one thing or another, which he pleases. See LIBERTY.

ELECTION, in *Theology*, signifies the choice which God, of his good pleasure, makes of angels or men, for the objects of mercy and grace.

The election of the Jews was the choice God made of that people to be more immediately attached to his worship and service, and for the Messiah to be born of them. And thus particular nations were elected to the participation of the outward blessings of Christianity.

ELECTION also, in the language of some divines, signifies a predestination to grace and glory, and sometimes to glory only. And it has been enjoined as an article of faith, that predestination to grace is gratuitous, merely and simply so; *gratia, quia gratis data.* But the divines are much divided as to the point, whether election to glory be gratuitous, or whether it supposes obedience and good works, i. e. whether it be before or after the provision of our obedience. See GRACE and REPROBATION.

ELECTIVE, something that is done, or passes, by election. See ELECTOR.

Some benefices are elective, others collative. Municipal offices in England are generally elective; in Spain, venal. Poland is an elective kingdom.

ELECTIVE Attraction. See CHEMISTRY *Index.*

ELECTOR, a person who has a right to elect or choose another to an office, honour, &c. See ELECTION.

Elector is particularly, and by way of eminence, applied to those princes of Germany in whom lies the right of electing the emperor; being all sovereign princes, and the principal members of the empire.

The electoral college, consisting of all the electors of the empire, is the most illustrious and august body in Europe. Bellarmine and Baronius attribute the institution of it to Pope Gregory V. and the emperor Otho ector. tho III. in the tenth century; of which opinion are the generality of historians, and particularly the canonists: however, the number of electors was unsettled, at least, till the 13th century. In 1356 Charles IV. by the golden bull, fixed the number of electors to seven; three ecclesiastics, viz. the archbishops of Mentz, Treves, and Cologne; and four secular, viz. the king of Bohemia, count Palatine of the Rhine, duke of Saxony, and marquis of Brandenburg. In 1648 this order was changed, the duke of Bavaria being put in the place of the count Palatine, who having accepted the crown of Bohemia, was outlawed by the emperor; but being at length restored, an eighth electorate was erected for the duke of Bavaria. In 1692, a ninth electorate was created, by the emperor Leopold, in favour of the duke of Hanover, of the house of Brunswic Lunenburg.

There is this difference between the secular and ecclesiastical electors, that the first have an active and passive voice, that is, may choose and be chosen; the last an active only. The three archbishops are to be 30 years old before they can be advanced to the dignity; the seculars 18, before they can perform the office themselves. These last have each their vicars, who officiate in their absence.

Besides the power of choosing an emperor, the electors have also that of capitulating with and deposing him; so that, if there be one suffrage wanting, a protest may be entered against the proceedings. By the right of capitulation, they attribute to themselves great privileges, as making of war, coining, and taking care of the public interest and security of the states; and the emperor promises, upon oath, to receive the empire upon these conditions. Elector, Electorate.

The electors have precedence of all other princes of the empire, even of cardinals and kings; and are addressed under the title of *electoral highness*.

Their several functions are as follow. The elector of Mentz is chancellor of Germany, convokes the states, and gives his vote before any of the rest. The elector of Cologne is grand chancellor of Italy, and consecrates the emperor. The elector of Treves is chancellor of the Gauls, and confers imposition of hands upon the emperor. The count Palatine of the Rhine is great treasurer of the empire, and presents the emperor with a globe at his coronation. The elector of Bavaria is great master of the imperial palace, and carries the golden apple. The marquis of Brandenburg is grand-chamberlain, and puts the ring on the emperor's finger. The elector of Saxony is grand marshal, and gives the sword to the emperor. The king of Bohemia is grand butler, and puts Charlemagne's crown on the emperor's head. Lastly, the elector of Hanover, now king of Great Britain, is arch-treasurer, though first erected under the title of *standard-bearer* of the empire.

ELECTORATE, a term used as well to signify the dignity of, as the territories belonging to, any of the electors of Germany; such as Bavaria, Saxony, &c. See ELECTOR.

ELECTRICITY.

INTRODUCTION.

General Principles.

1 G ral id of electr y. WHEN a glass tube of considerable size, perfectly clean and dry, is rubbed briskly with a dry hand, and immediately held over small pieces of paper, straws, feathers, or other light bodies, it will attract them, and after retaining them in contact with it for some time, repel them; and this attraction and repulsion will be alternately repeated several times.

If after rubbing the tube, the knuckle be presented to the closed end, a snapping noise will be heard, and the finger will receive a slight shock. When this experiment is made in the dark, a luminous spark appears at the moment the snap is heard, between the finger and the tube.

El ics. Many other substances, as amber, sealing-wax, rosin, &c. when rubbed with certain other substances, possess the property of attracting light bodies and emitting sparks. As amber was first observed to possess them, the bodies which are capable of exhibiting similar appearances have been termed ELECTRICS, from ηλεκτρον, *amber;* and the science which illustrates and explains these phenomena is denominated ELECTRICITY (A). Electrical phenomena then are characterized by the attraction and recession of light substances, the production of sensation in living bodies, and the evolution or production of light.

3 Electric power. We shall not at present attempt any inquiry into the cause of these phenomena, but shall content ourselves with calling the power by which they are produced, the *electric power*, reserving any investigation of its nature for a future part of this article, in which we shall treat of the *theory* of electricity. The term *electricity*, which is most properly applicable to the science, is also sometimes applied to the cause of the phenomena, or what we here call the *electric power*.

4 Excitation. When *electrics* are made to shew the action of the electric power, they are said to be *excited*.

5 Non-electrics or conductors. There are many substances which are incapable of being thus excited, and are therefore *non-electrics;* but which being placed near or in contact with an excited electric, receive from this a portion of the *electric power*, and are thus made capable of producing the same appearance as the electric. Thus if a metallic rod

---

(A) The attracting power of amber, when rubbed, is said to have been known to Thales the Milesian philosopher, 600 years before Christ.

General Principles.

rod or wire pointed at one end and rounded at the other, be attached by the pointed extremity to an excited *electric*, or even placed very near to it, the rounded extremity will attract light bodies, and emit sparks. As these substances are found to convey or *conduct* the *electric power* to any distance in proportion to their length, they are called *conductors*.

It is found that all bodies in nature are either *electrics* or *conductors*. This distinction was first made by Mr Stephen Gray, a pensioner of the Charter-house, in 1729. The conducting power of metals, and various other bodies, was his discovery. Neither of these classes of bodies are, however, perfect electrics or conductors, even in their most favourable state; and there is a gradation of effect from one class to the other. There are few electrics which may not under some circumstances be made to act as conductors; and, on the other hand, many conductors may be so far excited as to become in some measure electrics *per se*. The terms conductors and electrics *per se*, were first employed by Dr Desaguliers. The following table exhibits the electrics and conductors arranged according to their degree of electrical or conducting power, the remote extremes forming a sort of intermediate class.

Electrics.

Glass and all vitrifications, even the metallic.
All precious stones, of which the most transparent are the best.
Amber.
All resinous substances.
Wax.
Jet.
Silk in its different states.
Cotton.
Several dry and external animal substances, as feathers, wool, hair; parchments, and leather.
Paper.
White sugar, and sugar-candy.
Air, and other permanently elastic fluids.
Oils, especially the heaviest.
Dry and complete oxides of metallic substances.
The ashes of animal and vegetable substances.
Baked wood and other dry vegetable substances.
Most hard stones, of which the hardest are the best.
Ice at —13° Fahr.
Chalk, lime, and phosphorus.

Conductors.

Gold.
Silver.
Copper.
Platinum.
Brass.
Iron.
Tin.
Quicksilver.
Lead.
Semi-metals, more or less.
Metallic ores, more or less.
Well-burnt charcoal, either of animal or of vegetable substances.
Diluted acids.
Metallic ores.
The fluids of an animal body.
Water (especially salt water), and all fluids, excepting the aerial and oils.
Ice and snow.
Flame, smoke, and steam.
Most saline substances, especially the metallic salts.
Several earthy or stony substances.
The vapour of hot water.
Electricity pervades also such a vacuum as is produced by the best air-pump; but not the perfect absence of air, or the Torricellian vacuum, formed by boiling the quicksilver in a barometer tube.

Cavallo's Philosophy vol. iii.

Many of the substances given in the above table are found to change their nature under certain circumstances. Thus, among the electrics, glass heated to redness, melted resins and wax, baked wood, when very hot, and heated air, become conductors; and glass, which is usually the best electric, is sometimes from causes which have not been well ascertained a very indifferent one. The excitability of glass vessels is found to differ according to the degree of rarefaction of the included air; when this is rarefied as much as possible, the external surface of the vessel cannot be excited, while the internal surface exhibits strong marks of *electric power*; but when the included air is considerably condensed, the internal surface shews no marks of electric power, while the external is much more excitable than usual.

Among the conductors, the conducting power of charcoal varies in proportion to the degree of heat to which it has been exposed in the making, as, when imperfectly burned, it is a bad conductor. Indeed wood is capable of being made an electric or a conductor several times alternately according to its state. When fresh cut, it is a good *conductor*: thoroughly dried by baking, it becomes, as we have seen, an *electric*; burned to charcoal, by which its volatile ingredients are dissipated, it is again a conductor: but when reduced to ashes, it is once more made an *electric*.

Ice (B) is placed among the conductors: but in an experiment of M. Achard, it appeared that when distilled water was gradually frozen, so that one side of the vessel retained it fluid, and therefore permitted the air to escape, the ice thus produced would not conduct, but on the contrary became a very good electric, and was employed as such. Snow is a much worse conductor than ice. Water is a conductor, and so are the secondary salts; it is found that when water is impregnated with a salt, its conducting power is much increased.

We have, after Mr Cavallo, placed the *salts* among conductors; but, in strict propriety, this conducting power

---

(B) The conducting power of *common* ice was first shewn by M. Jallabert, professor of philosophy at Geneva; there seem, however, to have been various opinions respecting this fact till it was fully ascertained by Dr Priestley. Vid. *Priestley's History of Electricity*, Part viii. sect. 4.

neral
ciples.

power must be confined to salts in the state of crystals, as it has been proved by decisive experiments, that salts, when deprived of their water of crystallization, become non-conductors. The conducting power of crystallized salts is therefore probably owing to the water which they contain.

No leading relation holds between the chemical characters of bodies and their conducting powers. The best conductors, the metals, and the best electrics, as sulphur, are simple inflammables. Alkalies are conductors; the other metallic oxides are non-conductors. Other physical properties are equally independent of electric relations. Platinum, the densest of bodies, is a conductor; so is charcoal, a very light body, and even rarefied air. Brittleness, elasticity, and fluidity, are in the same predicament.

Electrics are called *non-conductors*, as they do not readily transmit *electric power*; they may hence be employed to check the passage of this power, or to confine its influence. When a body communicates with a conducting substance, as the earth, a table, the human body, &c. the electric power easily passes off; but when it is supported by an electric, the power may be retained for a considerable time. In this latter case the body is said to be *insulated*. The most important non-conductor is the atmospheric air in a dry state, and of its usual density. If it were really a conductor, electrical phenomena would be unknown, as the effects would be dissipated in the very moment of their production. The power of insulation also by other means, more consistent with stability of position in our apparatus, will afterwards appear.

We have seen (1, 3)), that fire or light appears to issue from an excited electric; and this appearance is stronger in proportion to the size of the electric, and the degree of friction which it has undergone. When a rounded body, as the knuckle or a metallic ball, is presented to the excited electric, the fire appears to dart from it in a spark; but if the presented body be pointed, the fire will appear to issue in a stream composed of luminous rays. These rays will take a different direction, according to the substance with which the electric is rubbed, and other circumstances which will be explained hereafter. In the case of the glass tube rubbed with the hand, when a pointed body, as a needle, or wire, is presented to the tube, the luminous rays will appear like a *star* around the point. The same appearance will take place on presenting a point to a stick of sealing-wax rubbed with any metallic body, as a piece of tinfoil; but when the sealing-wax is rubbed with a piece of woollen cloth, the rays will appear to issue from the point in a pencil diverging towards the wax. In some experiments which will afterwards be described, the stream of fire appears in an evident current, in a direction from the electric in some cases, as in the tube excited as above, and towards the electric in others, as in the wax rubbed with the woollen cloth. These different appearances have been supposed owing to two different states of the *electric power*, and these states have been called the two electricities. As in the former case, the fire seems to flow *from* the glass *into* the metallic body, as if there was an *excess* in the former, the glass is said to be electrified *plus*, or *positively*, and this is called *positive electricity*. In the latter case, as the stream appears to flow *from* the point *into* the sealing-wax, as if there were a *deficiency* in the latter, the sealing-wax is said to be electrified *minus*, or *negatively*, and this is called the *negative electricity*: As when glass is rubbed with most substances, *positive* electricity is excited, and *negative* when resinous bodies are rubbed with most substances, the former is often called *vitreous*, and the latter *resinous* electricity; and these terms are still preferred by many electricians, as implying no uncertain theory. The difference of these forms of electrical excitement was the discovery of M. Du Faye.

Pos e
and ga-
tive ectri-
city

General Principles.

8
or vitreous and resinous electricity.

The difference of these two states of the electric power may be further illustrated by the following simple experiment.

Plate CLXXXVII. fig. 1.

Let a stem of glass (A, B, fig. 1.) be fixed in a wooden pedestal C. Through the upper extremity A, pass a wire A, D, with a rounded end at D, and from this end suspend two very fine silken threads *a*, *b*. These threads in the usual state of the instrument will hang in the parallel position *a*, *b*; but if the end of the wire to which they are attached be presented to the excited tube, the threads will diverge from each other, and take a position as at *c d*. If in this diverging state they are presented to an excited stick of sealing-wax, they will collapse into their original position. Again the threads presented first to the excited sealing-wax will diverge, but presented in this state to the excited tube will collapse, thus shewing that these two states are opposite to each other, each destroying the effect produced by the other.

9
Electrified bodies.

The following table shows what kind of electricity will be excited by rubbing various electrics with different bodies.

The back of a cat	Positive	Every substance with which it has been hitherto tried.
Smooth glass	Positive	Every substance hitherto tried, except the back of a cat.
Rough glass	Positive	Dry oiled silk, sulphur, metals.
	Negative	Woollen cloth, quills, wood, paper, sealing-wax, white wax, the human hand.
Tourmalin	Positive	Amber, a blast of air.
	Negative	Diamond, the human hand.
Hare's skin	Positive	Metals, silk, loadstone, leather, hand, paper, baked wood.
	Negative	Other finer furs.
White silk	Positive	Black silk, metals, black cloth.
	Negative	Paper, hand, hair, weasels skin.
Black silk.	Positive	Sealing-wax.
	Negative	Hares, weasels, and ferrets skin, loadstone, brass, silver, iron, hand, white silk.

Sealing-wax

Sealing-wax	Positive	Metals, with the exception of those contained in the next list.
	Negative	Hares, weasels, and ferrets skin, hand, leather, woollen cloth, paper, iron, steel, lead, bismuth, plumbago.
Baked wood	Positive	Silk.
	Negative	Flannel.

A slight difference in the conditions of such experiments occasions striking varieties of result. Friction with an iron chain on a stick of sealing wax, the surface of which is scratched, produces positive electricity, but negative on a stick with a smooth surface.

9 Electri bodies.

It appears from (3.) that the power of producing electrical appearances may be communicated from an excited electric to a conductor. The more perfect the conductor, the more easily does it receive the electric power. Electrics may also be made to receive this power from excited electrics, but it is communicated to these with more difficulty than to conductors. When any body, whether electric or conductor, is made to exhibit electrical phenomena, either by being excited, or by communication, it is said to be *electrified.*

PART I.

OF THE GENERAL PHENOMENA OF EXCITED ELECTRICITY.

WHEN an electric is once excited, it retains the electric power for a longer or shorter time according to its situation and nature. If it communicates freely with conductors, it will lose it sooner in proportion as these are more perfect; but if it be *insulated,* it will continue in an electrified state for a considerable time.

10 Modes of exciting electricity.

Electrics may be excited in various modes; the greatest number of them by friction, as glass, precious stones, silk, sulphur, sealing-wax, amber, &c.; some by melting, and being allowed to cool, as sulphur, wax; or simply by heating or cooling, as the tourmalin; some by changing of form, and others by the contact of dissimilar bodies. We shall here give an account of the general appearances exhibited by the principal electrics when excited in these several modes.

11 Friction.

Friction, as we have observed, is the usual method of exciting electrics. These may be rubbed either by other electrics, or by conductors; in some cases they are best excited by being rubbed with the most perfect conductors. Thus glass rubbed with silk exhibits signs of electricity; but these are much stronger, if the silk be covered with some metallic substance, as an amalgam of zinc. Dust or moisture is found very much to diminish the excitability of electrics; but oil or any fat substance increases it. The appearances shown by electrics excited by friction, differ somewhat according to the nature of the electric, and the substance employed as a rubber; we shall describe the most remarkable of them, as they will serve to illustrate and explain the experiments which are afterwards to be introduced.

Chap. I. *Of the Phenomena produced by excited Glass.*

12 Phenomena from excited glass.

Dr William Gilbert, a native of Colchester in Essex, and a physician in London, who published, in the year 1600, a valuable treatise "*De Magnete,*" was the first, we believe, who observed the electrical property of glass when rubbed; but he discovered little more than that like amber it attracted and repelled light bodies. He found that the most transparent glass was the best electric*. In the beginning of the eighteenth century, Mr Hawkesbee, the author of the first treatise on electricity, made the first rational experiments on the electric power of glass. He observed that when the air within the globe was considerably rarefied, a strong light appeared in the inside on applying his hand to the globe, and when the air was restored to its natural density, a light appeared also on the outside, appearing as if sticking to his fingers or other bodies held near the globe.

13 Mr Haw sbee's e perimen

Having exhausted another globe of glass, he observed, that on bringing this near his excited globe, a light appeared within the former, and became very brilliant if the exhausted globe was kept in motion, but died away in a short time if it was suffered to remain at rest.

He coated more than half of the inside of a globe with sealing-wax of various thickness, and after exhausting the globe, he set it in motion. On applying his hand as a rubber, he was surprised to see the exact shape of his hand appearing on the concave surface of the wax, and that even where the coating of wax was interposed between his hand and the opposite side, though the wax was in some places an eighth of an inch in thickness.

Pitch or common sulphur melted answered as well as wax, but he could not produce these appearances by using melted flowers of sulphur. When he employed a very thick coating of common sulphur, he observed that there was a much greater light within the globe; but he could not so easily distinguish the figure of his hands.

On admitting a small quantity of air into the globe, the light diminished, and on the coating of sealing wax it entirely disappeared. While the globe continued exhausted, the coated part of it showed some attraction for light bodies, but if there was no wax, the globe would not attract at all; on admitting the air, the power of attraction was greater on the coated than on the uncoated part.*

Glass in any form is capable of excitation, but it is more easy, as well as more convenient, to employ a vessel or plate of glass than a solid rod or mass of that substance; and the thinner the vessel or plate is, the more easily is it excited. When a tube, plate, or vessel of glass is excited, it is found that one side is electrified positively

---

* *Gilbert de Magnete,* ii. 2.

* *Phy mech Expe ments.* 65.

positively and the other negatively. Both smooth and rough glass may be employed to produce electrical phenomena, but they require different rubbers. The best rubber for smooth glass is black oiled silk spread with an amalgam of zinc, made in the proportion of four or five parts of mercury to one of zinc. The best rubber for rough glass is soft new flannel. The amalgam of zinc may be most conveniently made in the following manner. Place the zinc over the fire in an iron ladle; and when the ladle is red hot, put a small quantity of tallow or suet on the zinc, which will immediately melt. It is best not to allow the zinc to melt without the addition of some fatty matter, as this metal is very easily oxidated or calcined, and thus a great part of it would be rendered unfit for the required purpose; this inconvenience is prevented by the fat which covers the surface of the melted metal, and protects it from the action of the air. When the zinc is melted, add the mercury, previously heated to the degree of boiling water; stir the mixture a little, and allow it to cool. Lastly, rub it well in a glass mortar, so as to unite the fat with it, which will prevent it from becoming hard by keeping, and will also preserve it longer from oxidation.

Mr Canton, the first person who employed an amalgam to increase the effect of friction on glass tubes, used one formed of two parts of mercury and one of tin-foil, with the addition of a little chalk. Mr Wilcke found that a piece of woollen cloth spread with a little wax formed a very powerful rubber for smooth glass. The best rubber for rough glass is soft new flannel.

14 curial phorus.

It had been observed by Mr Hawkesbee, that on shaking mercury in a glass vessel, in the dark, a considerable light was produced, and that this was much more remarkable when the air in the vessel was considerably rarefied. He called the light which he conceived to be emitted from the mercury, *mercurial phosphorus.*

Mr Cavallo found that, by shaking mercury in a glass tube hermetically sealed, and in which the air was pretty much rarefied, the tube was sensibly electrified on the outside; but the electricity produced was not constant, nor in proportion to the agitation. From this observation he was led to make some experiments, the results of which are very curious.

15 llo's eriments glass tu. F 2.

He prepared several tubes, such as are represented at fig. 2. Plate CLXXXVII. about 31 inches long, somewhat less than half an inch in diameter, and about one-twentieth of an inch thick.

They were closed at one end, and contained each three-fourths of an ounce of mercury, which being made to boil, the air within the tube was rarefied, and the open end was then hermetically sealed. Having made the tube clean and a little warm, he caused the mercury to flow from the one end to the other, by gently elevating and depressing either end, alternately, while the tube was held nearly in a horizontal position. The tube was thus rendered electrical, but so that the end where the mercury stood was electrified positively (c) and all the remaining part of the tube negatively. If the mercury was made to flow from the positive end to the negative, by elevating the former, the end to which it flowed became positive, while the rest of the tube acquired a negative electricity; but if in elevating the positive end where the mercury stood, that end were not touched with the hand, it became negative only in a slight degree, and if the mercury was made to flow back to it, and again retire from it, still without touching it, it became positive; whereas by touching it while elevating it, it was rendered strongly negative. The electric power was always strongest at the positive end. The electric power at either end was made much more apparent by coating each end for about two inches with tin-foil, as represented in the figure, so that the tubes would sometimes emit sparks on being brought near a conductor *.

16 Durability of the electricity of glass.

We have seen (6.) that when an electric is once excited, it retains the electric power for some time. Glass is one of the most remarkable electrics in this respect.

Mr Canton procured some very thin glass balls, about an inch and a half in diameter, with slender tubular stems of eight or nine inches in length. He electrified these balls in the inside, or semi-positively, and then sealed the stems hermetically. On examining them after some time, he found that they showed no signs of electricity; but on holding them at a small distance from the fire, they became strongly electrical, and still more so as they cooled. On repeatedly heating them, he found that the electric power diminished, but it was not impaired by keeping them for a week under water. One of them, which he had heated several times before immersing it in water, still retained a considerable degree of electric power at the end of above a month; and even at the end of six years they had not entirely lost it.

Mr Henley having electrified a small bottle, observed that it showed signs of electricity seventy days after, though it had stood all that time in a cupboard.

On the 5th of February he excited a glass cylinder; and from that time till the 10th of March following, various methods were employed to destroy its electricity. These always succeeded at the time, and the cylinder

---

* *Cavallo's Electricity*, vol. ii. p. 69.

(c) The method of distinguishing between positive and negative electricity will be more fully explained hereafter, as well as the modes in which either may be produced at pleasure. But it may be proper here to show a simple mode of distinguishing these two states of the electric power, which may be done by means of the instrument described in (8.). The electricity shown by excited polished glass was said to be positive; and it appeared that the threads of the instrument separated when brought near an excited tube, as also when brought near excited sealing-wax, the electricity of which is negative. If, therefore, when the threads are made to diverge by excited glass, they diverge still farther, or remain stationary, on being made to approach any other electrified body, the electricity of this last is *positive;* but if they collapse, it is *negative.* Again, if the threads, when made to diverge by excited sealing-wax, diverge still farther, or remain stationary, on being made to approach another electrified body, the electricity of this is *negative;* but if they collapse, it is *positive.*

General Phenomena

der lost all signs of electricity; but these signs returned again without any fresh excitation, and on the 10th of March the cylinder still retained considerable electric power. The marks of electricity sometimes became stronger or weaker, or even quite disappeared and returned, without any evident cause. The electricity was generally strongest when the wind was northerly, or when it had returned after having been destroyed by flame; it was generally weakest when there was a fire in the room where it was kept, or when the door was left open. He repeated the excitation, but not always with the same success; for sometimes the cylinder would lose all signs of electricity in a fortnight, and at others in twelve hours, till it was again excited*.

CHAP. II. *Of the Phenomena produced by excited Silk.*

SILK was first discovered to be an electric in the year 1729 by Mr Stephen Grey, while making experiments with his friend Mr Wheeler. These gentlemen attempted to conduct the electric power to a great distance by means of silk lines, as Mr Grey had done before by means of packthread; but they found that the silk refused to conduct, but seemed rather to retain the electric power. No experiments of any consequence were however made on this substance, till 1759, when Mr Symmer presented to the Royal Society a series of observations which he had made on silk stockings.

He had been accustomed to wear two pairs of silk stockings; a black and a white. When these were put off both together, no signs of electricity appeared; but on pulling off the black ones from the white, he heard a snapping or crackling noise, and in the dark perceived sparks of fire between them. To produce this and the following appearances in great perfection, it was only necessary to draw his hands several times backward and forward over his leg with the stocking upon it.

17 Strong attraction and repulsion between electrified stockings.

When the stockings were separated and held at a distance from each other, both of them appeared to be highly excited; the white stocking positively, and the black negatively. When kept at a distance from each other, both appeared inflated to such a degree, that they exhibited the entire shape of the leg. When two black or two white stockings were held in one hand, they repelled one another with considerable force, making an angle of 30 or 35 degrees. When a white and black stocking were presented to each other, they were mutually attracted; and if permitted, would rush together with surprising violence. As they approached, the inflation gradually subsided, and their attraction of foreign objects diminished, but their attraction of one another increased; when they actually met, they became flat, and joined close together like as many folds of silk. When separated again, their electric virtue was not in the least impaired for having once met. These appearances they were capable of exhibiting for a considerable time. When the experiment was made with two black stockings in one hand, and two white ones in the other, they were thrown into a strange agitation, owing to the attraction between those of different colours, and the repulsion between those of the same colour. This mixture of attractions and repulsions made the stockings catch at each other at greater distances than otherwise they would have done, and afforded a very curious spectacle.

When the stockings were suffered to meet, they stuck together with considerable force. At first Mr Symmer found that they required from one to 12 ounces to separate them. Another time they raised 17 ounces, which was 20 times the weight of the stocking that supported them; and this in a direction parallel to its surface. When one of the stockings was turned inside out, and put within the other, it required 20 ounces to separate them; though at that time ten ounces were sufficient when applied externally. Getting the black stockings newly dyed, and the white ones washed, and whitened in the fumes of sulphur, and then putting them one within the other, with the rough sides together, it required three pounds three ounces to separate them. With stockings of a more substantial make, the cohesion was still greater. When the white stocking was put within the black one, so that the outside of the white was contiguous to the inside of the black, they raised nine pounds wanting a few ounces; and when the two rough surfaces were contiguous, they raised 15 pounds one pennyweight and a half. Cutting off the ends of the thread and the tufts of silk which had been left in the inside of the stockings, was found to be very unfavourable to these experiments.

Mr Symmer also observed, that pieces of white and black silk, when highly electrified, not only cohered with each other, but would also adhere to bodies with broad and even polished surfaces, though these bodies were not electrified. This he discovered accidentally, a stocking which he had thrown out of his hand, having stuck to the paper-hangings of the room. He repeated the experiment, and found it continue hanging near an hour. Having stuck up the black and white stockings in this manner, he came with another pair highly electrified; and applying the white to the black, and the black to the white, he carried them off from the wall, and each of them hanging to that which had been brought to it. The same experiments held with the painted boards of the room, and likewise with the looking-glass, to the smooth surface of which both the white and the black silk appeared to adhere more tenaciously than to either of the former*.

18 Experiments o ribbons Mr Cig

Similar experiments, but with a greater variety of circumstances, were afterwards made by Mr Cigna of Turin, upon white and black ribbons. He took two white silk ribbons just dried at the fire, and extended them upon a smooth plain, whether a conducting or electric substance was a matter of indifference. He then drew over them the sharp edge of an ivory ruler, and found that both ribbons had acquired electricity enough to adhere to the plain; though while they continued there, they showed no other sign of it. When taken up separately, they were both negatively electrified, and would repel each other. In their separation, electric sparks were perceived between them; but when again put on the plain, or forced together, no light was perceived without another friction. When by the operation just now mentioned they had acquired the negative electricity, if they were placed not upon the smooth body on which they had been rubbed, but on a rough conducting substance, they would, on their separation, show contrary electricities, which would again disappear

---

* Phil. Trans. lxvii.

* Phil. Trans. v li. part i

eneral
enomena

disappear on their being joined together. If they had been made to repel each other, and were afterwards forced together, and placed on the rough surface above mentioned, they would in a few minutes be mutually attracted; the lowermost being positively and the uppermost negatively electrified.

If the two white ribbons received their friction upon the rough surface, they always acquired contrary electricities. The upper one was negatively, and the lower one positively electrified, in whatever manner they were taken off. The same change was instantaneously produced by any pointed conductor. If two ribbons, for instance, were made to repel, and the point of a needle drawn opposite to one of them along its whole length, they would immediately rush together.

The same means which produced a change of electricity in a ribbon already electrified, would communicate electricity to one which had not as yet received it; viz. laying the unelectrified ribbon upon a rough surface, and putting the other upon it; or by holding it parallel to an electrified ribbon, and presenting a pointed conductor to it. He placed a ribbon that was not quite dry under another that was well dried at the fire, upon a smooth plain; and when he had given them the usual friction with his ruler, he found, that in what manner soever they were removed from the plain, the upper one was negatively and the lower one positively electrified.—If both ribbons were black, all these experiments succeeded in the same manner as with the white. If, instead of the ivory ruler, he made use of any skin, or a piece of smooth glass, the event was the same; but if he made use of a stick of sulphur, the electricities were in all cases the reverse of what they had been before the ribbons were rubbed, having always acquired the positive electricity. When he rubbed them with paper either gilt or not gilt, the results were uncertain. When the ribbons were wrapped in paper gilt or not gilt, and the friction was made upon the paper laid on the plain above mentioned, the ribbons acquired both of them the negative electricity. If the ribbons were one black and the other white, whichever of them was laid uppermost, and in whatever manner the friction was made, the black generally acquired the negative and the white the positive electricity.

He also observed, that when the texture of the upper piece of silk was loose, yielding, and retiform like that of a stocking, so that it could move and be rubbed against the lower one, and the rubber was of such a nature as could communicate but little electricity to glass, the electricity which the upper piece of silk acquired did not depend upon the rubber, but upon the body on which it was laid. In this case, the black was always negative and the white positive. But when the silk was hard, rigid, and of a close texture, and the rubber of such a nature as would have imparted a great degree of electricity to glass, the electricity of the upper piece depended on the rubber.' Thus, a white silk stocking rubbed with gilt paper upon glass became negatively, and the glass positively, electrified. But if a piece of silk of a firmer texture was laid upon a plate of glass, it was *always* electrified positively, and the glass negatively, if it was rubbed with sulphur, and for the most part if it was rubbed with gilt paper.

General
Phenomena

If an electrified ribbon was brought near an insulated plate of lead, it was attracted, but very feebly. On bringing the finger near the lead, a spark was observed between them, the ribbon was vigorously attracted, and both together showed no signs of electricity. On the separation of the ribbon, they were again electrified, and a spark was perceived between the plate and the finger.

When a number of ribbons of the same colour were laid upon a smooth conducting substance, and the ruler was drawn over them, he found, that when they were taken up singly, each of them gave sparks at the place where it was separated from the other, as did also the last one with the conductor; and all of them were negatively electrified. If they were all taken from the plate together, they cohered in one mass, which was negatively electrified on both sides. If they were laid upon the rough conductor, and then separated singly, beginning with the lowermost, sparks appeared as before, but all the ribbons were electrified positively, except the uppermost.—If they received the friction upon the rough conductor, and were all taken up at once, all the intermediate ribbons acquired the electricity, either of the highest or lowest, according as the separation was begun with the highest or the lowest. If two ribbons were separated from the bundle at the same time, they clung together, and in that state showed no sign of electricity, as one of them alone would have done. When they were separated, the outermost one had acquired an electricity opposite to that of the bundle, but much weaker.

A number of ribbons were placed upon a plate of metal to which electricity was communicated by means of a glass globe, and a pointed conductor held to the other side of the ribbons. The consequence was, that all of them became possessed of the electricity opposite to that of the plate, or of the same, according as they were taken off; except the most remote, which always kept an electricity opposite to that of the plate *.

CHAP. III. *Of the Phenomena produced by excited Paper.*

19
Experiments on paper.

1. WHEN a single leaf of writing paper, after being warmed, is laid on a table, and rubbed briskly with a piece of India rubber, it becomes strongly electrical; on attempting to remove it from the table, it is found to adhere as if it were besmeared with some gluey substance; and if, before it is quite separated, it be suffered to return to the table, it will fly back with considerable force, and adhere almost as strongly as at first.

2. On separating it from the table immediately after rubbing, it will be strongly attracted by the table or any substance presented to it, and remain in contact for a considerable time.

3. When the knuckle is presented to the paper on its being first taken from the table, a snapping noise is heard, which is more perceptible if the knuckle be made to pass successively over different parts of the paper. If this experiment is made in the dark, sparks will be seen to accompany the snapping noise.

---

* Mem. of the Acad. of Turin, for 1763.

4. On employing a double piece, or two pieces of paper, these appearances will be increased. On attempting to separate the two pieces of paper, they are found to adhere closely together, and their separation is accompanied with a crackling noise, similar to that produced by the application of the knuckle, but not so loud. When quite separated, on being brought again within some inches of each other they are strongly and mutually attracted, and if, while separated, one of them be held between the other and some contiguous substance, it will be alternately attracted by that substance, and the other piece, according as it is nearer the one or the other.

5. Placing a piece of clean new flannel between the paper and the table, or between the folds of the paper, does not diminish the electrical appearances produced; but rubbing the paper with flannel produces no remarkable signs of electricity.

6. It is not necessary that the paper be rubbed on a table to produce these appearances; a book will answer as well, but with this difference, that if the book be in boards, the paper will produce no crackling when the knuckle is applied to it; but when the paper is double, the separation of the folds will be attended with the same crackling as before; whereas when the book is bound in leather, a single sheet when rubbed will produce the crackling on the application of the knuckle, while the double piece will produce it only when its folds are separated. The adhesion of the paper to the books is in both cases much slighter than its adhesion to the table, and in the case of the book in boards it is scarcely perceptible.

7. White paper of all kinds is capable of producing these appearances, when rubbed with caoutchouc; but blotting paper whether white or red produces them in a very inferior degree, probably on account of the weakness of its texture not allowing it to be rubbed with sufficient force.

In general, the stouter the texture of the paper, the stronger are the sparks and the attraction.

8. Paper does not retain its electricity for any great length of time; in general, it ceases to show any remarkable signs of electric power about 10 or 15 minutes after being excited.

9. Other substances besides caoutchouc may be employed as rubbers for the excitation of paper, especially the dry hand, but none succeed so well as caoutchouc.

The electric property of paper was first discovered by Mr Grey. The paper employed by him was the kind called white *pressing paper*, which is of the same nature with card paper. Not only did this paper, when made as hot as his fingers could bear, produce a light when drawn briskly through his fingers; but when his fingers were held near it, a light issued from them also, attended with a crackling noise*.

* Phil. Trans. Abr. vii. 9.

CHAP. IV. *Phenomena produced by the Tourmalin, and some other earthy minerals.*

20 Tourmalin the *lyncurium* of the ancients.

THE electrical power of this stone, so far at least as respects its attraction of light bodies, was known to the ancients; as Theophrastus speaks of a stone, by him called *lyncurium*, which agrees in all respects with the tourmalin, and which he says attracted straws, ashes, and even small cuttings of iron and copper.

21 Experiments b Æpinus; by the d de Noya Mr Can and Dr Priestle

Nothing more seems to have been known of this stone among the moderns till the year 1756, when M. Æpinus made a set of experiments on it, which were printed in the History of the Academy of Sciences and Belles Lettres of Berlin for that year.

In 1758, the duc de Noya, in conjunction with M. Daubenton and Adamson, made some experiments on the tourmalin, but they do not seem to have been so accurate as those of M. Æpinus.

Soon after this stone was introduced to the notice of the English, by Dr Heberden, who procured from Holland several, with which Æpinus's experiments were repeated by Messrs Wilson and Canton.

But a more complete series of experiments on the tourmalin were made by Dr Priestley, and of these we shall here give a detailed account, as they comprise nearly all that is known on the subject, till it was taken up by M. Haüy.

1. To ascertain the kind of electricity produced, he had always at hand a stand of baked wood with four arms projecting from it. Three of these were of glass, having threads of fine silk as it comes from the worm fastened to them, and at the end of each thread a small piece of down. From the other arm hung a fine thread about 9 or 10 inches long, while a brass arm suspended a pair of pith-balls. At the other extremity of this arm, which was pointed, a jar could be placed, to receive the electricity, and by the repulsive power of it keep the balls equally diverging with positive or negative electricity; or sometimes he suspended the balls in an uninsulated state within the influence of large charged jars: and lastly, he had always a fine thread of trial at hand, by which he could discover whether the stone was electrical or not before he began his experiments (D).

2. Before he began any experiments on the stone, also, he never failed to try how long the fine threads, which he used as electrometers, would retain their virtue; and found this to be various in various cases. When the threads were capable of retaining their electric virtue for a few minutes, he preferred them; but when this was not the case, he had recourse to the feathers, which never failed to retain it for several hours. They might be touched without any sensible loss of power, though they received their virtue very slowly. In the experiments now to be related, he made use of Dr Heberden's large tourmalin, whose convex side became positive and the flat side negative in cooling; and in all of them, when the positive or negative side of the tourmalin is mentioned, it is to be understood that which is positive or negative in cooling.

3. From Mr Wilcke's experiments on the production of spontaneous electricity, by melting one substance within another, he first conjectured that the tourmalin might collect its electricity from the neighbouring air: To determine which the following experiment was made. Part of a pane of glass was laid on the

---

(D) Dr Priestley's method will be better understood, after the reader has perused Chap. I. III. and XIII. of Part III.

the standard bar of an excellent pyrometer, and upon that glass the tourmalin was placed. This bar was heated by a spirit lamp, so that the increase or decrease of heat in the tourmalin could thus be exactly determined. In this situation he observed, that whenever he examined the tourmalin, the glass had acquired an electricity contrary to that side of the stone which lay upon it, and equally strong with it. If, for example, the flat side of the stone had been presented to a feather electrified positively, as the heat was increasing, it would repel it at the distance of about two inches, and the glass would attract it at the same or a greater distance; and when the heat was decreasing, the stone would attract, and the glass repel it at the distance of four or five inches. The case was the same whichever of the sides was presented, as well as when a shilling was fastened with sealing-wax upon the glass; the electricity both of the shilling and glass being always opposite to that of the stone. When it came to the turn, the electricity was very quickly reversed; so that in less than a minute the electricity would be contrary to what it was before. In some cases, however, viz. where the convex surface of the tourmalin was laid upon the glass or shilling, both of these became positive as well as the stone. This he supposed to be owing to the stone touching the surface on which it lay only in a few points, and that its electricity was collected from the air; which supposition was verified: for, getting a mould of Paris plaster made for the tourmalin, and heating it in the mould, fastened to a slip of glass, he always found the mould and glass possessed of an electricity contrary to that of the stone, and equally strong with it. During the time of cooling, the mould seemed to be sometimes more strongly negative than the stone was positive; for once, when the stone repelled the thread at the distance of three inches, the mould attracted it at the distance of nearly six.

4. On substituting another tourmalin instead of the piece of glass; it was observed, that when one of the tourmalins was heated, both of them were electrified as much as the tourmalin and glass had been. If the negative side of a hot tourmalin was laid upon the negative side of a cold one, the latter became positive, as would have been the case with a piece of glass. On heating both the tourmalins, though fastened together by cement, they acquired the same power that they would have done in the open air.

5. As the tourmalins could not in this case touch in a sufficient number of points, it was now thought proper to vary the experiment by cooling the tourmalin in contact with sealing-wax, which would fit it with the utmost exactness. On turning the stone, when cold, out of its waxen cell, it was found positive, and the wax negative; the electricity of the stone being thus contrary to what would have happened in the open air. The other side, which was not in contact with the wax, acquired the same electricity that it would have done though the stone had been heated in the open air; so that both sides now became positive. In like manner the positive side of the stone, on being cooled in wax, became negative.

6. On attempting to ascertain the state of the different sides of the tourmalin during the time it was heating in wax, many difficulties occurred. It was found impossible in these cases to know exactly when the stone begins to cool; besides, that in this method of treatment it must necessarily be some time in the open air before it can be presented to the electrometer; and the electricity of the sides in heating is by no means so remarkable as in cooling. In the experiments made with the tourmalin, when its positive side was buried in wax, it was generally found negative, though once or twice it seemed to be positive. On cooling it in quicksilver contained in a china cup, it always came out positive, and left the quicksilver negative; but this effect could not be concluded to be the consequence of applying the one to the other, because it is almost impossible to touch quicksilver without some degree of friction, which never fails to make both sides strongly positive though it be quite cold, and especially if the stone be dipped deep into it. At last, supposing that the stone would not be apt to receive any friction by simple pressure against the palm of the hand, he was induced to make the experiment, and found it fully to answer his expectations; for thus, each side of the stone was affected in a manner directly contrary to what would have happened in the open air.

7. Fastening the convex side of the large tourmalin to the end of a stick of sealing wax, and pressing it against the palm of the hand, it acquired a strong negative electricity, contrary to what would have happened in the open air. Thus it continued till it had acquired all the power it could receive by means of the heat of the hand; after which it began to decrease, though it continued sensibly negative to the very last. On allowing the stone to cool in the open air, its negative power constantly increased till it became quite cold.

8. On heating the same flat side by means of a hot poker held near it, and then just touching it with the palm of the hand when so hot that it could not be borne for any length of time, it became positive. Letting it cool in the air it became negative, and on touching it again with the hand it became positive; and thus it might be made alternately positive and negative for a considerable time. At last, when it became so cool that the hand could bear it, it acquired a strong positive electricity, which continued till it came to the same degree of heat.

9. The wax was removed from the convex, and fastened to the flat side of the stone; in which circumstances it became weakly positive, after receiving all the heat the hand could give it. On letting it cool in the open air it grew more strongly positive, and continued so till it was quite cold; and thus the same side became positive both with heating and cooling.

10. On heating the convex side by means of a poker, and pressing it against the palm of the hand as soon as it could be borne, it became pretty strongly negative; though it is extremely difficult to procure any appearance of negative electricity from this side; and care must be taken that a slight attraction of the electrified feather, by a body not electrified, be not mistaken for negative electricity.

11. On covering the tourmalin when hot with oil and tallow, no new appearances were produced; nor did the heating of it in boiling oil produce any other effect than lessening the electricity a little; and the event was the same when the tourmalin was covered with cement

General Phenomena

cement made of bees-wax and turpentine. On making a small tourmalin very hot, and dropping melted sealing-wax upon it, so as to cover it all over to the thickness of a crown piece, it was found to act through this coating nearly, if not quite, as well as if it had been exposed to the open air. Thus a pretty deception may be made: for if a tourmalin be inclosed in a stick of wax, the latter will seem to have acquired the properties of the stone.

12. On letting the stone cool in the vacuum of an air-pump, its virtue seemed to be diminished about one half, owing no doubt to the vacuum not being sufficiently perfect.

13. On fixing a thin piece of glass opposite and parallel to the flat side of the tourmalin, and about a quarter of an inch distance from it, in an exhausted receiver, the glass was so slightly electrified, that it could not be distinguished whether it was positive or negative.

14. On laying the stone upon the standard bar of the pyrometer, and communicating the heat to it by means of a spirit lamp, it was extremely difficult to determine the nature of the electricity while the heat was increasing to 70°; during which time the index of the pyrometer moved about one 7200th part of an inch. But if the stone was taken off the bar, and an electrified thread or feather presented to that side which had lain next it, the convex side was always negative, and the flat one positive.

14. To determine what would be the effect of keeping the tourmalin in the very same degree of heat for a considerable time together, it was laid upon the middle of the bar, to which heat was communicated by two spirit lamps, one at each extremity; and making the index move 45 degrees, it was kept in the same degree for half an hour without the least sensible variation; and it was observed, that the upper side, which happened to be the convex one, was always electrified in a small degree, attracting a fine thread at the distance of about a quarter of an inch. If in that time it was taken off the bar, though ever so quick, and an electrified feather presented to it, the flat side, which lay upon the bar, was negative, and the upper side very slightly positive, which appeared only by its not attracting the feather. On putting a piece of glass between the stone and standard bar, keeping it likewise in the same degree of heat, and for the same space of time as before, the result was the same; the glass was slightly electrified, and of a kind opposite to that of the stone itself. To avoid the inconvenience of making one side of the stone hotter than another, which necessarily took place when it was heated on the pyrometer, the following method was used. By means of two rough places which happened to be in the stone, it was tied with a silk thread which touched only the extreme edge of it; and thus being perfectly insulated, it might be held at any distance from a candle, and heated to what degree was thought necessary; while, by twisting the string, it was made to present its sides alternately, and thus the heat was rendered very equal in both. After being made in this manner so hot that the hand could scarce bear it, it was kept in that situation for a quarter of an hour. Then, with a bundle of fine thread held for some time before in the same heat, the electricity which it had acquired by heating was taken off, and it was found to acquire very little, if any; whence appeared the justness of an observation of Mr Canton's, that it is the change of heat, and not the degree of it, that produces the electric property of this stone.

15. On heating the stone suddenly, it may sometimes be handled and pressed with the fingers several times before any change takes place in the electricity which it acquires by heating, though it begins to cool the moment it is removed from the fire. In this case, however, the stone must be heated only to a small degree. When the heat is three or four times as great as is sufficient to change the electricity of the two sides, the virtue of the stone is the strongest, and appears to be so when it is tried in the very neighbourhood of the fire. In the very centre of the fire the stone never fails to cover itself with ashes attracted to it from every quarter; whence it acquired its name in Dutch.

16. The tourmalin often changes its electricity very slowly; and that which it acquires in cooling never fails to remain many hours upon it with very little diminution. It is even possible, that in some cases the electricity acquired by heating may be so strong as to overpower that which is acquired by boiling; so that both sides may show the same power in the whole operation. "I am very certain (says the doctor), that in my hands both the sides of Dr Heberden's large tourmalin have frequently been positive for several hours together, without any appearance of either of them having been negative at all. At this time I generally heated the tourmalin, by presenting each side alternately to a red hot poker, or a piece of hot glass, held at the distance of about half an inch, and sometimes I held it in the focus of a burning mirror; but I have since found the same appearance when I heated it in the middle of an iron hoop made red hot. The stone in all these cases was fastened by its edge to a stick of sealing-wax. This appearance I have observed to happen the oftenest when the iron hoop has been exceedingly hot, so that the outside of the stone must have been heated some time before the inside; and also I think there is the greatest chance of producing this appearance, when the convex side of the stone is made the hotter of the two. When I heat the large tourmalin in this manner, I seldom fail to make both sides of the stone positive till it be about blood-warm. I then generally observe a ragged part of the flat side towards one end of the stone become negative first, and by degrees the rest of the flat side, but very often one part of the flat side will, in this method of treatment, be strongly positive half an hour after the other part is become negative*."

22
Discove
of M. H

M. Hauy has found that the state of electrical excitation diminishes from the summits or poles towards the middle of the crystal, where it is almost nothing. This is shown by the action of these different parts on an insulated electrified needle, this instrument being attracted by one end, and repelled by the other, but not affected at all, or with a weak and uncertain motion, at the middle. When an uninsulated needle is employed it is attracted by either end. The ends show opposite states of electrical excitement, and the middle is neutral. Near each end there is a point in which the excitement is strongest, and which is a sort of focus for it. When a light body, e. g. a thread, electrified positively, is brought near the positive end, it is repelled, but is attracted by the negative end; and there is another

---

* Priest Hist. E part viii sect. 12

another fact which at first appears anomalous, that when brought near the focus of positive excitement it is attracted by that point. The reason is, that from that point to the middle of the crystal, the electricity, though positive, is counteracted in its effects by the neutral state of the middle of the crystal, as well as by the contrary electricity of its other extremity. A tourmalin is to be heated for these experiments by being taken in long pincers by the middle, and brought near a hot coal or a flame, or dipped for one or two minutes in hot water. Still held in this manner, it is to be presented to the different bodies on which its action is to be tried. When we wish it to preserve its electricity for a length of time, we place it on a little glass support. It is at temperature between 100° and 212° that the tourmalin exhibits these properties. When raised higher it loses them, and sometimes acquires a contrary electrical state; that end which was positive becoming negative, and the contrary.

If a tourmalin is broken during its electrical state, each fragment has its two extremities in opposite states of electricity, showing a striking similarity to a number of magnets.

M. Hauy found, that the vitreous or positive electricity was seated in that end which had most numerous plane surfaces. But the difference in this particular is often so slight, that it would not strike the eye on examining the form of the crystal, unless minutely attended to for the express purpose of drawing a conclusion regarding the distribution of its electricity in an excited state. That eminent mineralogist observed, that it followed certain differences in the decrements of the apposition of the integrant particles to constitute the secondary forms.

The transparent tourmalins are those in which the electrical powers now described are most conspicuous, but the green and dark varieties also possess it. The black tourmalin or black schorl possesses them in the weakest degree.

3 T opaz.

The Brasilian topaz has similar electrical properties to those of the tourmalin. This was discovered by Mr Canton. M. Hauy has found the topaz of Siberia to be possessed of the same properties. Those of Saxony do not become electrical by heat, but are excited by the slightest friction with the finger. Even the handling of one produces this effect, and gives it the appearance of being constantly electrical. In dry weather it retains its electricity for half an hour.

4 Ot mi- ner

M. Hauy found electrical properties also developed by borate of magnesia when heated, but subjected to different laws from those of the tourmalin, the points of negative and those of positive excitement being more numerous, and alternating with one another on the surface. This, however, turned out to be in conformity with the difference of crystallization. The tourmalin has only one axis. The borate of magnesia, being a cube, has four which pass through opposite solid angles. Each axis has a positive and a negative extremity, the negative being at that end at which the angles are complete, and the positive at that which has them defective.

Thus nature affords us minute electrical machines, which, though less striking in their effects than those of art, are found on examination to be more delicate and interesting.

Mesotype, when heated, becomes positively electrified in the terminated summit, and negatively on the extremity which is detached from the mass to which it belonged.

Crystallized oxide of zinc, or calamine, becomes electrical by being exposed for two or three seconds to a fire or the flame of a lamp, and retains that state for several hours after it has been cooled.

Chap. V. *Phenomena produced by excited Sulphur.*

25
Experiments on sulphur by M. Wilcke.

Sulphur is one of those electrics which may be made to exhibit electrical appearances by being melted and suffered to cool again. Dr Gilbert had shown that sulphur might be rendered electric by friction; but the first person who demonstrated its excitability by melting, was Mr Wilcke of Rostoch in Lower Saxony, who first called this *spontaneous electricity*.

He melted some crude sulphur in an earthen vessel, and left it to cool after placing the vessel on a conducting substance. On taking out the sulphur when cool, he found it strongly electrical, but this was not the case when the vessel was placed on an electric.

He then melted sulphur in glass vessels, and found that both the glass and the sulphur became electrical, but the former acquired a positive, and the latter a negative electricity. When glass vessels were employed, it did not matter whether they were placed on electrics or conductors, except that the electricity produced was stronger in the former case, and still stronger when the glass was coated with some metallic substance. The electricity of the sulphur was not produced till it began to contract, and was the strongest when the greatest degree of contraction had taken place. The electricity of the glass was always weakest when that of the sulphur was strongest, and the former was the strongest possible when the sulphur was shaken out before it had begun to contract. A silk thread, or a stick of glass, should be inserted in the sulphur, while fluid, to serve as a handle.

He found that when melted sulphur was poured into vessels of rough glass, or into hollowed cakes of sulphur, no electricity was produced.

Mr Wilcke also made experiments of the same kind with melted sealing-wax, and found that when this was left to cool in vessels of smooth glass or of wood, the sealing-wax acquired a negative, and the glass or wood a positive electricity; but when it was cooled in cups of sulphur, the sealing-wax became electrified positively, and the sulphur negatively †.

26
Æpinus's experiments.

Æpinus made some experiments by cooling melted sulphur in metal cups. On examining them after the sulphur was cold, he found that while the sulphur remained in the cups neither of them showed any signs of electricity; but the moment they were separated, both appeared strongly electrical. The marks of electricity disappeared, however, on replacing the sulphur in the cups, and returned on their being again separated. When separated, the sulphur was electrified positively, and the cups negatively; but if, before replacing the sulphur in the cups, the electricity of either was taken off, the sulphur and cups, when together, would show signs of that electricity that had not been taken off ‡.

It must be remarked here, that though the electricity of the sulphur, sealing-wax, &c. in the above experiments

---

† *Wilcke Disput.*

‡ *Æpini Tentamen.*

ments appears to be the consequence of their cooling after being melted, it is in fact excited by a degree of friction which these substances undergo by their contraction while cooling in the cups, or by being touched with the hand in making the experiment; for it is found that if they are cooled under circumstances that prevent all friction, a very small degree of which is sufficient to excite these bodies, no electricity is produced. This appears from experiments made by M. M. Van Marum and Van Troostwyck, for the purpose of ascertaining this point, an account of which is contained in the 33d volume of Rozier's Journal, to which we must refer our readers.

27 Durability of the electric power in sulphur

The durability of the electric power in excited sulphur is so remarkable, that Mr Grey, from some experiments which he made on this and similar substances, was led to suppose it perpetual. In particular, he poured melted sulphur into a conical drinking-glass, and when it was cold he found, that on taking off the glass the sulphur never failed to attract light bodies, and that in every state of the atmosphere; and in fair weather the glass would also attract.

Mr Henley, who repeated Mr Grey's experiments, says, he has never known the sulphur fail of showing signs of electricity on the removal of the glass.

Although it be true that sulphur, as well as rosin, sealing-wax, amber, and silk, retain the electric power for a considerable time, this is, however, continually diminishing, and at length disappears altogether.

28 Electricity of chocolate.

Other substances, as well as sulphur and sealing-wax, become electrical by cooling after being melted. Mr Henley observed that chocolate, when first from the mill, as it cools in the tin pans into which it is received, becomes strongly electrical, and retains this property for some time after being taken out of the pans, but loses it by handling. If melted again, and left to cool as before, its electricity returns, though in a less degree; and thus it may be renewed once or twice, but still in a much smaller degree than before. But if before pouring it into the pan, it be well mixed with a little olive oil, it becomes again strongly electrical. Chaptal observed the same phenomena during the congelation of the glacial phosphoric acid.

29 Sealing-wax excited by being broken.

When a stick of sealing-wax is broken across, each piece becomes electrified at the extremities that were contiguous, the one positively and the other negatively.

30 Electricity of wood shavings.

When wood that is hard and pretty dry, is cut or shaved, the shavings are rendered electrical. This fact was observed by Mr William Wilson, who, from a number of experiments, draws the following conclusions.

From these experiments it appears, that when very dry wood is scraped with a piece of window glass, the shavings are always positively electrified. And if chipped with a knife, the chips are positively electrified if the wood is hot, the edge of the knife not very sharp, and negatively electrified if the wood is quite cold. But if the edge of the knife is very keen, the chips will be negatively electrified whether the wood is hot or cold.

The greatest number of trials was made with the insulated knife, which was always electrified contrarily to the chips; but the surface of the wood where the chips were cut from was very seldom electrified, and when it was, it was always but weakly so, and of the same denomination as that of the weakest of the other two. Mr Wilson repeatedly found that if a piece of dry and warm wood is suddenly split asunder, the two surfaces which were contiguous are electrified, one side positive and the other negative. Muscovy talc, when its laminæ are suddenly torn apart, appears electrical, and sometimes exhibits a bright flash of light.

31 Electri of pow

Powders, either of electrics or conductors, are rendered electrical by dropping them on an insulated metallic plate.

The method, as described by Mr Cavallo, is as follows:

"Insulate a metal plate upon an electric stand, such as a wine glass, and connect with it a cork-ball electrometer; then the powder required to be tried, being held in a spoon, at about six inches above the plate, is to be let fall gradually upon it. In this manner, the electricity acquired by the powder, being communicated to the metal plate, and to the electrometer, is rendered manifest by the divergence of the threads; and its quality may be ascertained in the usual manner; to be hereafter described.

"It must be observed, that if the powder is of a conducting nature, like the amalgam of metals, sand, &c. it must be held in some electric substance, as a glass phial, a plate of sealing-wax, or the like. Sometimes the spoon that holds the powder may be insulated; in which case, after the experiment, the spoon will be found possessed of an electricity contrary to that of the powder.

"In performing these experiments, care must be taken to render the powders, and whatever they are held in, as free from moisture as possible; sometimes it being necessary to make them very warm, otherwise the experiment is apt to fail. The following are the particulars which have been observed with this method, which, however, are neither numerous, nor often repeated; but they may suffice to excite the curiosity of those persons, who have leisure and the opportunity of repeating them more at large and in a greater variety.

"Powder of rosin, whether it be let fall from paper, glass, or a metal spoon, electrifies the plate strongly negative; the spoon, if insulated, remaining strongly positive. Flower of sulphur produces the same effect, but in a little less degree. Pounded glass, let fall from a piece of paper, made dry and warm, electrifies the plate negatively, but not in so strong a degree as rosin. If let fall from a brass cup, it electrifies the plate positively, but in a very small degree.

"Steel filings let fall either from a glass phial or paper, electrify the plate negatively; but brass filings, treated in the same manner, electrify the plate positively. The amalgam of tin-foil and mercury, gunpowder, or very fine emery, electrify the plate negatively, when they are let fall upon it from a glass phial. Quicksilver, from a glass phial, electrifies the plate positively.

"Soot from the chimney, or the ashes of common pit-coal mixed with small cinders, electrify the plate negatively, when let fall from a piece of paper."

3 Electri show vapou

M. Volta discovered, that when water and some other fluids are reduced to a state of vapour, by throwing the fluid on some lighted coals placed in an insulated crucible, the vapour shews signs of positive electricity, while the coals it is leaving are negatively electrified.

electrified; calomel, when it fixes by sublimation to the upper part of a glass vessel, is found to be strongly electrical; and hence it is concluded, that all fluids in the act of evaporation become electrical, the vapour being electrified positively, and the body which it is leaving negatively; and again, that when vapour becomes condensed into a fluid, it becomes negatively electrified, leaving the bodies with which it was last in contact in a state of negative electricity.

33 lvanic ctricity.

Some conductors arranged in certain ways will produce electrical appearances without friction, or communication with any electric except the air.

Thus if a plate of zinc, a plate of silver, or of copper, and a piece of woollen cloth moistened with some saline solution, as of muriate of ammonia, be arranged in the order we have mentioned one above another, they will manifest signs of electricity, which will be the stronger in proportion as the sets of metal and cloth are more numerous.

The same appearances will be more manifest if the metallic plates joined together be fixed in a trough at small distances, while the intermediate spaces are filled with the saline solution.

As the appearances produced by conductors arranged in this way are of a peculiar nature, we shall refer the consideration of them till we come to Galvanism.

The glass tube and the dry hand, mentioned in (1.), constitute the most simple *electrical apparatus* of which the essential parts are the *electric* and the *rubber*. But for the purpose of experiment it is necessary to have the electric of considerable size, furnished with some proper substance which can always perform the office of a *rubber*, and so firmly fixed as not to be easily disturbed from its situation in the course of our experiment. We shall then have what is called an *electrical machine*.

As much of the success of electrical experiments depends on the proper construction and management of the *machine* and its attendant apparatus, we shall here give a pretty full account of the usual apparatus, before we proceed in explaining the principles of the science.

PART II.

OF ELECTRICAL APPARATUS.

Chap. I. *Of the Construction of Electrical Machines.*

34 struc- of elec- al ma- es.

WE shall first lay down the general principles on which the construction of an electrical machine and the adjusting of its several parts depend; and shall afterwards describe some of the more important machines which are now in use.

The principal parts in an electrical machine are the *electric*, the *engine* by which it is to be set in motion, the *rubber*, and *prime conductor*.

35 tric.

Several substances have, at various times, been employed as electrics, as *sulphur* (E), *rosin*, *polished glass*, and *rough glass*; and they have been used of various forms, as *globes*, *spheroids*, *cylinders*, &c. The reason of this variety of form seems to be that experience had not shown what form was the most convenient; but the different substances were employed for the purpose of producing a positive or negative electricity, as the nature of the experiment or the fancy of the operator might require.

But as this purpose is better answered by insulating the rubber, or allowing it to communicate freely with conductors, polished glass is almost the only substance at present employed as the electric of a machine. Globes of glass are sometimes used, but the most convenient forms are cylinders and plates.

36 der.

The most convenient size for globes is from nine to twelve inches diameter. They are made with one neck, which is cemented to a strong brass cap, in order to adapt them to a proper frame. The most convenient cement for holding together the parts of electrical apparatus is made by melting together, over a gentle fire, two parts of rosin, two of bees-wax, and one of powdered red ochre. The cement is much better than rosin alone, as it serves the purposes of insulation equally well, and is much less brittle. Globes were formerly much more used than at present; their great advantage appears to be, that by making the electric revolve on an axis nearly perpendicular, the upper part is more completely insulated; but one great disadvantage attends this motion, namely, that as the pressure is applied at a distance from the fulcrum, it in time loosens the adhesion of the strongest cement.

37 Cement for electrical apparatus.

38 Plates of glass.

Plates of glass are much in fashion on the continent; and they seem to attribute to this form much of the wonderful power of their machines, as of that at Haarlem, to be hereafter mentioned. Perhaps the greatest advantage of plates is that the friction may be applied to both surfaces at once; but it may be doubted, whether this be not an imaginary advantage, and this form is attended with several material inconveniences; as, 1st, Plates cannot bear any great pressure of the rubber; 2d, They cannot be insulated without very complicated machinery; 3d, As they are fixed by the centre, and the friction is applied towards the circumference, if much force be employed, there will be great danger

---

(E) The first person who constructed any thing like an electrical machine was Otto Guericke, burgomaster of Magdebourg, who lived in the latter end of the 17th century. He formed a globe of sulphur by melting this substance in a glass globe, which he then broke away from it, little imagining that the glass itself would have answered his purpose much better. *Vid. Experimenta Magdeburgica.*

danger of breaking the plate, or at least of loosening it, and thus disturbing the equability of its motions; and 4thly, They are much more expensive than any other form, and hence, as they are much exposed to injury, the replacing of them becomes a very serious object.

The ingenious Mr Cuthbertson has contrived to obviate some of these disadvantages, and his plate machines are very conveniently managed, as well as very powerful in their effect.

39 Cylinders to be preferred.

On the whole, the cylindrical form seems preferable to any other, and this is now almost universally employed. The cylinders should be blown as light as possible, consistently with sufficient strength, and their surface should be as equable and free from knots or protuberances as may be; for these not only render the cylinder more liable to be broken, but prevent the silk of the rubber from being closely applied to every part of the surface. To avoid these inequalities, the cylinder should be blown at the time when the glass is in the most complete state of fusion, and this is found to be the case when the pot is about half emptied, which happens at the London glass-houses on Wednesdays and Thursdays.

The cylinders are usually made of the best flint-glass, but it is not determined which is the most suitable kind. In size they vary from eight inches long and four in diameter, to two feet long and one foot in diameter, which is perhaps as large as they can be conveniently blown. Very small cylinders are, however, of little use, and it may be doubted whether the diameter should not be greater in proportion to their length than what is above assigned. It is of great consequence that the cylinders should be properly annealed, as when they have been too suddenly cooled, they are apt to fly in pieces in the act of whirling.

Cylinders are made with two necks; and the openings of these, or at least of one, should be so wide as to admit the hand to clean the inner surface of the glass, which is sometimes sullied by condensed vapour. These necks are cemented as above directed, to caps of brass, which are much superior to wooden caps, as they may be made much more smooth and equal.

Brass caps have been objected to on account of the conducting power of the metal; but this objection is absurd, as the insulation depends on the distance between the cap and the cushion, which, as will be mentioned presently, should be as great as possible. Indeed wood, if ever so well dried, is but a very imperfect insulator, and the hardest can never be so completely polished as a metallic substance. The brass cap should be composed of two parts; one a ring to be cemented round the neck of the cylinder, with an aperture sufficient to admit of the introduction of the hand within the glass, and with a surface as extensive as possible, that the adhesion of the cement may be the more complete; the other a bead or lid of brass completely polished, to be screwed into the ring, and with an orifice into which the winch, or the pin on which the other end of the cylinder is supported, may be screwed.

40 Coatings o globes and cylinders.

It has been thought of advantage to line the inside of the glass with some electric substance, as wax, rosin, &c.: this has been thought by some to increase the excitability of the glass. It seems ascertained, that if such a coating does not make a good cylinder better, it at least often improves a bad one. The composition most approved for coating globes or cylinders is formed of four parts of Venice turpentine, one part of rosin, and one of bees-wax, melted together and kept boiling over a gentle fire for about two hours, with frequent stirring. When a vessel is to be coated with this composition, a sufficient quantity of it, broken into small pieces, is to be put within the globe or cylinder, which is then held to the fire to melt the composition; and by constantly turning it round, the coating is to be spread equally over the surface to about the thickness of a sixpence. In doing this, care must be taken to heat the glass very gradually and equally, otherwise it is liable to be broken during the operation.

41 Means of moving th electric.

The electric is set in motion either by a simple winch, or by means of multiplying wheels. The former, as being more simple, and consequently less liable to produce disorder in the motion of the machine, is generally preferred. The handle of the winch is sometimes made of glass, but this is unnecessary; for the glass does not shorten the interval which is most favourable to the dispersion of the electric power.

Multiplying wheels were much more common formerly than at present. The usual method of employing these is, to fix a wheel on one side of the frame of the machine, which is turned by a winch, and has a groove round its circumference.

Upon the brass cap of the neck of the glass globe, or one of the necks of the cylinder, is fixed a pulley, whose diameter is about the third or fourth part of the diameter of the wheel: then a string or strap is put over the wheel, and the pulley; and by these means, when the winch is turned, the globe or cylinder makes three or four revolutions for one revolution of the wheel. One inconvenience attending this construction, is, that the string is apt to become so very slack, as to prevent the machine from working. To remedy this, the wheel should be made moveable with respect to the electric, so that, by means of a screw, it may be fixed at the proper distance; or else the pulley should have several grooves of different radii.

The chief advantage of multiplying wheels, is that the arm of the operator is less fatigued by turning the machine than when a simple winch is used; and as by these the motion of the electric is rendered quicker, that its electric power is supposed to be proportionally increased.

In some machines, instead of the pulley or string described above, a wheel and pinion are used, or a wheel and an endless screw. This machinery requires considerable nicety in its construction, is apt to produce an unpleasant rattling, and unless frequently oiled, the constant friction of the parts against each other soon wears them away, so as to render the motion unsteady.

42 Rubber.

The rubber (F), by which the electric is to be excited,

(F) For a long time the only rubber employed was the dry hand of the experimenter, till the middle of the 18th century, when M. Winckler, professor at Leipsic, introduced the cushion. It was even long after this before cited, consists of two parts. One part is a cushion, which is usually made of a piece of red basil skin, stuffed with hair or flannel. The cushion is either fixed to a piece of wood well rounded at the edges, and fastened to a support of glass, or some other insulating substance; or where two conductors are employed, it is fixed to one of these. The cushion should be made as hard as the bottom of an ordinary hair chair, and so adapted to the surface of the cylinder, as to press equally on it in every part. For this purpose it is generally provided with a spring, by which it is adapted to any inequalities of the surface of the glass; in the usual construction of the cushion the spring is placed without, but Mr Jones, instrument-maker in London, made what he considers as a great improvement on the mode of placing it. This consists in a spring placed within the rubber itself; the action of which is found to be better suited for adapting the rubber to the inequalities of the glass, than that placed entirely without the rubber. It consists of a piece of flexible iron or brass, represented edgewise by A, fig. 3.; and it is evident that it acts in a much more parallel and uniform manner than the former, which is constantly changing the pressure of the line of contact betwixt the rubber and cylinder while it passes from the under to the upper side, thus rendering the effect inconstant.

The length of the cushion should not exceed one-third of the length of the cylinder; for if it were longer, the insulation would be much less complete, since one end of the conductor (when the rubber is fixed to a conductor) must always be nearer to the hand by two or three inches than the cushion.

The other part of the rubber consists of a piece of black Persian silk as broad as the length of the cushion, and reaching from it over nearly one half of the cylinder. It should be sewed upon a wire, bent at both ends, and these ends are adapted to holes made on the upper edge of the wood to which the cushion is fastened; or it may be glued to the edge of the cushion: but the former mode of fixing it is to be preferred, as it can then be easily removed.—This silk flap operates as a continuation of the rubber, which, by partially maintaining the excited state of the glass, prevents the tendency of the acquired electricity to pass back into the cushion.

The rubber should be insulated in the most perfect manner; as, when insulation is not required, it may be easily taken off by a chain or wire hung upon it, and, thus communicating with the earth or with any unelectrified body; but where there is no contrivance for insulating the rubber, it is impossible to perform many of the most curious experiments. In short, to construct the rubber properly, it must be made in such a manner, that the side it touches in whirling may be as perfect a conductor as it can be made, in order to supply electricity as quickly as possible; and the opposite part should be as perfect a non-conductor as possible, in order that none of the electric power accumulated upon the glass may return back to the rubber; which has been found to be the case when the latter was not made in a proper manner (G).

43 Wolff's improvement of the rubber.

Of late, a considerable improvement in the rubber has been made by M. Wolff, of Hanover. The construction and advantage of his rubbers, as applied to a plate machine similar to that of Van Marum, of which an account will be given in the sequel, is thus described by the author in a paper in Gilbert's *Annalen der Physick* for 102, and translated in Nicholson's Journal, for February 1804, from which we have copied them.

The four rubbers are made of dry walnut wood soaked in amber varnish, and are $5\frac{3}{8}$ inches long, $1\frac{1}{2}$ broad, and a little more than one quarter of an inch thick. The metallic plate that communicates with the leather covered with amalgam, is only $1\frac{1}{2}$ inch broad, and is fixed externally to the centre of the piece of wood. The rubbers are pressed towards the glass by means of a spring. They are covered with a piece of thick woollen, upon which is a piece of fine neat's leather, After the leather is fastened to the wood, it is wetted, and pressed between two boards, where it is kept till it is again dry. Thus it is rendered very flat, and its edge very sharp, and all its parts will apply to the surface of the glass. This piece of leather is covered with another a little broader, the rough surface of which is towards the glass, and its lower edge on the side towards which the plate moves; and its upper edge on the other side, from which the plate moves, being likewise very sharp. The piece of silk is applied with accuracy to this leather. Before it is fastened on, it is heated, and besmeared first with butter of cacao, then with a large quantity of Kienmayer's amalgam (H); and after it is fastened on, it is compressed in conjunction with the wood, or pressed strongly against the machine. The leather is next covered with amber varnish, amalgam is spread over this, and after the varnish is dry, it is smoothed with a burnisher. This is repeated several times. The whole being very dry, and the rubber being pressed so as to touch the glass in all points, the leather coated with amalgam (I) is covered with a piece of fine white paper, as long as the leather, and half an inch broader, so as to cover the seam that fastens the silk to the leather, and the paper is fastened

---

fore electricians could be persuaded that any rubber was better than the clean dry human hand. Vid. *Priestley's Hist.* part i. sect. 7.

(G) The improvement of the silk flap was first introduced by Dr Nooth. Vide *Phil. Trans.* vol. lxiii.

(H) He adds to this amalgam as much silver, as the mercury can dissolve in conjunction with the zinc.

(I) The amalgam mentioned by M. Wolff is formed of two parts of *mercury*, one part of *purified zinc*, and one of *pewter*. The zinc and pewter are melted together, and, before the mixture is quite cool, the mercury is added. The whole is then poured into a close box, shaken for some time, and left to cool on a marble slab. When nearly cold, it is reduced to powder in a glass or earthen mortar, taking care not to triturate it so long as to make it turn gray. The Baron de Kienmayer, the author of this amalgam, has given a particular account of its preparation and uses in the 33d vol. of Rozier's Journal, p. 96. *q. v.*

ed to the wood above or below, accordingly as it is on the ascending or descending side of the plate.

Dry paper is known to be capable of acquiring a high state of electricity, which induced me to try this substance as an immediate rubber. The following are the advantages which by my experiments, repeated and varied in a great number of ways, I have found paper as a rubber to possess over every other known substance.

1. The glass is not rendered dull by the friction, as happens by frequent using, when it is in immediate contact with the amalgam.

2. By the immediate contact of the amalgam, the glass frequently contracts streaks here and there, which occasion a circulation of the fluid. This cannot take place in the construction I propose.

3. Neither the glass nor the silk can be soiled. It is well known, that the cleanness of the glass, as well as of the rubber and the whole machine in general, is of importance in producing an intense electricity. It is true, that it has been proposed to apply the amalgam to the glass instead of the rubbers; but the greater effect, that seems to be produced by this last method, is only apparent, and consists entirely in the circulation of the fluid on the glass, while, far from exciting or accumulating more of the fluid, this process and the circulation disperse it.

4. The amalgam on the leather does not require to be frequently renewed. The dust of the amalgam, that is deposited on the edges of the paper, is injurious only when accumulated there in sufficient quantity to be conveyed to the glass, from which however it may easily be removed.

5. The return and passage of sparks to the rubbers are rendered more difficult, as the paper sufficiently covers the borders of the rubbers, that are turned towards the axis.

6. In my construction the rubbers may be larger than in the usual way, and in reality they are larger in proportion in my machine than in Van Marum's. No spark passes the axis, unless the air be very damp. I am persuaded, that, by adopting my construction, the rubbers of a plate of 32 inches, such as Van Marum's is, may be eleven inches, instead of nine, in which case there would still be two inches for the diameter of the piece of wood that fastens the plate to the axis, and three inches for the distance from this piece to the rubbers; which I think would be sufficient in these circumstances; and the friction being on a larger surface of the plate, the effect must naturally be much greater. I shall try this alteration of the rubbers on large plates of Bohemian glass, as well as on English cylinders of 18 inches diameter, and 21 inches long. The results already obtained with a small cylinder give me reason to hope much more complete success with a large one.

7. With my rubbers the friction may be rendered much greater, than with those the amalgam of which is in immediate contact with the glass, and soils it; besides, the plate turns with a uniform friction.

8. The activity of the machine is extraordinarily increased by this construction. The greater freedom with which the plate moves, even under a greater pressure, and the paper's preventing the glass from being soiled, would be sufficient to produce this effect; even if the greater pressure alone did not occasion a more powerful effect than can be obtained from common machines.

44
Prime conductor.

The last part of a machine which we are to describe is the *prime conductor*. The object of this part of the apparatus is to concentrate the power of the excited electric. It was the invention of the German electricians.

This is a cylindrical tube, usually made of brass, copper, or tinned iron, the two first of which are much the best, as they admit of more nicety in the construction, especially of being better polished. When required very large, the cylinder may be made of pasteboard covered with tin-foil or gold-leaf. It is of great consequence that the conductor be made perfectly free from points or edges, and where holes are made in it, as is commonly done, for the purpose of experiment, these should have their edges perfectly smooth and even. The cylinder is closed at both ends by spherical lids or covers, made so as to fit with the greatest accuracy, but so as to be taken off, if requisite. These ends are sometimes made larger than the rest of the cylinder; but this is unnecessary, and it is much better that they should form with it one smooth and uniform surface. In some machines the conductor is placed at right angles to the glass cylinder, but it is now usually placed parallel to it. At the end or side opposite the glass, are fixed a row of metallic points, for receiving the electric power; these are generally either fixed immoveably in the side or end of the conductor, or are fixed along a separate piece of strong brass wire, which is made to shut into two holes in the conductor, so that the points can be removed at pleasure. Mr Reid contrived to fix them to rings turning on an axis, the ends of which were forced into holes made in the conductor, so that the points rested on the glass, with which they were thus in perpetual contact, without disturbing its motion. It is certainly of great advantage to have the points as near the glass as possible, but this mode of fixing them is attended with the inconvenience of multiplying the protuberances on the surface of the conductor. Mr Singer introduced the improvement of placing the points on a wire, moveable on its axis by means of a spring socket annexed to the stem. The points are thus placed at any elevation; and when they are a little above the horizontal line, the danger of scratching the glass is prevented.

The size of the conductor is of some consequence; in general its length should equal that of the glass cylinder including its necks, and its diameter should be about one-third of that of the cylinder. It should be insulated by being fixed on a pillar of glass covered with sealing-wax. For this purpose, the sealing-wax may be dissolved in alcohol (spirit of wine), and thus applied to the glass pillar; but it is better to heat the glass gradually, and then rub it over with the sealing-wax till it is covered to a sufficient thickness. Where there are two conductors, one of them supports the rubber, and is called the *negative* conductor; this is not furnished with points: the other, which is what we have just described, is placed opposite and parallel, on the

the other side of the glass, and is called the *positive* conductor (K).

It is proper to have several brass balls furnished with stalks, some straight, and others curved, which may be fitted into the holes in the surface of the conductor.

The balls should be of various sizes, and should be made to screw upon the ends of the stalks, some of which should be terminated by points. It is convenient also that some of the stalks be made with a joint, so that the ball or point may be placed in any position.

45 Electrical machines should be furnished with one or more chains, by which, when insulation is not required, either of the conductors may be made to communicate with the table or with the floor.

There is also attached to the electrical machine, a stool with four glass feet, for the purpose of insulating various bodies in the course of experiment. This is called *the insulating stool.* It should be made either of baked wood or thick glass, and sufficiently large to support an ordinary chair, or at least to allow a person easily to stand on it.

Chap. II. *Description of some particular Electrical Machines.*

46 The first machine which we shall describe is one invented by Dr Priestley, which has been considered by some as so ingenious, that it has been called *a universal electrical machine.*

It is thus described by this author in his history.

The frame consists of two strong mahogany boards of the same length, parallel to one another, about four inches asunder; and the lower is an inch on each side broader than the upper. In the upper board is a *groove*, reaching almost its whole length. One *pillar*, which is of baked wood and immoveable, is let through the upper board, and firmly fixed in the lower, while the other pillar slides in the groove above mentioned, in order to receive globes or cylinders of different sizes; but it is only wanted when an axis is used. Both the pillars are perforated with *holes* at equal distances, from the top to the bottom; by means of which globes may be mounted higher or lower according to their size; and they are tall, to admit the use of two or more globes at a time, one above the other. Four of a moderate size may be used, if two be fixed on one axis; and the wheel has several grooves for that purpose.

If a globe with only one neck be used, a brass arm with an open socket, is necessary to support the axis beyond the pulley; and this part is also contrived to be put higher or lower, together with the brass socket in which the axis turns. The axis is made to come quite through the pillar, that it may be turned by another handle, without the wheel, if the operator chooses. The frame being screwed to the table, may be placed nearer to, or farther from the wheel, as the length of the string requires, in different states of weather. The wheel is fixed in a frame by itself, by which it may have a situation with respect to the pulley, and be turned to one side, so as to prevent the string from cutting itself. The hinder part of this frame is supported by a foot of its own.

The rubber consists of a hollow piece of copper lined with horse hair, and covered with a basil skin. It is supported by a socket, which receives the cylindrical axis of a round and flat piece of baked wood, the opposite part of which is inserted into the socket of a bent steel spring. These parts are easily separated; so that the rubber, or a piece of wood that serves to insulate it, may be changed at pleasure. The spring admits of a twofold alteration of position. It may be either slipped along the groove, or moved in a contrary direction, so as to give it every desirable position with respect to the globe or cylinder; and it is besides furnished with a *screw*, which makes it press harder or lighter, as the operator chooses.

The prime conductor is a hollow vessel of polished copper, in the form of a pear, supported by a pillar, and a firm basis of baked wood, and it receives its fire by means of a *long arched wire, or rod of very soft brass*, easily bent into any shape, and raised higher or lower, as the globe requires; and it is terminated by an *open ring*, in which are hung *some sharp-pointed wires* playing lightly on the globe when it is in motion. The body of it is furnished with *holes* and *sockets*, for the insertion of metallic rods, to convey the fire wherever it is wanted, and for many other purposes convenient in a course of electrical experiments. The conductor is thus made steady, and yet easily put into any situation. It collects the fire perfectly well, and (what is of the greatest consequence though but little attended to) retains it equally everywhere.

When positive electricity is wanted, a wire or chain, as is represented in the figure, connects the rubber with the table, or the floor. When negative electricity is wanted, that wire is connected with another conductor, such as is represented at fig. 5. while the conductor at fig. 4. is connected by another wire or chain with the table. If the rubber be made tolerably free from points, the negative power will be as strong as the positive.

In short, the capital advantages of this machine are, that glass vessels, or any other electric body, of any size or form, may be used, with one neck or two necks at pleasure; and even several of them at the same time if required. All the essential parts of the machine, the *globe*, the *frame*, the *wheel*, the *rubber*, and *conductor*, are quite separate; and the position of them to one another may be varied in every manner possible. The rubber has a complete insulation, by which means the operator may command either the positive or negative power, and may change them in an instant. The conductor is steady and easily enlarged, by rods inserted into the holes, with which it is furnished, or by the conjunction of other conductors in order

---

(K) M. Boze, professor at Wittemburg, first employed a *prime conductor*; his conductor was a tube of iron or tin, which he insulated at first by its being held by a man standing on cakes of rosin, and afterwards by suspending it by silken lines, horizontally before the globe. For a long time a gun-barrel was employed as a prime conductor.

order to give larger sparks, &c. The wheel may be used or not at pleasure; so that the operator may either sit or stand to his work, as he pleases; and he may with the utmost ease both manage the wheel and his apparatus.

Plate CLXXXVII. fig. 4. This machine is figured in Plate CLXXXVII. fig. 4. where

a a, Represent the two boards of the frame.
b, One of the pillars.
c, The brass arm with the open socket.
d, The axis on which the globe turns.
e, The frame to which the wheel is fixed.
f, The rubber; *g*, The piece of baked wood; *h*, The steel spring; *i*, The screw.
k, The prime conductor; *l*, The rod or wire; *m*, The points.
n, The wire for connecting the rubber with the table.

47 Machine by Dr Ingenhousz. Next to Dr Priestley's machine, we shall describe one which was invented by Dr Ingenhousz, in which a plate of glass is employed instead of a globe or cylinder.

There is a circular plate of glass, about a foot in diameter, perforated in the centre by an iron axis, upon which it is turned vertically by means of a winch. It has four cushions, each above two inches long, which are situated at the opposite ends of its vertical diameter. It moves in a frame composed of a bottom board about a foot square, or a foot long and about six inches broad, upon which are raised two other smaller boards, parallel to each other, and fastened together at the top by a small wooden cross bar. By these upright boards, the axis of the plate is supported, and to them the cushions are fastened. When the machine is used, the bottom of the frame is fastened to the table by an iron crank. The conductor in this machine is made of hollow brass; and is furnished with branches extending from its extremities, and approaching very near the circumference of the plate.

An improvement on this machine is thus described by Dr Walker in his Lectures on Familiar Philosophy.

Plate CLXXXVII. fig. 6. "It is made of a round plate of thick looking-glass, (fig. 6. Plate CLXXXVII.). This plate turns on an axis *a*, supported by the mahogany frame *c c c*, by the handle *g*. The rubbers are of red leather stuffed with curled hair, and nailed to thin slips of wood, *d d*, one on each side of the glass, and made to press the glass very close by the screws *x x*; to these rubbers are attached oiled silk curtains, *z z*, on both sides of the glass. The conductor *w w w*, is of brass, and fixed to the frame, *c c c*, by the glass supporter *q*, which insulates the conductor *w*, and terminates in the two knobs, *s s*; into these knobs are screwed small cylinders of brass, with a number of points that nearly touch the glass, and receive the electric matter from it; they cannot be seen in the drawing, being behind the curtains. For exciting positive electricity in all kinds of weather and situations, this is the most powerful and convenient machine ever yet invented†."

48 Machine in Teyler's museum at Haarlem. A very powerful machine, in which plates of glass are employed, is that in Teyler's museum at Haarlem, constructed by Mr John Cuthbertson. It consists of two circular plates of glass, each 65 inches in diameter, and made to turn upon the same horizontal axis, at the distance of 7½ inches from one another. These plates are excited by eight rubbers, each 15½ inches long. Both sides of the plates are covered with a resinous substance to the distance of 16¼ inches from the centre, both to render the plates stronger, and likewise to prevent any of the electricity from being carried off by the axis. The prime conductor consists of several pieces, and is supported by three glass pillars 57 inches in length. The plates are made of French glass, as this is found best next to the English flint, which could not be procured of sufficient size. The conductor is divided into branches which enter between the plates, but collect the fluid by means of points only from one side of the plate. The force of two men is required to work this machine: when it is required to be put in action for any length of time, four are necessary.

By this machine Van Marum made his experiments on metals, &c. which will be mentioned hereafter.

49 Van Marum's new machine. Plate CXCII More lately, Dr Van Marum has constructed a new machine, of smaller dimensions, but of much greater *proportional* power than the preceding. It is thus described in Nicholson's Journal. Fig. 75. Plate CXCIII. exhibits a perspective view of the machine, and fig. 76, 77, 78, 79, a section, exclusive of the cushions. In the view it may be observed that the cushions are each separately insulated upon pillars of glass, and are applied nearly in the direction of the horizontal diameter of the plate, instead of the vertical diameter as heretofore. The ball diametrically opposite to the handle is the prime conductor, and the semicircular piece with two cylindrical ends, serves, in the position of the drawing, to receive the electricity from the plate. By the happy contrivance of altering the position of this semicircular branch from vertical to nearly horizontal, the cylindrical ends may be placed in contact with the cushions, and the prime conductor instantly exhibits negative electricity. But as it is necessary that the cushions should communicate with the ground when the positive power is wanted, and that they should be insulated when the negative power is required, there is another semicircular branch applied to the opposite side of the plate nearly at right angles to the first. That is to say, when positive electricity is wanted, this second branch denoted by I, I in the section fig. 76. is placed nearly horizontal, and forms a communication from the cushions to the ground through a metallic rod from K behind the mahogany pillar which supports the axis; but when, on the contrary, the negative power is wanted, and the branch from the prime conductor is placed in contact with the cushions, this other branch from the axis is put into the vertical situation, and carries off the electricity emitted from the plate of glass.

The axis of the plate B *h*, fig. 76. is supported by a single column A, which for that purpose is provided with a bearing-piece K, on which two brass collar-pieces DD, represented more at large and in face in fig. 78. are fixed, and carry the axis itself. The whole of fig. 76. is reduced to one-16th of its real dimensions, unless contracted by the shrinking of the paper after printing; to obviate which, it may be remarked that the diameter of the plate is 31 English inches. The axis has a counterpoise O, of lead, to prevent too great friction in the collar D nearest the handle. The arc of

---

† *Walker's Lect.* vol ii. 2d edit.

of the conductor EE, which carries the two small receiving conductors FF, is fixed to the axis G, which turns in the ball H. On the other side of the plate is seen the other arc II, of brass wire, half an inch in diameter, fixed to the extremity of the bearing-piece K, so that it may be turned in the same manner as the arc EE. The two receiving conductors FF are six inches long, and two and a half inches in diameter. The double line P represents a copper tube terminating in a ball Q. It moves like a radius upon the stem R of the ball S, which being screwed into the conductor H, serves to confine the arm P in any position which may be required. The diameter of the ball S is only two inches, which, together with certain other less rounded parts of this apparatus, may serve to show that the considerable electricity from this machine is less disposed to escape than if it had proceeded from a cylinder. The dissipation of electricity along the glass supports is prevented by a kind of cap T, of mahogany, which affords an electrical well or cavity underneath, and likewise effectually covers the metallic caps into which the glass is cemented. The lower extremity of the cap is guarded in the same manner by a hollow piece or ring V, of mahogany, which covers the metallic socket into which the glass is cemented. The three glass pillars are set in sliding-pieces, as marked on the platform of fig. 75. which are nine inches long.

The rubbers of this machine differ in no essential particular from those described by the inventor in the Journal de Physique for February 1791; and the apparatus for applying them is described in the same work for April 1789. Fig. 77. represents a section of this judicious piece of mechanism seen from above, and one-fourth of the real size. A metallic sliding-piece *bb*, is slided into a correspondent face, on the ball Z, which is one of those fixed on the top of the glass pillars near the circumference of the glass plate in fig. 75. To this is affixed the piece *d d*, which terminates in two hinges *g g*, that allow the springs *e e* to move in the plane of the horizon. The pieces *g g* represent the wood-work of the cushions attached to the extremities of the springs by the hinges *h h*. The springs are regulated by the bolt and screw *i i*. The two cushions are thus made to apply to the plate equally through their whole length; the actions on the opposite sides of the plates are accurately the same; and the play of the hinges *gg*, prevents the plate from being endangered by any strain in the direction of its axis. It is certain that, before this adequate provision was made to secure those essential requisites, it was impracticable to apply the cushions to a plate with the same safety and effect as to cylinders, which possess much strength from their figure. An ingenious workman will probably find little difficulty in constructing those rubbers from this description and drawing; but the most precise information respecting every circumstance and dimensions is to be found in the lectures above quoted.

The inner extremities of the cushions are defended by the plates of gum lac YY, which cover the three sides or edges, and prevent their attracting the electric power from the ends of the receiving conductor.

The part of the axis which moves between the collars is made of steel. The middle of the non-conducting part of the axis is a cylinder of walnut-tree *a a a a*, baked until its insulating power is equal to that of glass, and then soaked in amber varnish, while the wood still remains hot. The two extremities of this cylinder, which are of a less diameter, are forced, by strong blows, with a mallet, into the stout brass caps *b* and *c*, in which they are retained by two iron screws *d d*. The cylinder *a a*, and the brass caps, are covered with a layer of gum-lac *e e e e*, to preserve the insulating state of the wooden cylinder more perfectly, and to prevent the cap *b* from throwing flashes to the rubbers. The bottom of the cap *b* is screwed home on the capped extremity of the steel axis B. The base of the cap *c*, which is four inches in diameter, terminates in an axis one inch thick, and two in length; the extremity of which is formed into a screw. The glass plate is put on this projecting part, and secured in its place by a nut of box-wood, forced home by a key, applied in the holes *i i*. Two rings of felt are applied on each side of the glass, to defend its surface from the contact of the wood and the metal; and the central hole in the glass, which is two inches in diameter, contains a ring of box-wood, which prevents its immediate application to the axis.

As it is necessary that the axis G should be parallel to the axis of the plate, in order that the conductors FF may move parallel to the plate itself, the pillar M is rendered adjustable by three bearing screws *r r r* at the bottom, which re-act against the strong central screw T, and this is drawn downwards by its nut. The conductors FF are also adjustable by the sliding pieces *v v*, and the binding-screws *ww*, which also afford an adjustment to bring the axis of each small conductor parallel to the face of the glass plate. A similar adjustment may be observed at the extremities of the arc II.

Fig. 79. represents a section of the moving part of the branch II, one-half of its real size. A brass plate α α is screwed to the face of the capital K by three iron screws β. To this is screwed another ring δ δ, which affords a groove for the moveable ring γγ, into which the arms II are fixed. This is accordingly applied in its place before the ring δ δ is fixed.

The wooden part of the rubbers *g g*, fig. 77. is covered with thin plates of iron, excepting the surface nearest to the glass. The intention of this is to maintain a more perfect communication between the rubbed part of the cushion and the earth or negative conductor, as the case may be.

The plates of gum-lac YY, are applied to the rubbers, each by means of a thin plate of brass, to which they are affixed by heat. There are two wires rivetted in the plates, which are thrust into correspondent holes in the wooden part of the cushion.

The mahogany column A ends in a square ζζ, upon which the piece K is fitted and firmly applied, by means of the screw and nut exhibited in the section *.

The plate machine, in any of its forms, may be made to exhibit the two electricities at the same moment, by being fixed on an insulating table.

The following description of a useful machine is taken from Mr Cavallo, who considers it as one of the most complete with which he is acquainted.

The frame of this machine consists of the bottom board ABC, fig. 7. which when the machine is to be used, is fastened to the table by two iron clamps, one of which

Plate CLXXXVII. fig. 7.

---

* Nicholson's Journ. 4to, vol. i. p. 48.

which appears in the figure near C. Upon the bottom board are perpendicularly raised two strong wooden pillars KL, and AH, which support the cylinder, and the wheel. From one of the brass caps of the cylinder FF, an axle of steel proceeds, which passes quite through a hole in the pillar KL, and has on this side of the pillar a pulley I, fixed upon its square extremity. Upon the circumference of this pulley there are three or four grooves, in order to suit the variable length of the string *a b*, which goes round one of them, and round the groove of the wheel D. The other cap of the cylinder has a small cavity, which fits the conical extremity of a strong screw, that proceeds from the pillar H. The wheel D, which is moved by the handle E, turns round a strong axle, proceeding from almost the middle part of the pillar KL.

The rubber G of this machine is on each end two or three inches shorter than the cylinder (i. e. the cylinder exclusive of the necks), and it is made to rub about one-tenth part of the cylinder's circumference, or rather less; it consists of a thin quilted cushion of silk, stuffed with hair, and fastened by silk strings upon a piece of wood which is properly adapted to the surface of the cylinder. And to the lower extremity of the cushion, or rather of the piece of wood to which the cushion is tied, a piece of leather is fastened, which is turned over the cushion, i. e. stands between it and the surface of the cylinder, and to the extremity of which a piece of silk, or oiled silk is fastened, which covers almost all the upper part of the cylinder. Upon this leather, which reaches from the lower to almost the upper extremity of the cushion, some of the amalgam is to be worked, so as to forced as much as possible into its substance; if mosaic gold is to be tried, then the leather should be new, and whereon no other amalgam has been put. This rubber is supported by two springs, screwed to its back, and from which it may be easily unscrewed, when occasion requires it. The two springs proceed from the wooden cap of a strong glass pillar, perpendicular to the bottom board of the machine. This pillar has a square wooden basis, that slides in two grooves in the bottom board ABC, upon which it is fastened by a screw. In this manner the glass pillar may be fastened at any required distance, and in consequence the rubber may be made to press harder or lighter upon the cylinder. The rubber in this manner is perfectly insulated; and, when insulation is not required, a chain with a small hook may be hanged to it, so as to have a regular communication with the piece of leather; the chain then falling upon the table, renders the rubber uninsulated.

AB represents the prime conductor belonging to this machine. This is of hollow brass, and is supported by two glass pillars varnished, that by two brass sockets are fixed in the board CC. This conductor receives the electric power through the points of the collector L, which are set at about half an inch distance from the surface of the cylinder of the machine.

If the handle E of the wheel be turned, (and on account of the rubber it should be turned always in the direction of the letters *a b c*) this machine standing in the situation that is represented in the figure, will give positive electricity, i. e. the prime conductor will be electrified positively. But if a negative electricity be required, then the chain must be removed from the rubber and hung to the prime conductor; for in this case the electricity of the prime conductor will be communicated to the ground, and the rubber remaining insulated, will appear strongly negative. Another conductor, equal to the conductor AB, may be connected with the insulated rubber, and then the operator may obtain as strong negative electricity from this, as he can positive from the conductor AB.

90 Mr Nair machine. Fig. 8.

The next machine which we shall mention is one invented by Mr Nairne, which is chiefly employed for medical purposes; but a modification of which. to be presently described, will answer for most purposes of electrical experiment better than any other.

The cylinder in Mr Nairne's machine is about twelve inches long and seven in diameter; it turns upon two wooden pieces cemented on the top of two strong glass pillars, BB. These pillars are made fast into the bottom board of the machine, which is fastened to the table by means of a crank. There are grooves made in the under part of the bottom of the crank, through which the pieces FE slide. On these pieces the pillars stand by which the two conductors are supported; and in order to place these conductors nearer to the cylinder, or remove them farther from it, the pieces on which they stand are moveable inwards or outwards, and may be fixed by the two screw nuts LL. The rubber is fastened to the conductor R; and consists of a cushion of leather stuffed, having a piece of silk glued to its under part. This last being turned over the surface of the cushion, and thus interposed between it and the glass, goes over the cylinder, and almost touches the pointed wires which are situated on the other conductors. The conductors are of tin covered with black lacquer, each of them containing a large coated glass jar, and likewise a smaller one, or a coated tube, which are visible when the caps NN are removed. To each conductor is fixed a knob G, for the occasional suspension of a chain to produce positive or negative electricity. The part of the winch C, which acts as a lever in turning the cylinder, is of glass. Thus every part of the machine is insulated, the cylinder itself and its brass caps not excepted. And to this the inventor has adapted some flexible conducting joints, a discharging electrometer, and other utensils necessary for the practice of medical electricity.

A modification of this machine is represented at fig. 9.

Fig 9.

a, the handle of the cylinder.
b, the *negative*, *c*, the *positive* conductor.
d, the silk flap of the rubber.

51 Mr Re portab machin Fig. 1

Mr Reid's portable machine, as improved by Mr Lane, is the last which we shall describe, and is represented at fig. 10. A is the glass cylinder, moved vertically by means of the pulley at the lower end of the axis. This pulley is turned by a large wheel B, which lies parallel to the table. There are three pulleys of different dimensions marked in the figure; one of which revolves four times for every revolution of the large wheel E. The conductor C, is furnished with points to collect the fluid, and is screwed to the wire of a coated jar D, which stands in a socket between the cylinder and the wheel. This figure also shews how Mr Lane's electrometer, to be afterwards described, may be adapted to this machine.

A great many other machines have been described in the Philosophical Transactions, Journal de Physique, and in various books on electricity; but those now described are the most material.

Chap. III. *General Directions for using the Electrical Machine.*

52 It is of the greatest consequence that the machine, as well as the table on which it stands, and every thing in its neighbourhood, be perfectly free from dust; it is therefore necessary to begin by wiping every part of the machine, &c. with a clean, dry, soft linen cloth. If the weather is not warm and dry, it will be proper also to place the machine for some time before the fire, that it may be perfectly free from moisture. The cylinder, if used lately and not cleaned, may have contracted spots of dirt and grease; in which case it must be rubbed with a soft rag dipped in spirit of wine.

53 The conductors are now to be fixed in a proper situation, so that the rubber of the negative conductor may press closely to the cylinder on one side, and the points of the positive conductor may approach on the other as near to it as possible, without touching. Then while the cylinder is made to revolve, the amalgam is to be applied to it, where it is not covered with the silk; this is best done by means of a piece of leather to which the amalgam has been previously fastened, which is a better method than by spreading it on the rubber. As the amalgam is liable to oxidation from exposure to the air, it is proper to scrape the surface of it before it is applied to the cylinder; and if any old amalgam has been left on the cushion of the rubber, this should also be scraped before using the new.

54 After having made these arrangements, on whirling the cylinder in contact with the rubber, without bringing any conducting body near the former, or insulating the latter, we shall perceive in the dark a stream of fire issuing from the place of contact between the rubber and the cylinder, and adapting itself to the form of the cylinder, so as to involve it in a blue flame mixed with bright sparks; the whole making a very perceptible whizzing and snapping noise. If the finger is brought near the cylinder in this situation, the flame and sparks leave the cylinder and strike the finger; and this phenomenon continues as long as the globe is whirled round.

On applying the prime conductor, the light will vanish, and be perceptible only upon the points presented to it by the cylinder; but if the finger is now brought near the conductor, a very smart spark will strike it, and that at a greater or smaller distance, according to the strength of the machine. This spark, when the electricity is not very strong, appears like a straight line of fire; but if the machine acts very powerfully, it will put on the appearance of zig-zag lightning, throwing out other sparks from the corners, and strike with such force as to give considerable pain to those who receive it.

55 If these appearances do not take place, or only in a slight degree, soon after the applying the amalgam, a little oil is to be spread on the palm of the hand, which must slightly touch the cylinder as it moves round; in general this is instantly followed by a copious emission of sparks, numerous torrents of which will now pass from the edge of the silk to the knuckles. Sometimes, however, after using all these precautions, the machine does not act well, and in this case the rubber should be examined, to see if any thing is wrong there. The rubber should be removed from the glass pillar or the negative conductor, to which it is fastened, by taking out the screws by which it is usually secured; it is then to be brought near the fire so that the silk may be perfectly dried, after which a little tallow or suet should be rubbed upon the cushion, and it should then be replaced in its situation. If the silk of the rubber is fitted to the cushion by means of a wire as described in (42.) it will only be necessary to take out this wire, in order to dry the silk. 56

While both conductors remain insulated, the machine will not continue to act long, or at least its action will be much less powerful; but if the negative conductor or rubber be made to communicate with the floor or a moist wall, it will in general continue its action for any length of time required. 57

The weather is found to have considerable influence on the action of an electrical machine; in wet weather it will neither act so powerfully, nor for so long a time, as when the weather is moderately warm and dry, unless perpetual care be taken to keep every part of it warm and clean. Very hot dry weather is also unfavourable to the action of the machine, and when this happens, even the floor of the room may be too dry to serve as a conductor; it is then necessary to connect the rubber by a chain which communicates with some moist surface, as a cellar, or a pump.

58 Mr Nicholson lays down the following directions for preparing the machine for experiment.

Mr Nicholson's directions for increasing the power of the cylinder.

Clean the cylinder, and wipe the silk.

Grease the cylinder, by turning it against a greased leather till it is uniformly obscured. I use the tallow of a candle.

Turn the cylinder till the silk flap has wiped off so much of the grease as to render it semitransparent.

Put some amalgam on a piece of leather, and spread it well, so that it may be uniformly bright. Apply this against the turning cylinder. The friction will immediately increase, and the leather must not be removed until it ceases to become greater.

Remove the leather, and the action of the machine will be very strong*.

Chap. IV. *An Enumeration of some other Parts of an Electrical Apparatus to be described hereafter.*

There are many other parts of the electrical apparatus; but these we can only enumerate here, as their description and use will come more properly to be explained under the principles on which they are constructed.

Fig. 12. and 13. represent different forms of coated jars or Leyden phials employed for the accumulation of the electrical power, and the usual forms of the discharging rod.

Fig. 14. shews one of the most approved forms of the electrical battery.

Fig. 15. represents a stand supporting four electrometers

---

* *Phil. Trans.* for 1789.

Principles of Electricity illustrated by experiment.

meters for ascertaining the presence and measuring the degree of electricity.

Fig. 17. exhibits the usual form of the quadrant electrometer, invented by Mr Henley, placed on the end of the prime conductor.

Fig. 18. represents Mr Bennet's gold-leaf electrometer.

Fig. 19. shews Mr Cavallo's pocket electrometer.

Fig. 29. represents Mr Henley's universal discharger; and fig. 30. a press belonging to it.

Fig. 31. and 32. shew an outline of Mr Morgan's discharging rod.

Fig. 42. represents Mr Nicholson's instrument for distinguishing positive and negative electricity.

Fig. 67. gives a view of Lane's electrometer.

Fig. 68. and 69. represent Mr Brooke's electrometer as made by Mr Adams.

Fig. 70. represents Cuthbertson's compound or universal electrometer.

Fig. 71. and 72. are two views of Dr Robison's comparable electrometer.

Fig. 80. is a figure of an electrical machine in which silk is employed as an electric instead of glass.

Fig. 85. represents Bennet's doubler, and fig. 86. Nicholson's revolving doubler.

Principles of Electri city illus trated b experime

The rest of the apparatus figured in the plates will be enumerated and fully described in the succeeding parts of the article.

Besides the apparatus which we have described and enumerated, the electrician should have several glass tubes, some of smooth and others of rough glass, sticks of sealing-wax, a piece of yellow amber, &c. for exciting positive and negative electricity, when these two states are to be observed or compared.

It is of some consequence that an electrician should have some mechanical facility; as he may often be required to renew or repair parts of his apparatus, either to save expence, or from being at a distance from a skilful workman. For this purpose, few tools are necessary. The principal are a turner's lathe, for turning caps, balls, pedestals, &c.; a blow-pipe with a proper lamp, for bending tubes, or opening and closing such as are of large diameter; a few files of various degrees of fineness, and various forms, as flat, half-round, rat-tail, &c.

PART III.

AN EXPERIMENTAL ILLUSTRATION OF THE PRINCIPLES OF ELECTRICITY.

59 WE propose, in this part, to describe the principal phenomena of *communicated electricity*; and to illustrate these by experiments, which we shall, as nearly as can be done, class under certain general heads. After recounting the experiments which illustrate each head, we shall describe the construction and explain the uses of the several electrical instruments which depend on the principle laid down. We shall also take an opportunity, in this part, of tracing the origin and progress of the more important discoveries which have been made in the experimental part of the science.

As it must be supposed that the reader is at present unacquainted with the *theory* of electricity, the principles to which the several experiments in this part are referred, will be merely such general facts as have been observed in the course of experiment, independent of theory. In the following part of this article, we shall endeavour more accurately to illustrate these phenomena, and explain them according to the most generally received theories of electricity.

CHAP. I. *Of Electrical Attraction and Repulsion, and the Instruments which depend on them.*

60 *An electrified body attracts bodies brought near to it, and after holding them in contact with it for some time, again repels them.*

Experiment 1.—Suspend a downy feather by a silken thread; on making it approach within a few inches of the prime conductor, while the cylinder is set in motion, it will be attracted to the conductor, and almost immediately repelled; and thus alternately attracted and repelled, as long as the machine continues to be worked.

This experiment may be thus varied in a pleasing manner. Take a glass tube, no matter whether smooth or rough, and, after rubbing it, present to it a downy feather; this will, as in the former instance, be instantly attracted, and be retained for a short time in contact with the tube; when it will be repelled. If, at the time of its repulsion, the tube be held in the air at a distance from surrounding objects, the repelled feather will float above the tube, and may be driven about the room as long as it does not touch any object in its neighbourhood. If one person hold a smooth glass tube, and another a rough tube or a stick of sealing-wax, and a feather be let loose between them when excited, the feather will leap from one to the other, and thus the two persons will seem to drive it between them like a shuttlecock, whence this experiment is called the *electrical shuttlecock*.

61 Dancing figures. Plate CLXXXVI fig 2

Exper. 2.—Let there be two metallic plates, one as *c*, fig. 20. supported by a stand, so that it may be placed on a table, &c.; the other *d* provided with a hook, by which it may be hung by a chain to the prime conductor, at some distance from the other plate. Then cut some small figures of men or other objects in paper, or, what is better, form them out of the dry pith of elder, or of rushes, and lay them on the lower plate. On working the machine the figures will rise from the lower plate, and move perpetually from the one plate to the other, as represented in the figure.

Exper. 3. Place a leaf of gold, silver, or Dutch metal on the palm of the hand, and bring it within a few inches of an electrified conductor; it will first move to the nciples Electri- y illus- ted by riment. Plate XXVIII. g. 21.

the conductor, then to the hand alternately, as long as the conductor is electrified.

Exper. 4.—Let a solid rod of glass, as *a*, fig. 21. be made to pass through a bell *b*, perforated for the purpose, and let one end of the rod be fixed in a wooden foot, while the other supports two metallic arms, *c*, *d*, *e*, *f*, crossing each other, and knobbed at their extremities. From each extremity let a small bell without a clapper be suspended by a metallic wire, and from each arm, at a little distance from the extremities, let the clappers of these bells be suspended by silken threads. On connecting the top of the stand with the prime conductor, and setting the machine in motion, the clappers will begin to move between the central bell and the other four so as to ring the whole five.

Here the bells receive the electric power from the prime conductor, and being electrified, attract and repel the clappers which hang freely between them.

Exper. 5.—Connect a circular ring of brass with the conductor of the electrical machine, so as to hang near an inch and a half from the flat surface of a table, and place within it, on the table, a very light glass ball of two inches diameter. The ball will be attracted by the ring, will touch it, and become electrified at the point of contact; this point will then recede, and be attracted by the table, while another part of its surface will be attracted by the ring; and, by the repetition of this process, the ball is made to revolve and travel round the ring. This arises from the non-conducting property of the ball, by which different parts of its surface are in different states of electricity at the same time.

Exper. 6.—Tie a small body, as for instance a light piece of cork, to a silk thread about eight inches long, and holding the thread by its end, let the small body hang at the distance of about eight inches from the side of the prime conductor electrified. This same body, if the electrization of the conductor is not strong, will not be attracted. But if a finger or any conducting substance be presented to that side of the small body which is farthest from the prime conductor, then the small body will immediately move toward the prime conductor; and when this body has touched the prime conductor, it will be instantly repelled from it, on account of the repulsion existing between bodies possessed of the same kind of electricity.

Indeed, if this insulated body be very near to the prime conductor, or the prime conductor strongly electrified, then the small body will be attracted without presenting to it any conducting substance; or the natural fluid belonging to that body will be all crowded on that side of it which is nearest to the prime conductor.

If this small body, instead of the silk, be suspended by a linen thread, it will be attracted at a much greater distance, than in the other case.

Bodies in the same state of electricity, i. e. *which are all electrified positively, or all negatively, have a tendency to repel each other.*

Exper. 1.—Stick a downy feather into one of the holes of the prime conductor. When the cylinder is moved the feather will begin to swell, and its plumes will separate to a considerable distance from each other.

This experiment may be varied, by placing the representation of a human head upon the prime conductor. When the cylinder is moved, the hair of the head will bristle up and stand erect as represented in fig. 22.

Principles of Electricity illustrated by experiment. Fig. 22.

Exper. 2.—Let small balls made of cork, or the pith of elder well dried, be suspended from the prime conductor by threads of an equal length. While the cylinder continues at rest, the balls will touch each other, but as soon as the machine is set in motion they will repel each other to a greater or less distance, according as the electric power produced is stronger or weaker.

It is not necessary that the threads be in contact with the prime conductor, for if the balls be brought near the conductor while the machine is in motion, they will recede from each other as before.

The same effect will be produced whether the balls are hung from the positive or the negative conductor.

From the circumstance observed in the above experiments we deduce the following important corollary.

63 Corollary.

Objects brought near an electrified body are electrified by position.

The communication of electricity from an electrified body, to another which is not in contact with it, but is only in its vicinity, may for the present be conceived by remarking that these bodies are surrounded with air. Air, although an electric, is not a very perfect electric, but is more or less also a conductor, especially when it is moist. When a body is electrified it communicates to the air in contact with it a portion of its electric power, and thus the air becomes electrified, and of course imparts to the bodies which are surrounded by it a degree of electricity; and this the more easily as it is in a better conducting state.

The apparent action of the air in communicating electricity to a body which is surrounded by it, may be illustrated by the following experiments.

Insulate in a horizontal position a metallic rod about two feet long, having blunt ends, and at one of its ends suspend an electrometer, like that represented in fig. 16.; then bring within three or four inches distance of its other end an excited glass tube. On the approach of the tube, the balls of the electrometer will open, and if you present towards them a body positively electrified, you will perceive that they diverge with positive electricity. If the tube be removed, the balls come together again, and no electricity remains in them, or in the metallic rod. But if while the tube is near one end of the rod, and the ball diverge with positive electricity, the other end of the rod, viz. that from which the electrometer hangs, be touched with some conductor, the cork balls will come immediately together, and they will remain so when the conductor has been removed;—remove now the excited glass tube, and the balls will immediately diverge with negative electricity: which shows that the rod remains electrified negatively.

If the above experiment be made with an electric negatively electrified (for instance, a rod of sealing-wax instead of the excited glass-tube) then the apparent electricities in the rod will be just the reverse of what they were before; for, in this case, that end of the rod to which the electric has been presented, will be positive, and the opposite end negative; which opposite end, if touched in this state with some conducting substance, will acquire some electric power from that substance;

the

Principles of Electricity illustrated by experiment.

and when, after that substance has been removed, the excited electric is also removed, the rod will remain positive.

In making this experiment, care must be taken that the end of the rod be very blunt, and that the electric be not very powerfully excited; otherwise a spark may pass from this to the rod, which renders the experiment precarious.

Take two rods of metal, each about a foot long, furnished with knobs at both ends; and, either by silk lines or by insulating stools, insulate them, so that they may stand horizontally in one direction, and about a quarter of an inch distance from one another. To the middle of each of these rods hang an electrometer, like that represented in fig. 16. This done, take an excited glass tube, and bring it to about three inches distance from the knob of one of the rods; on doing which, the electrometers of both rods will appear electrified: keep the tube in that situation for about two seconds, then remove it. The rods now will remain electrified, as appears by the electrometers; the first, viz. that to which the excited tube had been presented remaining negative, and the other positive.

In this experiment, if, instead of the glass tube, an electric, negatively excited, be brought near the end of one rod, then that rod will be electrified positively, and the other negatively.

This is all that we can properly explain at present with respect to the agency of the air in the production of electrical phenomena. We shall take occasion to consider this subject more fully in a future part of this article, when we shall see that a variety in the state of the air produces considerable diversity in the phenomena.

On the principle of electric repulsion, and the above corollary, depend the action of several instruments which are of great use in electrical experiments, and which we shall now describe.

64
Electroscopes or electrometer.

Instruments which are employed to ascertain the presence of electricity are called *electroscopes*, As they are generally employed to measure the degree of electricity produced, they are also called *electrometers*, and by this name we shall in future distinguish them.

65
Abbe Nollet's.

The first electrometer appears to have been constructed by the abbe Nollet; it consisted of two threads of silk, which, as has been shown, recede from each other on the approach of an electrified body. He observed the angle of their divergency by its shadow cast on a board placed behind them. Mr Waitz improved this electrometer by appending small weights to the threads *.

66
Mr Canton's electrometer.

Mr Canton contrived an electrometer which is the foundation of those which are now in common use. He got a pair of balls turned in a lathe out of the dry pith of elder; these he hung by threads of the finest linen, and kept them in a narrow box with a sliding cover, where they were so disposed that the threads could lie straight. When he was to use it, he held the box by the extremity of the cover, and allowed the balls to hang freely from a pin to which they were fixed †.

Plate CLXXXVIII. fig. 15.

Fig. 15. represents a stand supporting the electrometers DD, CC. B is the basis of it, made of common wood. A is a pillar of wax, glass, or baked wood. To the top of the pillar, if it be of wax or glass, a circular piece of wood is fixed; but if the pillar be of baked wood, that may constitute the whole. From this circular piece of wood proceed four arms of glass, or baked wood, suspending at their ends four electrometers, two of which, DD, are silk threads about eight inches long, suspending each a small downy feather at its end. The other two electrometers, CC, are those with very small balls of cork, or of the pith of elder; and they are constructed in the following manner:—*a b* is a stick of glass about six inches long, covered with sealing-wax, and shaped at top in a ring: from the lower extremity of this stick of glass proceed two fine linen threads (L) *c c*, about five inches long, each suspending a cork or pith-ball *d*, about one-eighth of an inch in diameter. When this electrometer is not electrified, the threads *c c* hang parallel to each other, and the cork-balls are in contact; but when electrified, they repel one another, as represented in the figure. The glass stick *a b* serves for an insulating handle, by which the electrometer may be supported, when it is used without the stand AB.

Plate CLXXXVIII. fig. 16.

Another species of the above electrometer is represented in fig. 16.; which consists of a linen thread, having at each end a small cork-ball. The electrometer is suspended by the middle of the thread on any conductor proper for the purpose, and serves to shew the kind and quantity of its electricity *.

6
Mr Henley's quadrant ele
trometer
Fig. 17.

Fig. 17. represents the quadrant electrometer of Mr Henley, one of the most useful instruments of the kind yet discovered, as well for measuring the degree of electricity of any body, as to ascertain the quantity of a charge before an explosion; and to discover the exact time the electricity of a jar changes, when without making an explosion, it is discharged by giving it a quantity of the contrary electricity. The pillar LM is generally made of wood, the graduated arch NOP of ivory, the rod RS is made of very light wood, with a pith ball at the extremity; it turns upon the centre of the semicircle, so as always to keep near its surface; the extremity of the stem LM may either be fitted to the conductor or the knob of a jar. When the apparatus is electrified, the rod is repelled by the stem, and moves along the graduated arch of the semicircle, so as to mark the degree to which the conductor is electrified, or the height to which the charge of the jar is advanced.

Beccaria recommends fixing the index between two semicircles, because when it is placed over one only, the electricity of this repels and counteracts the motion of the index. Other improvements and variations have been made in this instrument, which will be described hereafter.

The first account of Mr Henley's electrometer was given in the Phil. Trans. vol. lxii. by Dr Priestley, who speaks of it in very high terms in a letter to Dr Franklin. He considers it as a perfect instrument for measuring degrees of electricity, but it will appear hereafter that this is not the case.

68
M. Ac
hard's
servati
on the
vision
the sc

The scale in Mr Henley's quadrant is divided into equal parts; but M. Achard has already shewn that when this is the case, the angle at which the index is held suspended by the electric repulsion is not a true measure the

* Histoire de l'Electricité.

† Phil. Trans. vol. xlix. p. 300.

* Cavallo Electricit vol i. p. 168.

(L) These threads should be wetted in a weak solution of salt.

measure of the repulsive force; to estimate which truly, he demonstrates that the arc of the electrometer should be divided according to a scale of arcs, the tangents of which are in arithmetical progression.

The balls of the ordinary electrometer may be made of *pith* or of *cork*, but the latter must be very smooth and well polished. They are best made in a turner's lathe. They may be made of any shape, provided they are regular and free from edges. A very convenient electrometer is made of two long, slender pieces of rush pith, made and appended to short threads of flax. These may easily be hung parallel to each other, whereas in the usual ball-electrometers the threads to which the balls are hung form an angle with each other. This parallelism of the threads is of advantage, and was considered of so much consequence by Lord Stanhope (better known to electricians by the title of Lord Mahon) that he was at great pains to suspend his balls in a parallel position.

69 Ben- 's electrometer. Plate xxviii. ig. 18.

Of all the instruments by which it has been attempted to measure electricity, none have been found to answer the purpose better than that invented by Mr Bennet, and which is represented in fig. 18. It consists of two slips of gold leaf *a a*, suspended in a glass cylinder *b*. The foot, *c*, may be made of wood or metal, and the cap, *d*, should be of metal; the latter being made flat at top for the convenience of putting any thing upon it that is to be electrified. The cap is about an inch wider than the diameter of the glass, and its rim about three quarters of an inch broad, hanging parallel to the glass to keep it sufficiently insulated, and to turn off the rain, when the instrument is employed in experiments on atmospherical electricity. Within this is another circular rim about half as broad as the former, lined with silk or velvet, so that it may be made to fit the outside of the glass exactly, while the cap may be easily taken off to repair any damage done to the gold leaf. From the centre of the cap hangs a tin tube somewhat longer than the depth of the inner rim, in which a small peg, *f*, is placed, which may be taken out occasionally. To this peg, which is rounded at one end and flat at the other, two slips of gold leaf are fastened with paste, gum water, or varnish. They are about a fifth part of an inch broad and two inches long, and are generally made tapering to a point. In one side of the cap is a small tube, *g*, to place wires in; *h*, *h*, are two long pieces of tin-foil fastened with varnish on opposite sides of the internal surface of the glass, where the slips of gold leaf may be expected to strike, and in connexion with the foot of the instrument. The upper end of the glass is covered and lined with sealing-wax as low as the outer rim, in order to make the insulation more complete.

70 rove- t of this ument.

An improvement on this electrometer is to make the cylinder pretty long, and to have a small additional tube of gum lac on the end of it. The slips of tinfoil reach almost to the edge of the outer rim, and are sharp pointed at the top, widening in the middle and decreasing in breadth again as they descend.

71 antages his in- ment.

The great advantage of this instrument over the electrometers which we have described above is its extreme sensibility, which will appear from the following examples.

72 xtreme ibility.

1. On putting powdered chalk into a pair of bellows, and blowing it upon the cap, this was electrified positively when the nozzle of the bellows was about six inches from it; but at the distance of three feet from the nozzle, the same stream electrified the cap negatively. Thus it appears that the electricity may be changed from positive to negative merely from the circumstance of this stream of chalk being more widely diffused in the air. It may also be changed by placing a bunch of fine wire, silk, or feathers, in the nozzle of the bellows: and it is likewise negative when the air is blown from a pair of bellows wanting the iron pipe, so that it may come out in a large stream; but this last experiment succeeded best when the air was damp. There is likewise a remarkable difference between the experiments in which the electricity is positive and that in which it is negative, the former being communicated to the cap with some degree of permanency, so that the slips of gold leaf continue for some time to diverge; but the latter being only momentary, and the slips collapsing as soon as the cloud of chalk is dispersed. The greater permanency of the electricity in the former case is owing to some of the chalk sticking to the cap when the nozzle of the bellows is very near it.

2. A piece of chalk drawn over a brush, or powdered chalk put into the brush, and projected upon the cap, electrifies it negatively; but its electricity is not communicated. It is only produced by position.

3. Powdered chalk blown with the mouth or bellows from a metal plate placed upon the cap, communicates to the cap a permanent positive electricity. If the chalk is blown from the plate either insulated or not, so that the powder may pass over the cap, if not too far off, the electricity communicated is also positive; or if a brush be placed upon the cap and a piece of chalk be drawn over it, the slips of gold-leaf when the hand is withdrawn gradually open with positive electricity as the cloud of chalk disperses.

4. Powdered chalk falling from one plate to another placed upon the instrument electrifies it negatively.

Other methods of producing electricity with chalk and other powders have been tried; as projecting chalk from a goose wing, chalking the edges of books and clapping the leaves of the book suddenly together, also sifting the powder upon the cap, all which electrified it negatively; but the instrument being placed in a dusty road, and the dust struck up with a stick near it, electrified it positively. Breaking the *glass-tear* upon a book electrified it negatively, but when broke in water it did not electrify it.

Wheat flour and red lead produced a strong negative electricity in all cases where the chalk produced a positive electricity. The following powders were like chalk: red ochre, yellow rosin, coal ashes, powdered crocus metallorum, aurum mosaicum, black-lead, lamp-black (which was only sensible in the two first methods), powdered quick-lime, umber, lapis calaminaris, Spanish brown, powdered sulphur, flowers of sulphur, iron filings, rust of iron, sand. Rosin and chalk, separately alike, were changed by mixture; this was often tried in dry weather, but did not succeed in damp; white-lead also sometimes produced positive and sometimes negative electricity when blown from a plate.

If a metal cup be placed upon the cap with a red hot coal in it, and a spoonful of water be thrown in, it electrifies it negatively; and if a bent wire be placed in

Principles of Electricity illustrated by experiment.

in the cap, with a piece of paper fastened to it to increase its surface, the positive electricity of the ascending vapour may be tried by introducing the paper into it.

73 Its sensibility increased by a lighted candle.

The sensibility of this electrometer may be considerably increased by placing a candle on the cap. By this means, a cloud of chalk, which in the other case only just opens the gold-leaf, will cause it to strike the sides for a long time together; and the electricity, which was not before communicated, now passes into the electrometer, causing the gold-leaf to repel after it is carried away. Even sealing-wax by this means communicates its electricity at the distance of 12 inches at least, which it would scarcely otherwise do by rubbing upon the cap.

A cloud of chalk or wheat flour may be made in one room, and the electrometer with its candle be afterwards leisurely brought from another room, and the cloud will electrify it before it comes very near. The air of a room adjoining to that wherein the electrical machine was used, was very sensibly electrified, which was perceived by carrying the instrument through it with its candle.

No sensible electricity is produced by blowing pure air, by projecting water, by smoke, flame, or explosions of gun-powder.

A book was placed upon the cap, and struck with silk, linen, woollen, cotton, parchment, and paper, all which produced negative repulsion; but when the other side of the book was struck with silk, it became positive; this side, struck at right angles with the former, was again negative; and by continuing the strokes which produced positive, it changed to negative for a little while; and by stopping again, became positive. No other book would do the same, though the sides were scraped and chalked, upon a supposition that altering the surface would produce it. At last, one side of a book was moistened, which changed it; whence it was concluded, that one edge of the book had lain in a damp place; which conjecture was farther confirmed by all the books becoming positive in damp weather, and one of them being dried at the fire again became negative.

When the cap is approached with excited sealing-wax, the gold-leaf may be made to strike the sides of the glass more than twelve times; and as the sealing-wax recedes, it strikes nearly as often; but if it approaches much quicker than it recedes, the second number will sometimes be greater.

The quantity of electricity necessary to cause a repulsion of the gold-leaf is so small, that the sharpest points or edges do not draw it off without touching; hence it is unnecessary to avoid points or edges in the construction of this instrument.

To the experiments on blowing powders from a pair of bellows, it may be added, that if the powder is blown at about the distance of three inches upon a plate which is moistened or oiled, its electricity is contrary to that produced by blowing upon a dry plate. This shews that the electricity of the streams of powder issuing out of the bellows is only contrary to the more expanded part, because it is within the influence of its own atmosphere; for when this is destroyed by the adhesion of the powder to the moistened place, it is negative when the bellows are positive, as it was before positive when the more expanded cloud was negative.

Principles of Electricity illustrated by experiment.

This instrument is also free from an inconvenience which attends the electrometers in which cork or pith balls are employed. In these, when the balls are electrified, they are very apt to adhere together for some time before the repulsion takes place, and then they often separate with a jerk so as to recede from each other farther than they ought to do, and thus make the electricity produced appear greater than it really is; whereas the slips of gold-leaf in Bennet's electrometer do not adhere together, and separate equally and gradually.

74 Its defects.

This instrument is, however, not without its defects, as the delicate texture of the gold-leaf renders it very difficult to fasten the slips, so as to keep them entire, and also prevent the instrument from being easily removed from one place to another. Mr Cavallo proposes to remedy these defects in the following manner: When the slips are cut and are lying upon paper, or on the leather cushion upon which they are cut, make them equal in length, by measuring them with a pair of compasses, and cutting off a suitable portion from the longest; then cut two bits of very fine gilt paper, each about half an inch long, and a quarter of an inch broad, and by means of a little wax, stick one of them to one extremity of each slip of gold-leaf, so as to form a kind of letter T. This done, hold up in the fingers of one hand, one of those pieces of paper with gold-leaf suspended to it, and hold the other with the fingers of the other hand; then bringing them near to each other, and having adjusted them properly, viz. so as to let them hang parallel and smooth, force the pieces of paper, which now touch each other, between the two sides of a sort of pincers made of brass wire, or of very thin and hammered brass plate, which pincers are fastened to the under part of that piece which forms the top or cover of the glass vessel. As these gold slips are very apt to be spoiled, we should keep several of them ready cut in a book, each having a cross piece of paper fastened to one extremity, so that, in case of accident, a new pair of gold slips may be soon put between the aperture of the above-described pincers; and by this means the electrometer is rendered, in a certain manner, portable.

75 Cavallo's mode of remedying these defects.

76 Mr Cavallo's pocket electrometer. Fig. 19.

Mr Cavallo describes an electrometer which is nearly as sensible as Mr Bennet's, and is not liable to the inconveniences above mentioned. It is represented at fig. 19.

The case or handle of this electrometer is formed by a glass tube, about three inches long, and three-tenths of an inch in diameter, half of which is covered with sealing-wax. From one extremity of this tube, i. e. that without sealing-wax, a small loop of silk proceeds, which serves occasionally to hang the electrometer on a pin, &c. To the other extremity of this tube a cork is adapted, which, being cut tapering on both ends, can fit the mouth of the tube with either end. From one extremity of this cork, two linen threads proceed, a little shorter than the length of the tube, suspending each a little *cone* of pith and elder. When this electrometer is to be used, that end of the cork which is opposite to the threads is pushed into the mouth of the tube; then the tube forms the insulated handle nciples Electri- illus- ted by eriment.

handle of the pith electrometer, as represented fig. 19. *c.* But when the electrometer is to be carried in the pocket, then the threads are put into the tube, and the cork stops it, as represented at *b.* The peculiar advantages of this electrometer are, its convenient small size, its great sensibility, and its continuing longer in good order than any other we have yet seen.

a, Represents a case to carry the above-described electrometer in. This case is like a common toothpick case, except that it has a piece of amber fixed on one extremity, which may occasionally serve to electrify the electrometer negatively, and on the other extremity it has a piece of ivory fastened upon a piece of amber. This last amber serves only to insulate the ivory, which, when insulated, and rubbed against woollen cloths, acquires a positive electricity; and it is therefore useful to electrify the electrometer positively.

There are many other electrometers employed by electricians; but these cannot properly be described at present, as they are constructed on principles which have not yet been explained. They will be noticed in their proper place.

77 Capillary syphon, &c.

By the electric power, fluid or plastic conducting substances, that have part of their surface projecting into the surrounding air, are formed into much more attenuated streams or threads.

Exper. 1.—Suspend a small metallic bucket full of water from the prime conductor, and place in the water a glass syphon, the diameter of whose tube is so small that the water will only drop from it. Now set the cylinder of a machine in motion, and the water will begin to flow in a full stream from the end of the syphon. The stream will sometimes be subdivided, and if the experiment is made in the dark, the water will appear luminous.

Exper. 2.—Dip a sponge in water, and suspend it from the prime conductor. The water which before only dropped from the sponge, will now flow very fast, and appears in the dark like fiery rain.

The effect of electricity on water flowing through capillary tubes, was first observed by M. Boze; but was more accurately investigated by the Abbé Nollet. He found that the stream of water through a capillary tube, was accelerated in the inverse ratio of the diameter of the tube, till the diameter of the tube was less than a line; but that after this the stream was not sensibly accelerated. The important application which the abbé thought he could make of this experiment will be seen hereafter.

Exper. 3.—Insulate a condensed air fountain, and electrify it; the jet will be minutely subdivided and expanded over a considerable space, but will return to its original limit when the electrization is discontinued.

Exper. 4.—Fasten a piece of sealing-wax to a wire, inserted in one of the holes of the prime conductor. Soften the wax by heat, then turn the cylinder; very fine threads of sealing-wax will be separated, and if received on paper, will cover it with minute fibres resembling fine red wool.

Principles of Electricity illustrated by experiment.

78

When an insulated vessel is electrified, and an insulated body, such as a ball-electrometer, is suspended within the cavity of the vessel, the body shows no signs of electrical attraction or repulsion.

79 Electrical well.

The experiment by which this principle is to be illustrated, is called the *electrical well*, and is thus described by Mr Cavallo.

"Place upon an electric stool a metal quart mug, or some other conducting body nearly of the same form and dimension; then tie a short cork-ball electrometer, of the kind represented fig. 16. (M), at the end of a silk thread proceeding from the ceiling of the room, or from any other proper support, so that the electrometer may be suspended within the mug, and no part of it may be above the mouth; this done, electrify the mug, by giving it a spark with an excited electric or otherwise, and you will see that the electrometer, whilst it remains in that insulated situation, even if it be made to touch the sides of the mug, is not attracted by it, nor does it acquire any electricity; but if, whilst it stands suspended within the mug, a conductor standing out of the mug be made to communicate with, or only presented to it, then the electrometer acquires an electricity contrary to that of the mug, and a quantity of it, which is proportionable to the body with which it has been made to communicate; and it is then immediately attracted by the mug.

"If, by raising the silk thread a little, part of the electrometer, i. e. of its linen threads, be lifted just above the mouth of the mug, the balls will be immediately attracted; for then, by the action of the electricity of the mug, it will acquire a contrary electricity, by giving to, or receiving the electric power from, the air, above the cavity of the mug."

This experiment may be made in greater perfection by employing a globular glass vessel, with a narrow neck just sufficient to admit the electrometer, which should be fastened to a crooked glass rod, so that it may be presented to any part of the cavity. The outside of the vessel should be smeared with some clammy substance, as syrup or treacle, and may be insulated by placing it on a wine glass. The balls presented to the outside when the vessel is electrified, will be repelled; but presented to any part of the inside, they will show no signs of electricity, unless touched with some substance, as a wire, while within the cavity; when, on being taken out, they will repel each other.

This experiment was invented by Dr Franklin, and is called by him the *electrical cup.*

The intensity of the excitement in an electrified conductor, suffers diminution in proportion to the extent of surface.

Exper. 5.—Insulate a smooth metallic cup with rounded edges. In the cup place a quantity of gold chain with a silk thread attached to it, by which the chain may be raised out of the cup at pleasure; attach a pith ball electrometer to the cup, and electrify it. In proportion as the chain is raised from the cup, the divergence of the pith balls is diminished, and is restored again

---

(M) Instead of the electrometer, there may be used any other kind of small conducting body; but that seems best adapted to such experiments.

again in proportion as the chain is replaced. If this experiment is performed on a scale of sufficient magnitude, electric sparks will be procured, and the difference arising from the extension of the surface by the raising up of the chain will appear in the different powers of the sparks.

Chap. II. *Of the Diversities exhibited by the Electric Power in its passage from Pointed surfaces, and from Obtuse surfaces.*

80 *When the electric power passes between an electrified body and a pointed conductor, a luminous stream is produced, attended with a current of air from the point.*

Exper. 1.—Fix a metallic point in the prime conductor, and set the machine in motion. No crackling, but rather a hissing noise, will be heard, and a light will appear as if issuing from the point; and on holding the hand near it, a strong blast of air will be found to proceed from it. On holding another point at the distance of about half an inch from the point in the prime conductor, a stream of light will be seen passing between them, attended with a crackling noise. This current of air will be sufficiently strong to turn any light bodies which are freely suspended, and in this way the following pleasing experiments may be made.

Plate CLXXXVIII. fig. 23. *Exper.* 2.—Cut a round flat piece of cork, with the edges very smooth, and stick a number of small crow quills into the circumference, with the feather ends as represented in fig. 23.; pass a needle through the centre of the cork, and suspend this needle by a small magnet *m*: on holding the cork near the point, the current of air will make it move round with great swiftness.

Fig. 24. *Exper.* 3.—Let four arms of wire, with their extremities pointed and turned all in the same direction, be stuck in the circumference of a small circular piece of light wood, supported on a pointed wire, as represented in fig. 24. On bringing the wires near the point in the conductor, while the machine is in motion, they will move swiftly round as before, and in the dark, a beautiful circle of fire will be produced by the light issuing from the points. If figures of dogs, horses, &c. formed of elder pith, be stuck on the points, they will appear as if pursuing each other, thus forming what Mr Kinnersly called the *electrical horse-race*.

81 Electrical horse race. Fig. 25. *Exper.* 4.—Fix eight bells near the edge of a circular board supported on four feet, as represented fig. 25. having a glass pillar *e* in the centre terminated by a point *g*. On this point place the pointed wires used in the last experiment, hanging from one of them as *d*, a small glass clapper by a silken thread; and connecting the apparatus by a chain *h*, proceeding from the prime conductor. On setting the machine in motion, the wire will move round, and the clapper ring the bells.

82 Electrical orrery. Plate CLXXXVIII fig. 26. *Exper.* 5.—By this motion of circulating points, we may in some measure imitate the revolutions of the heavenly bodies, forming what is called the *electrical orrery*. Let a single wire, with the extremities pointed and turned as before, be nicely balanced on a point; fix a small glass ball over its centre, as *a*, fig. 26. to represent the sun. At one extremity of the wire, let a small wire be soldered perpendicularly, and on this balance another small wire with its ends pointed and turned, and having a small pith ball *w* in its centre to represent the earth, and a smaller ball of the same kind at one of the angles for the moon. Let the whole be supported upon a glass pillar, and be conducted by a chain proceeding from the prime conductor to the wire supporting the glass ball. Now, when the machine is put in motion, the wires will turn round, so that the ball representing the earth will move round the central ball, and the little ball at the angle of the smaller wire will at the same time revolve about the earth.

83 Gravitation resisted by the action of points. Fig. 27. *Exper.* 6.—The power exerted by electricity upon points, may under some circumstances be made to counteract the power of gravitation. Let an inclined plane be formed of two parallel wires fastened by their extremities to four pillars of solid glass, M, N, O, P, fig. 27. fixed in a board, so that the two at one end shall be higher than the other two. Then fix a wire with its ends pointed and turned in the same direction, at right angles upon a wire axis. When this axis is laid upon the inclined plane, it will of course roll to the bottom, but if, when it has nearly arrived there, the machine be put in motion, the wire will return up the plane, revolving on its axis.

84 The electrified cotton. *Exper.* 7.—Take a small lock of cotton, extended in every direction as much as can conveniently be done, and by a linen thread about five or six inches long, or by a thread drawn out of the same cotton, tie it to the end of the prime conductor; then set the machine in motion, and the lock of cotton on being electrified, will immediately swell, by repelling its filaments from one another, and will stretch itself towards the nearest conductor. In this situation let the cylinder be kept in motion, and present the end of your finger, or the knob of a wire, towards the lock of cotton, which will then immediately move towards the finger, and endeavour to touch it; but take with the other hand a pointed needle, and present its point towards the cotton, a little above the end of the finger, and the cotton will be observed immediately to shrink upwards, and move towards the prime conductor. Remove the needle, and the cotton will come again towards the finger. Present the needle, and the cotton will shrink again.

85 *When the electric power passes between an electrified body and a conductor whose surface is obtuse, a luminous spark is produced, attended with an explosion, and these appearances are more or less strong in proportion as the surfaces are more or less obtuse.*

86 Drawing sparks. *Exper.* 1.—When the prime conductor is situated in its proper place, and electrified by whirling the cylinder, if a metallic wire, with a ball at its extremity, or the knuckle of a finger, be presented to the prime conductor, a spark will be seen to issue between them, which will be more vivid, and will be attended with a greater or less explosion, according as the ball is larger. The strongest and most vivid sparks are drawn from that end or side of the prime conductor which is farthest from the cylinder. The sparks have the same appearance whether they be taken from the positive or the negative conductor; they sometimes appear like a long line of fire reaching from the prime conductor

ductor to the opposed body, and often (particularly when the spark is long, and different conducting substances in the line of its direction) it will have the appearance of being bent to sharp angles in different places, exactly resembling a flash of lightning.

87
gure of e electric ark.

The figure of the spark varies with the superficial dimensions of the part from which it is taken. If it be drawn from a ball of two or three inches in diameter, it will have the appearance of a straight line; but if the ball from which it is drawn be much smaller, as half an inch in diameter, it will assume the zig-zag appearance above mentioned. These differences arise from the resistance of the surrounding air; for in a vacuum the short sparks are uniform, and the long ones rarely deflected.

We have just seen that when the electric power passes from a point to a point, there are no sparks, but a luminous stream appears; but if the point be obliterated, by being thrust back so as to be on a level with the surface of the conductor, by being held between the fingers, &c. the sparks will appear as before. Or inclose a metallic point in a glass tube, so that it may be placed at any distance from the open ends of the tube. In this situation its influence as a point will be destroyed, and it will transmit electricity by sparks like a ball.

88
ngth of e spark.

The length of the spark, or the distance through the air which it strikes from the conductor, depends on several circumstances; as, the length and diameter of the conductor; the termination of the surface from which, or to which, the spark passes; the dimensions of the cylinder; and the position of the conductor.

1. If the conducting body be increased in length only, the distance of the spark will be shortened. This fact was very early observed by Dr Priestley. He found that a spark from the end of a wire several yards in length, and about one-fourth of an inch in diameter, was not longer than one taken from a conductor two feet in length, and two inches in diameter. Signior Volta found, that when he connected several rods, eight feet long, and half an inch in diameter, suspended at the distance of eight inches from each other, the spark drawn from them was not so long as one drawn from a conductor of the same length, but of twelve inches diameter. Mr Brooke of Norwich connected nearly twenty rods of wood covered with tin-foil, near seven feet long, and three-fourths of an inch in diameter, at about a foot from each other, so that the whole apparatus resembled a large gridiron, which was suspended from the ceiling by glass rods. From so large an extent of conducting surface no spark exceeding six inches could be drawn; whereas from a conductor eight feet long, and five inches in diameter, sparks may often be drawn above nine inches long, with the same cylinder.

2. If the diameter of the conductor be increased in proportion to its length, the spark is not so long as when it is shortened, while the diameter is increased. A conductor twelve feet long, and eight inches in diameter, does not yield a spark above half the length that may be drawn from a conductor of the same diameter, only six feet long.

3. The spark will strike to a greater distance, according as the cylinder is smaller in proportion to the conductor. A much longer and more violent spark was drawn from Mr Brooke's gridiron conductor with a cylinder only four inches in diameter, than from a conductor five feet long, and six inches in diameter, with the same cylinder.

4. The length of the spark is greater from a ball of moderate dimensions than from the surface of the prime conductor.

5. The spark will be longer when the conductor is placed parallel to the cylinder, than when it is at right angles with the cylinder.

89
Sound of the spark.

The *sound* of the spark varies according as the surfaces between which it strikes are more or less obtuse. It is louder when the spark is taken from the prime conductor, than when taken from a ball annexed to it; and it is loudest of all when the spark strikes from one flat surface to another: a straight spark is always louder than one of the zig-zag appearance, If the spark be made to pass from one end of a glass tube (closed at both ends and very dry) to the other, the sound is entirely hushed.

90
Force of the spark.

When the spark is received by the knuckle, it produces a sensation which is more or less painful. It is more pungent when received from the prime conductor than from a ball attached to it. The spark produces a more painful sensation in proportion as it is shorter.

91
Light of the spark.

The most remarkable circumstance attending the electric spark is the light (N) produced in its passage through the air. The sparks which usually pass between the rubber of the negative conductor, through the cylinder to the points of the positive conductor, are of a beautiful light blue colour; but when the spark passes between the prime conductor and a ball of the diameter of an inch, its edges are purplish, and from these diverge several ramifications of a purple or indigo colour. If the balls between which the spark passes are not more than half an inch distance from each other, a continued stream of the most brilliant light will be produced, attended with a whizzing noise. If the distance of the balls from each other be increased, sparks equally brilliant will be produced; but their succession will be less quick, and no continued steam will appear.

The light emitted from electrified conductors is more copious and brilliant in proportion as their surfaces are more extended. If a person standing on an insulating stool, and connected with the prime conductor of a machine in motion, hold a flat plate of metal, as a pewter plate, while another person standing on the floor holds another plate, large flashes of vivid light will appear between the plates, so as to illuminate a dark room.

92
Peculiar odour attending the spark.

Soon after the cylinder is set in motion, and sparks begin to issue, a peculiar odour may be perceived; and if the machine acts well, this is very powerful. It is difficult

---

(N) The first person who seems to have observed the electric light was Otto Guericke. He appears indeed only to have had a glimpse of it; and the first who perceived it in any great degree was Dr Wall, on rubbing a pretty large piece of amber. Vid. *Philos. Trans. abridged*, vol. ii.

Principles of Electricity illustrated by experiment.

difficult to describe this odour, but it seems to resemble that of phosphorus.

93

CHAP. III. *Of charging and discharging the Leyden Phial; with directions for the construction of Jars and Batteries.*

The electric power is communicated to electrics with difficulty, unless their surfaces be covered with some conducting substance; but it may be accumulated on them in a much greater degree than on conductors.

94 Dancing balls.

Exper. 1.—Take a common tumbler or glass jar, and having placed a brass ball in one of the holes of the prime conductor, set the machine in motion, and let the balls touch the inside of the tumbler; while the ball touches only one point, no more of the surface of the glass will be electrified, but by moving the tumblers about so as to make the ball touch many points successively, all these points will be electrified, as will appear by turning down the tumbler over a number of pith or cork balls placed on a table. These balls will immediately begin to fly about, thus showing the electric attraction and repulsion illustrated in (61.). This experiment is commonly called the experiment of the *dancing balls*, and is represented at fig. 28.

95 Construction of the Leyden phial. Plate CLXXXVIII. fig. 12.

Expr. 2.—Let a glass jar, either cylindrical, such as is represented at fig. 12. Plate CLXXXVIII. or with as wide a mouth as possible, be covered on both its inside and outside surfaces to within two inches of the top, with tinfoil fastened on by means of gum water. The jar is then said to be *coated*. Fit to the mouth of the jar a piece of baked wood, through the centre of which pass a wire, whose lower extremity is terminated by a number of other wires, which must be made to touch the inside coating, while its upper extremity projects an inch or two above the mouth of the jar, and terminates in a metallic ball *a*. This ball should be perforated so as to receive a wire supporting a quadrant electrometer.

96 Method of charging and discharging it.

The jar being thus prepared, let the knob *a* communicate with the prime conductor, and let it remain while the cylinder is in motion till the ball *c* of the electrometer stands nearly horizontal; the jar is then said to be *charged*. This requires a much longer time than to raise the electrometer to the same height when no such jar is presented, although the conductor should be connected with a much more extensive surface of conducting matter. That instrument does not indicate the actual quantity of excitement, but its intensity, or its tendency to equilibrium by motion or explosion. It may be removed from the conductor without any effect being produced so long as the inside coating has no communication with the outside.

Let there be provided a curved brass rod, terminating at each end in a knob, and furnished with a glass handle, such as D *e f*; if now one of the knobs, as *e*, be made to approach the ball *a* of the jar, while the other knob *f* touches the outside coating, a considerable explosion will take place, and the jar will lose its electricity, as will appear by the ball of the electrometer falling into a perpendicular situation.

The jar is then said to be *discharged*, and the rod *d e f* is called a *discharging rod.*

Principles of Electricity illustrated by experiment.

A jar or phial of glass thus constructed is, for a reason which will presently appear, called a *Leyden jar* or *phial.*

In this experiment, the jar is not charged to its utmost height. If, instead of stopping when the index of the quadrant is nearly at right angles, we persist in charging, there will soon appear several luminous streams passing from the prime conductor across the cylinder to the cushion. Presently an explosion will take place from the phial, and this is called its *spontaneous discharge*. If the phial is not very strong, it will probably either be broken, or on examination will be found perforated in some part. If the glass be very thin, a spontaneous discharge will soon take place, attended with a harsh crackling noise, and the phial will certainly be cracked. A spontaneous discharge happens much more readily when the neck of the phial is very small, and consequently the wire comes very near the uncoated part of the glass.

If the uncoated part of the glass be moist or dusty, the jar will not receive a charge, so that it is necessary to be very careful in cleansing the jar before using it. When the uncoated part is made very hot, the spontaneous discharge is much accelerated.

The appearance of the uncoated part of the jar, when the discharge is made in the dark, is very curious. A great number of luminous streams will be seen pouring over the edge of the jar from the inside to the outside.

The force of the explosion depends very much on the termination of the extremity of the *discharging rod*. If this be terminated by a large ball, the noise will be much greater than when the ball is small; if it be terminated by a small obtuse surface, a hissing noise is heard before the explosion, and this is faint. But if the rod terminate in a point, no explosion will take place, but the jar will be silently discharged.

In the above experiment the jar is charged positively, it having been in contact with the positive conductor; but if it be connected with the negative conductor, the jar will be charged negatively. This will be more fully illustrated by and by.

As the accumulation of the electric power by means of coated jars forms one of the most important discoveries which have been made in this science, we shall here relate the method in which the discovery was made.

This discovery was accidental, and was the result of an experiment made in the end of the year 1745 by M. Van Kleist, dean of the cathedral in Cammin, who sent the following account of it to Dr Lieberkuhn at Berlin.

97 Discovery of the Le den phial by M. Va Kleist.

When a nail or a piece of thick brass-wire, &c. is put into a small apothecary's phial, and electrified, remarkable effects follow; but the phial must be very dry or warm. I commonly rub it once beforehand with a finger, on which I put some pounded chalk. If a little mercury, or a few drops of spirit of wine, be put into it, the experiment succeeds the better. As soon as this phial and nail are removed from the electrifying glass, or the prime conductor to which it has been exposed, is taken away, it throws out a pencil of flame so long, that with this burning machine in my hand, I have taken about sixty steps in walking about my room. When it is electrified strongly, I can take it into another room, and there fire spirits of wine with it. If, while it is electrifying, I put my finger, or a piece of gold nciples Ele tri- y illus- ated by eriment.

gold which I hold in my hand, to the nail, I receive a shock which stuns my arms and shoulders.

A tin tube, or a man placed upon electrics, is electrified much stronger by this means than in the common way. When I present this phial and nail to a tin tube, which I have, fifteen feet long, nothing but experience can make a person believe how strongly it is electrified. Two thin glasses have been broken by the shock of it. It appears to me extraordinary, that when this phial and nail are in contact with either conducting or non-conducting matter, the strong shock does not follow. I have cemented it to wood, metal, glass, sealing-wax, &c. when I have electrified without any great effect.

M. Van Kleist communicated this experiment to several of his acquaintances, but they all for some time failed in their attempts to repeat it.

98 Eleri- nt by M Cunens.

An experiment of a similar kind was soon after made at Leyden by Mr Cuneus. Making an attempt to communicate the electric power to water, contained in a phial, in which was a nail, happening to hold his glass in one hand, while he disengaged it from the prime conductor with the other, when he imagined that the water had received as much electricity as it was capable of acquiring, he was surprised with a sudden shock in his arms and breast, which he had not in the least expected.

This experiment was afterwards repeated in the presence of M. M. Allamand and Muschenbroeck with similar results: and as it was at Leyden that the experiment was made with the greatest success, and afterwards improved, it obtained the name of the Leyden experiment, and a phial so constructed as to exhibit similar phenomena, has been ever since called a Leyden phial.

99 Vi s w h led to is dis- co y.

Indeed the philosophers of Leyden seem to have some merit in this discovery, which with them does not appear to have been merely accidental. The views which are said to have led to it were as follow. Professor Muschenbroeck and his friends, observing that electrified bodies, exposed to the common atmosphere, which is always replete with conducting particles of various kinds, soon lost their electricity, and were capable of retaining but a small quantity of it, imagined, that were the electric bodies terminated on all sides by original electrics, they might be capable of receiving a stronger power, and retaining it a longer time. Glass being the most convenient electric for this purpose, and water the most convenient non-electric, they first made these experiments with water in close bottles *.

* iestley Hi Elec.

100 Pr ressive im ve- m of the L en phi.

For a long time water and spirit of wine were the only conductors employed in this experiment; but it was soon found by Dr Watson, that the experiment succeeded better when the outside of the glass was coated with some metallic leaf, as sheet-lead, or tin-foil, while the phial contained some water within; and after this there was a natural transition to the use of an internal as well as external metallic coating, and thus the Leyden phial was completed in its present form (o).

Principles of Electricity illustrated by experiment.

101 Electrical battery described.

A number of coated jars having their internal coatings connected together by metallic wires, constitute what is called a *battery*. Fig. 14. represents an electrical battery of the most approved form, containing nine jars. The bottom of the box is covered with tin-foil to connect the exterior coatings; the inside coatings of the jars are connected by the wires *a b c*, *d e f*, *g h i*, which meet in the large ball A; a ball D proceeds from the inside, by which the circuit may be conveniently completed. In one side of the box, near the bottom, is a hole through which a brass hook passes, and which communicates with the metallic lining of the box, and consequently with the outside coating of the jars. To this a wire or chain is occasionally connected when a discharge is made; and for the more convenient making of this discharge, a ball and wire, D, proceed to a convenient distance from the centre of the ball A. When the whole force of the battery is not required, one, two, or three jars may be removed, only by pressing down the wires belonging to them, until their extremities can slip out of their respective holes in the brass ball, and then turning them into such a posture that they cannot have any communication with the battery. The number of jars represented in this figure is rather small for some purposes; but it is better to join two or three small batteries, rather than have a single large one, which is inconvenient on account of its weight and unwieldiness.

102 Directions for the construction of jars and batteries.

As coated jars form one of the most expensive parts of an electrical apparatus, it is of consequence that the electrician should himself be able to adjust them for experiment, and repair the coating, &c. when injured. We shall therefore give particular directions for the preparation of jars and batteries. The circumstances necessary to be attended to, respect principally the form of the coated electric, the substance employed as an electric, and the conductor employed as a coating.

103 Form of jars, &c.

For most experiments the best form is that of a cylindrical jar, in which the mouth is large enough to admit the introduction of the hand. A phial of this form is much more easily coated, cleaned, or repaired, than one of any other form. Mr Cuthbertson used to make his jars *entirely* cylindrical, but now he is of opinion that it is better to have the mouth a little contracted, and he has of late always made his jars of this latter form. For illustrating the theory of coated electrics, as we shall see hereafter, plates are the most convenient, and they are also useful in some experiments. Dr Robison prefers bottles of a globular form to any other, and he commonly employed the balloons used in distillation, which he says make excellent jars. The bottles employed for holding mineral acids also make very good jars, but they are rather inferior to the balloons, as having very thick bottoms. For ordinary purposes, where a glass house is at a great distance,

---

(o) Dr Watson was indebted for the hint of a *metallic* coating to Dr Bevis, who was also the first electrician that employed a *plate* of glass coated on both sides in performing the experiments with coated electrics. Hence the coated plate is often called, especially by the continental electricians, Bevis's plate, or square, *le carreau de Bevis*.

Principles of Electricity illustrated by experiment.

common green glass bottles or apothecary's phials with the mouths as wide as possible, will answer very well.

104 Electrics employed.

With respect to the electric employed for this purpose, glass is to be preferred on many accounts, and of this the best kind, as flint or crystal: but the expence here becomes a very considerable object, especially as the jars of a battery are very apt to break by reason of the inequality of their strength; for it should seem that the force of the electric power in a battery is equally distributed among all the bottles, without any regard to their capacities of receiving a charge singly considered. Thus if we express the quantity of charge which one jar can easily receive, by the number 10, we ought not to connect such a jar in a battery with one whose capacity is only 8; because the whole force of electricity expressed by 10 will be directed also against that whose capacity is only 8, so that the latter will be in danger of being broken. It will be proper, therefore, to compare the bottles with one another in this respect before putting them together in a battery. Besides the consideration of the absolute capacity which each bottle has of receiving a charge, the time which is taken up in charging it must also be attended to; and the jars of a battery ought to be as equal as possible in this respect as well as the former. The thinner a glass is, the more readily it receives a charge, and *vice versa;* but it does not follow from thence, as was formerly imagined, that on account of its thinness it is capable of containing a greater charge than a thicker one. The reverse is actually the case; and though a thick glass cannot be charged in such a short time as a thin one, it is nevertheless capable of containing a greater degree of electric power. In fact, if the glass be thinner than one-eighth of an inch, the phial will not bear any considerable charge. If the thickness of the glass be very great, no charge can indeed be given it; but experiments have not yet determined how great the thickness must be which will prevent any charge. Indeed it is observed, that though a thick glass cannot be charged by a weak electrical machine, it may be so by a more powerful one: whence it seems reasonable to suppose that there is no real limit of this kind; but that, if a machine could be made sufficiently powerful, glasses of any thickness might be charged.

Glass is attended with one considerable inconvenience; that it is very apt to attract moisture, and therefore the jars require perpetual care in wiping before they are used; and this, when a large battery is employed, becomes a very troublesome operation. It is the uncoated part of the jar which is injured by the moisture, for it is found, that if the coating be moist, the jar is more easily and more completely charged.

105 Substitute for glass by Beccaria.

Electricians have often endeavoured to find some other electric which might answer better than glass for this purpose, at least be cheaper; but except Father Beccaria's method, which may be used very well, no remarkable discovery has been made relating to this point. He took equal quantities of very pure colophonium and powder of marble sifted exceeding fine, and kept them in a hot place a considerable time, where they became perfectly free from moisture; he then mixed them, and melted the composition in a proper vessel over the fire, and when melted poured it upon a table, upon which he had previously stuck a piece of tin-foil, within two or three inches of the edge of the table. This done, he endeavoured with a hot iron to spread the mixture as equally as possible, and to the thickness of one-tenth of an inch all over the table; he afterwards coated it with another piece of tin-foil, reaching within about two inches of the edge of the mixture; in short he coated a plate of this mixture as he would a plate of glass. This coated plate seems, from what he says, to have had a greater power than a glass plate of the same dimensions: even when the weather was not very dry, and if it is not liable to be easily broken by a spontaneous discharge, it may be conveniently employed in place of glass; for it does not very readily attract moisture, and consequently may hold a charge better and longer, than glass; besides, when broken, it may be again repaired by means of a hot iron, whereas a broken plate or vessel of glass can seldom be employed again.

106 Talc a very good electric for coating.

Talc, or Muscovy glass, is one of the most convenient electrics for the purposes of coating. It is not very apt to contract moisture, and will retain a charge for a very considerable time.

A very convenient portable phial may be constructed of sealing wax in the following manner: Procure a phial made of tin-plate, or white-iron (as it is called in Scotland), with a long neck; cover the outside of this phial with sealing wax as far as the neck, and coat the sealing wax to within a little of the neck with tin-foil. In this phial it is evident that the sealing wax is the electric, of which the tin-foil forms the outer and the tin-plate the inner coating.

107 Method of coating plates and jars.

When plates or jars having a sufficiently large opening are to be coated, the best method is to coat them with tin-foil on both sides, which may be fixed upon the glass with varnish, gum water, bees wax, &c.; but in case the jars have not an aperture wide enough to admit the tin-foil, and an instrument to adapt it to the surface of the glass, brass-filings, such as are sold by the pin-makers, may be advantageously used; and these may be stuck on with gum water, bees wax, &c. but not with varnish, for this is apt to be set on fire by the discharge. Care must be taken that the coating do not come very near the mouth of the jar, for that will cause the jar to discharge itself. If the coating is about two inches below the top, it will in general do very well; but there are some kinds of glass, especially tinged glass, that when coated and charged have the property of discharging themselves more easily than others, even when the coating is five or six inches below the edge.

It is much more difficult to coat vessels of a globular form than plates or cylindrical jars; but the former may be coated with tolerable ease by attending to the method of cutting the tin-foil. This should be cut into the form of gussets, as in covering a globe or in making a balloon; and they should be pasted on, so as to overlap each other about half an inch. After having coated the sides of a balloon in this manner, the bottom is to be covered with a circular piece of tin-foil. The thinner the foil, the better it is adapted for the inside coating; and it may readily be applied by first pasting it upon paper, and then pasting either the paper or the foil next the glass.

In coating plates of glass it is better to cut the tin-foil into circular pieces, as it is found that a circular space

inciples
Electri-
y illus-
ated by
eriment.

space is capable of giving as great a charge to the glass, as a square coating of the same breadth, and a spontaneous discharge does not so readily take place from the circular edge, as from the edges of a square coating.

108
r
ooke's
de of
ting.

Mr Brooke discovered, that when jars are coated with tin-foil first pasted upon paper, they were rendered much less liable to be broken by the discharge. As the trials which led to this discovery afford a useful lesson to the young electrician, we shall relate them in his own words.

"In making electrical experiments, and in particular those in which the Leyden phial is concerned, a method of preserving the bottles or jars from being struck through by the electric power, is very desirable; but I do not know that it has hitherto been accomplished. The number of them that have been destroyed in many of my experiments, have led me to various conjectures to preserve them: at the same time I have been obliged to make use of bottles instead of open-mouthed jars. And as coating the former withinside is very troublesome, it has put me on thinking of some method more easy, quicker, and equally firm and good, as with tinfoil. With respect to the new method of coating, I failed; though something else presented itself rather in favour of the former: therefore, introducing the process here will not be of very great use; unless in saving another the trouble of making use of the same method, or giving a hint towards the former so as to succeed with certainty. My aim was to find something that should be quick and clean, and not easy to come off with the rubbing of wires against it, and yet a good conductor. My first essay was with a cement of pitch, rosin, and wax, melted together; into which, to make it a good conductor, I put a large proportion of finely sifted brass filings. When this mixture was cold, I put broken pieces of it into the bottle, and warmed the bottle till it was hot enough to melt the cement in it so as to run, and cover the bottle withinside; then I coated the outside with tin-foil, as is commonly done, and now it was fit for use or ready to be charged, to which I next proceeded; and I believe I had not made more than four or five turns of the winch, before it spontaneously struck through the glass with a very small charge. I then took off the outside coating, and stopped the fracture with some of my common cement, after which I put the coating on again; and in as little time as before, it was struck through again in a different place; and thus I did with this bottle five or six times; sometimes it struck through the glass in four different places. This made me consider what it might be that facilitated the spontaneous striking through the glass, and likewise what might retard it. I had, long before, thought that jars or bottles appeared to be struck through with a much less charge, just after their being coated, or before they were dry, than when they had been coated long enough for the moisture to be evaporated from the paste, with which I mostly lay on the tinfoil, and could only consider the dry paste as a kind of mediator between the tinfoil and the glass, or, in other words, that the moisture in the paste was a better conductor and more in actual contact with the glass than the paste itself when dry. And the coating the bottles with the heated cement, though long afterward, did not alter my former idea: for it appeared as if the hot cement, with the conducting substance in it, might be still more in actual contact with the glass than the moisture in the paste. On these probabilities I had to consider what might act as a kind of mediator more effectually than the dry paste, between the glass and the tinfoil. It occurred, that common writing paper, as being neither a good conductor nor insulator, might be serviceable by being first pasted smoothly to the tinfoil, and left to dry. The paper then being pasted on one side, having the tinfoil on the other, I put them on the glass together with the tinfoil outward, and rubbed them down smooth. This succeeded so well that I have never since had any struck through that were thus done, either common phials or large bottles, which contain near three gallons each, though some of the latter have stood in the battery in common use with the others for a long time. And as I have never had one struck through that has been prepared in this way, I am much less able at present to tell how great a charge they will bear before they are struck through, or whether they will be struck through at all [*]."

Principles of Electricity illustrated by experiment.

The mineral acids serve very well for an inside coating to jars; but their use is attended with some risk, from their corrosive quality.

109
Directions for fixing the wire, &c.

The wire through which the charge is made, should not be less than the fourth of an inch in diameter; it should be terminated by a metallic ball, at least one inch in diameter.

If the phials be intended to be frequently removed from one place to another, the charging wire must be fastened so as to be always steady in the centre of the phial. For this purpose, some employ a piece of wood, to fit the mouth of the phial like a lid, but the length of insulation which separates the coating from the phial is thus diminished, and consequently, as we ſhall see hereafter, the phial is more liable to a gradual spontaneous discharge, so that it is much more difficult to charge it. The wire is best fastened below the edge of the inner coating, and in this way Mr Cuthbertson constructs his jars, the mouth being left entirely open.

When the phial is not to be removed from the situation in which it is charged, the wire may be fastened to the conductor.

110
Construction of batteries.

Batteries may be formed either of plates or jars. A very compendious battery may be made in the following manner. Select a number of plates of the best crown glass that are very flat and thin; coat them on each side with a circular piece of tinfoil pasted in the middle of the plate, so as to leave a margin sufficiently wide to prevent a spontaneous discharge; let a narrow slip of tinfoil pass from the circumference of the coating on each side, and lay the plates upon each other so that these slips may coincide. Let the slips be connected at their ends by a wire which touches them all; then if one of these slips be connected with the prime conductor, and the other with the ground, the whole may be charged or discharged together. If we wish to have a number of these plates connected so as to form a perpetual battery, they may be cemented by covering the tin-coated margins with melted pitch, and pressing the plates down on each other while the pitch is soft till the coatings touch each other. But if we desire to make use only of a few

---

[*] *Brooke's Miscellaneous Experiments and Observations.*

of the plates at a time, and to vary their number, they may be placed upon their edges in an open frame; and when we wish to make a break in the chain of plates, this may easily be done by placing one of them at right angles to the rest.

A very convenient battery may be formed in this way with coated plates of Muscovy glass; but great caution is necessary in the use of such plates, as they are very easily broken by a spontaneous discharge, and it is not easy to discover where the crack has happened.

111 Mr Brooke's mode of constructing his batteries.

Mr Brooke of Norwich constructed his batteries, which appear to have been very powerful, of green glass bottles. Some of them, like that represented in the figure, had only nine of these bottles; but when a greater power was wanted, more were added. Jars would have been preferred to bottles, on account of their being more easily coated by reason of their wide mouths; but being less easily procured, he was content to put up with this inconvenience. The mean size of these bottles was about eight inches in diameter; they were coated 10 inches high, and made of the thickest and strongest glass that could be procured, weighing from five pounds and a half to seven pounds each. In the construction of a battery of 27 bottles, he disposed of them in three rows; nine of the stoutest and best composing the first row, nine of the next in strength being disposed in the second, and the third containing the nine weakest. All of these were of green glass, but not of the same kind. Some of those which stood in the foremost row, were composed of a kind very much like that of which Frontigniac wine bottles are made; and our author remarks, that this kind of glass seems to be by much the best, as being both harder and stronger, and less liable to break by a high charge. The second and third rows of the battery consisted of bottles whose diameter was from six and a half to ten inches, and which were coated from eight and a half to eleven inches high; none of their mouths being larger than an inch and a half, nor less than three quarters of an inch.

All the bottles of this battery, as well as the single ones which he commonly made use of in his experiments, were coated both on the inside and outside with slips of tinfoil from three-eighths to three-fourths of an inch wide, laid on with paste of flour and water, at the distance of about a slip between each.

112 Mr Morgan's rules for the construction of batteries.

Mr G. Morgan lays down the following requisites, essential in the construction of a battery.

1. Its connecting wires should be perfectly free from all points and edges.

2. The connecting wires should be easily moveable, so that when accident has lessened the number of phials, the number of wires may be reduced so as to correspond with the remaining quantity of glass.

3. The phials should not be crowded; for in such a case, if necessity should oblige us to employ phials of different heights or sizes, the tinfoil of the higher ones, being in contact with the uncoated glass of the lower ones, the insulation will thus be rendered less complete.

4. The size of the phials should not be large; for though an increase of magnitude lessens the trouble of cleaning, it at the same time increases the expence of repairing damages which frequently occur.

5. The several wires should be fixed very steadily, or in such a manner as not to admit of any shaking.

6. The battery should take up the least possible room; for as it increases in size, so is the probability increased of its being exposed to the influence of surrounding conductors.

113 Origin of the electri- cal batter

The first electrical battery appears to have been constructed in the year 1746 by Mr Gralath, a German. Dr Franklin constructed a battery consisting of eleven plates of common window glass, and with this he made most of the experiments which will be mentioned hereafter. The construction of the battery was greatly improved by Dr Priestley, who formed them of considerable size and power. In his history he describes and figures one consisting of sixty-four jars, each ten inches high, and two inches and a half in diameter, and the whole battery containing 32 square feet of coated surface.

114 Van Marum's battery.

But the most complete electrical batteries are those made by Mr Cuthbertson for Teyler's museum at Haarlem. Of these batteries there are two, differing in their magnitude and mode of construction, but allowed to be equally perfect. The first was completed in the year 1784, and is composed of 135 jars in nine boxes, which may be used separately or combined, as the nature of the experiment requires. Each box is a separate battery of itself; and the description of one box will be sufficient for explaining its construction and use. Each box contains 15 jars; each jar is 11 inches high, and six inches in diameter, contracted at the mouth to four inches, and coated so as to contain 140 square inches; and thus the whole battery will contain about 132 square feet of coated surface. Each box is divided into 15 partitions, five of which are in the length and three in the breadth; the height of the sides of the box being somewhat lower than the coating of the jars, as are also the partitions in which they stand. The lid of the box is made without hinges, for the convenience of releasing it from the box, that it may be removed while experiments are performed. It is taken off by lifting it upwards. The outside coatings of the jars are connected by means of cross wires passing under the bottom of each jar; and those on the inside by means of a brass frame, bearing 15 brass balls, fixed upon the frame above the centre of each jar. All these balls, excepting the four at the corners, have wires screwed to them and hanging downwards into the inside of each jar; but the wires of the four corner jars are screwed to a foot, which is cemented to the bottom of each in the inside. Upon these wires the whole frame rests, and is kept in its proper position. The four corner balls have holes, which receive the ends of the wires, and terminate at a proper height from the jars. By this contrivance the inside connecting frame may at any time be easily removed. It is according to the above construction that Mr Cuthbertson forms his present batteries, excepting that he has increased the size of the jars, so as to make one battery contain about 17 square feet; and he engages to prove by experiment, that the batteries of his construction are far superior to any others. Teyler's second grand battery was finished by Mr Cuthbertson in 1789. This is the largest and most complete battery that was ever made. It consists of 100 jars of the same shape with that of inciples Electri- ty illus- ated by periment.

those already described, only that they are so enlarged in size, that each of them contains $5\frac{1}{2}$ square feet of coated surface, instead of 140 inches, and the whole battery contains 550 square feet of coating; and for conveniency, it is put into four separate cases, each containing 25 jars in the form of a square, five on each side. The boxes are lined with lead on the inside for forming the outside communication; each jar has a perpendicular stand resting upon its bottom, and supported from falling sideways by three stays on the inside. Upon the top is screwed a three-inch brass globe, from which proceeds a brass tube about an inch in diameter, to a large brass globe, supported by the middle jar at a proper height, so as to keep the inside communication properly arranged.

115 thod of airing cked

Various expedients have been thought of to repair jars when cracked, and enable them to bear another charge, but they seem to have been attended with very little success. Mr Brooke found that when any of his bottles was broken by the discharge, it might be conveniently mended and made serviceable in the following manner. "Take of Spanish white eight ounces; heat it very hot in an iron ladle, to evaporate all the moisture; and when cool sift it through a lawn sieve; add three ounces of pitch, three quarters of an ounce of rosin, and half an ounce of bees wax; heat them all together over a gentle fire, stirring the whole frequently for near an hour; then take it off the fire, and continue the stirring till it is cold and fit for use." The bottles cemented with this composition, however, were not judged to be sufficiently strong to stand in their original place, but were removed to the second or third row, as it was apprehended they could best sustain the charge.

116 he dis- rging Plate XVIII. g. 13.

In relating the experiment of charging and discharging a Leyden phial, we have briefly described the *discharging rod*. Discharging rods are made of various forms and dimensions; fig. 13. represents one of the most common forms. It is convenient that the legs should move upon a hinge, so that the balls may be placed at a greater or less distance as occasion may require; the extremities of the legs should terminate in points, and the balls be made to screw on and off at pleasure.

117 Hen- uni- al dis- ger. g. 29.

Fig. 29. represents Mr Henley's universal discharger; an instrument of very extensive use in forming communications between jars, or directing the shock through any particular substance. AB is a flat board fifteen inches long, four broad, and one thick, and forming the basis of the instrument. DC are two glass pillars cemented in two holes upon the board AB, and furnished at their tops with brass caps; each of which has a turning joint, and supports a spring tube, through which the wires EF and ET slide. Each of these caps is composed of three pieces of brass, connected with each other in such a manner, that the wire EF, besides its sliding through the socket, has two other motions, viz. a horizontal one, and a vertical one. Each of the wires is furnished with an open ring at one end, and at the other has a brass ball; which, by a short spring socket is slipped upon its pointed extremity, and may be removed from it at pleasure. HG is a circular piece of wood five inches diameter, having a slip of ivory inlaid on its surface, and furnished with a strong cylindrical foot, which fits the cavity of the socket I. This socket is fixed in the middle of the bottom board, and has a screw at K; by which the foot of the circular board is made fast at any required height.

Principles of Electricity illustrated by experiment

Plate CLXXXIX fig. 30.

Fig. 30. is a small press belonging to this instrument. It consists of two oblong pieces of wood, which are forced together by the two screws, *a*, *a*. The lower end has a circular foot equal to that of the circular table H. When this press is to be used, it must be fixed into the socket I, in place of the circular board HG; which in that case is to be removed.

118 Mr Morgan's rules for constructing a discharging rod.

Mr G. Morgan gives the following rules for the construction and use of discharging instruments.

1. They should be constructed so as to allow no other passage to the electric power, than that of the intended circuit.

2. The conducting wires of the instrument should be made to come into contact with the inner surface of the coated electric as speedily as possible; for when approaching gradually, part of the charge is taken off previous to the explosion, the power of which is thus greatly diminished.

3. The operator should not be within the atmosphere of the conductor at the time of making the discharge.

4. The discharging instrument and the inside of the charged surface should be separated as rapidly as they were connected.

119 His discharging rod. Fig. 31.

On these principles the instrument employed by Mr Morgan, in his experiments on the conducting power of various substances, is constructed, and is thus described by him.

A and B, fig. 31. are two brass wheels, whose diameter is four or five inches; they are connected by an axis, which is made to turn easily in a collar, fixed upon the glass stem DM. The wires DC, and EF, are screwed into the circumference of the wheels, but on sides directly opposite to each other. The length of these wires is regulated by the distances at which the discharging rod is fixed from the conducting body, and their direction is perpendicular to the axis of the wheels. Two other wires are to be fixed perpendicularly to the planes of the wheels, to the circumference of which they are screwed as nearly as possible, but at opposite points, so that they may strike objects lying in the same line, parallel to the axis, at the distance of half a revolution from each other. The length of these last wires is regulated by the distances at which they join the metallic or other connection that is formed with the outside of the coated phial.

The mode of using this discharging rod is as follows. When C is brought into contact with the conductor, it receives the electric power, and conveys it through G into the outside of the coated surface. The motion of C is not stopped by the contact, but the continuance of it brings E into the same contact by which the residue of the jar is conveyed through K to the outside. The glass stem should penetrate deeply into each of the caps, for the whole apparatus will be otherwise loosened and put out of order, by the necessary rapidity of the motion and the conquassation of parts attending it.

If C, in its circumvolutions, strike against an immoveable body in connection with the conductor, it is frequently stopped, and then its ball is injured, or a change unfavourable to the accuracy of the experiment takes place.

Fig. 32.

To prevent these inconveniences, C, fig. 32. strikes the

the ball A which is connected with the brass tube that penetrates into the conducting substance, with an elastic wire bent into the form of a spring. The points and edges of this instrument are rendered impotent by fastening a box to the brass tube, so that the ball A may move backwards and forwards in the hollow of it, when struck by C. The box should be made of hard wood, and its edge carefully turned and well polished.

120 Cautions.

When a coated jar has been discharged, either spontaneously, or by a discharger, there is still a portion of the charge remaining, sufficient to give a slight shock, as will be found by grasping the outside with one hand, and with the other touching the ball of the wire. As this remaining charge, especially in large jars or batteries, is often so considerable as to give a pretty severe shock, it is therefore proper to caution the experimenter, not to touch the outside of the jar or battery, or any conductor which communicates with the inside at the same time.

Every machine will not charge jars equally well, but the power of charging will depend much on the goodness of the cylinder.

In a battery it sometimes happens, that one or more of the jars is more apt than the rest to undergo a spontaneous discharge, and in this case, the whole of the battery will be discharged at the same time, although the other jars, without this accident, would have contained a much higher charge.

121 MrNairne's mode of preventing the jar of a battery from being broken by a discharge.

To remedy the inconvenience of some of the jars in a battery bursting at the time of the discharge, Mr Nairne proposed that the discharge should not be made through a perfect conductor of a shorter circuit than five feet: and this method be found so effectual, that after he adopted it, he was able to discharge a battery for a hundred times without breaking a single jar, which before was continually happening. It must be observed, however, as will appear soon, that when the circuit through which the discharge is made, is considerably lengthened, the force of the discharge is also proportionably diminished. Hence in many experiments, where it is necessary to employ the highest possible charge, this method of diminishing the risk of breaking the jars is inadmissible.

122 An insulated phial cannot be charged.

If a Leyden phial, or any other coated electric, be insulated or placed so that its external coating has no communication with conducting bodies, it cannot be charged.

Place a Leyden phial on the insulating stool, or on a wine glass turned mouth downwards; connect the knob of the jar, or its outside coating, with the prime conductor, by means of a chain, and set the machine in motion. It will then be observed that the quadrant electrometer on the knob will soon rise to 90°, seeming to indicate that the jar is charged. On taking off the connection between the jar and the prime conductor, and endeavouring to discharge the jar by means of the discharging rod, or by the hands, it will however appear that the jar has received only a very slight charge, as no considerable spark will strike the ball of the discharging rod, and no remarkable shock will be felt by the hand.

If now the outside of the jar, still standing on the insulator, be connected with the floor, table, &c. by a chain, and then charged, the result will be very different, as the jar will then receive its usual charge.

If a jar be insulated, and one side of it, instead of being connected with the earth, be connected with the insulated rubber, while the other side communicates with the prime conductor, the jar will be charged, and perhaps in a more expeditious manner.

To make the above experiment in a clearer and more satisfactory manner, place the jar upon the stool as before, and with its wire not in contact, but at about half an inch distance from the prime conductor; hold the knob of another wire at such a distance from the outside coating of the jar, as the knob of the jar is from the prime conductor, then let the winch of the machine be turned, and it will be observed, that whenever a spark comes from the prime conductor to the wire of the jar, another spark passes from the outside coating of the jar to the knob of the wire presented towards it. In this manner the jar becomes charged.

If instead of the knobbed wire, a pointed wire be presented to the outside of the jar, the point will appear illuminated with a star; and if instead of presenting any wire to the jar, a point be connected with its coating, the point will appear illuminated with a brush of rays which will last as long as the jar is charging.

If the knob of another jar be presented to the outside coating of the insulated jar in the above experiment, it will also be charged.

123 The char of a coate electric re sides in th electric.

The charge of a coated jar, or any coated electric, resides in the jar, or electric, and not in the coating.

Take an uncoated phial, and, for a coating on the outside, stick a piece of tinfoil with a little tallow or bees wax, so that it can just adhere to the glass; and for an inside coating put into the jar a quantity of small shot or mercury: stop the mouth of the jar with a perforated cork, through which insert a knobbed wire, so as to communicate with the shot or the mercury. Then hold the phial thus coated, by its outside coating, and charge it by presenting the knob of the wire to the prime conductor. When it is charged turn it upside down, so that the wire, and the mercury or shot within the jar, may fall into a dry glass vessel; then remove also the outside coating. During this operation the phial does not lose its charge; and if the shot or mercury be examined, it will be found that they are not more electrified than would happen to any other insulated body of equal conducting power, after having been in contact with the prime conductor. Now replace the outside coating on the phial, and pour into it the shot or mercury; then touch with one hand the outside coating, and with the other introduce a knobbed wire within the phial so as to touch the inside non-electric, and you will feel a shock, which will prove that the jar has lost very little of its charge by removing the coatings.

The same experiment may be more conveniently made by laying a pane of glass upon a metal plate, and covering an equal part of the upper surface with tinfoil, having a silk thread fastened to one of its sides, by which it may be easily taken off when the glass is charged, and as easily replaced when required.

124 Discove by Dr Frankli

This important fact, that the charge in a coated electric resides in the electric, and not in the coating, was ascertained by Dr Franklin.

When he first began his experiments upon the Leyden phial, he imagined that the electric power was all accumulated inciples Electri- y illus- ated by eriment.

accumulated in the substance of the non-electric in contact with the glass; but he afterwards found, by the following ingenious analysis of the bottle, that the power of giving a shock lay in the glass itself, and not in the coating.

In order to find where the strength of the charged bottle lay, he placed it upon glass; then first took out the cork and the wire, and finding the virtue was not in them, he touched the outside coating with one hand, and put the finger of the other into the mouth of the bottle, when the shock was felt quite as strong as if the cork and the wire had been in it. He then charged the phial again, and pouring out the water into an empty bottle insulated, expected that if the force resided in the water it would give the shock, but he found it gave none. He then judged that the electric fire must either have been lost in decanting, or must remain in the bottle, and the latter he found to be true; for filling the charged bottle with fresh water, he found the shock, and was satisfied that the power of giving it resided in the glass itself.

He made the same experiment with panes of glass, laying the coating on lightly, and changing it as he had before changed the water in the bottle, and the result was the same in both. This experiment is more satisfactory than the former; because when the water is poured out of the phial, there still remains a thin coating of the fluid, which might be thought to contain the power of giving a shock.

125 *A charged jar may be gradually discharged by making a conducting body communicate alternately with the outside and the inside coating.*

126 elec- ed spi- Plate CXXXIX 23.

Experiment 1.—Fig. 33. represents an electric jar, having a wire, CDE, fastened on its outside, which is bended so as to have its knob E as high as the knob A. B is the figure of a spider formed out of a piece of cork slightly burned, with a few short threads run through it to represent its legs. This spider is to be fastened at the end of a silk thread, proceeding from the ceiling of the room, or any other support, so that the spider may hang midway between the two knobs AE, when the jar is not charged. Let the place of the jar upon the table be marked; then charge the jar, by bringing its knob A in contact with the prime conductor, and replace it in its marked place. The spider will now begin to move from knob to knob, and continue this motion for a considerable time, sometimes for several hours.

This experiment is one of the earliest that were made by Dr Franklin and his friends, and is described by Dr Franklin in one of his letters to Collinson.

Fi 34.

Exper. 2.—Let a coated jar be insulated by passing it through a ring fixed upon a glass stand, as represented at fig. 34. From the ball *a* of the wire which communicates with the inside coating suspend a wire to which are hung three bells and two clappers, and suspend a similar wire with the same number of bells and clappers from the ball, *b*, of a wire which is made to communicate with the outside coating. Hang the chain *q* to the wire *a*, so that it does not touch the table, and charge the jar by holding the knob *a* to the prime conductor. While the jar is charging, the bells hanging from *b* will ring. When the jar is charged, remove it from the prime conductor, and unhook the chain *g*, by means of a wire fastened to a glass handle, and let it lie on the table. If now the ball *b* be touched, the bells which are suspended from it will cease ringing, and the bells suspended from *a* will ring, and will continue to ring for a considerable time if not touched. But, now again, if *a* be touched, these bells will cease, and those at *b* will begin to ring, and thus each set may be made to ring alternately, but never both sets at once till the bottle is discharged.

Principles of Electricity illustrated by experiment.

127 Lateral explosion.

If a jar be discharged with a discharging rod that has no electric handle, the hand that holds it in making the discharge, feels some kind of shock, especially when the charge is considerable.—In other words: A person, or any conducting substance, that is connected with one side of a jar, but forms no part of the circuit, will feel a kind of shock, i. e. some effect of the discharge. This may be rendered visible in the following manner. Connect with the outside of a charged jar a piece of chain; then discharge the jar through another circuit, as for instance, with a discharging rod in the common way, and the chain that communicates with the outside of the jar, and which makes no part of the circuit, will appear lucid in the dark, i. e. sparks will appear between the links. This chain will also appear luminous, when it is not in contact with the outside of the jar, but only very near it; and on making the discharge, a spark will be seen between the jar and the end of the chain near it. This electrical appearance out of the circuit of a discharging jar is that which we call the *lateral explosion:* and to make it appear in the most conspicuous manner, observe the following method, which is that of Dr Priestley.

When a jar is charged, and stands upon the table as usual, insulate a thick metallic rod, and place it so that one of its ends may be contiguous to the outside coating of the jar; and within about half an inch of its other end, place a body of about six or seven feet in length, and a few inches in breadth; then put a chain upon the table, so that one of its ends may be about one inch and a half distant from the coating of the jar; to the other end of the chain apply one knob of the discharging rod, and bring the other knob to the wire of the jar in order to make the explosion. On making the discharge in this manner, a strong spark will be seen between the insulated rod, which communicates with the coating of the jar, and the body near its extremity, which spark does not alter the state of that body in respect to electricity; hence it is imagined, that this lateral spark flies from the coating of the jar, and returns to it at the same instant, allowing no perceptible space of time, in which an electrometer can be affected. Whether this lateral explosion is received on flat and smooth surfaces, or upon sharp points, the spark is always equally long and vivid.

CHAP. IV. *Of the method of distinguishing Positive and Negative Electricity.*

128 Positive and negative electricity distinguished by the electrometer.

THESE states of electricity are usually distinguished by means of the common pith-ball electrometer.

Experiment.—Set the machine in motion, while both conductors are insulated, or without connecting either the prime conductor or the rubber with contiguous bodies. We have before remarked (44.), that the prime conductor was called the *positive*, and that to

Principles of Electricity illustrated by experiment.

which the rubber is adapted the *negative* conductor; that they are so in these circumstances may be demonstrated according to the explanation given in note (c.)

On presenting a pith-ball electrometer to the cylinder whose electricity we have agreed to call *positive*, the balls will diverge, and will continue to diverge when brought near that side of the prime conductor which is most remote from the cylinder; but being carried to the other conductor, they will instantly collapse; thus showing that the electricity of the rubber is opposite to that of the other conductor or of the cylinder, i. e. that it is negative. This may be shown in another way. The balls presented to the rubber will diverge with negative electricity, but being brought near the other conductor in this divergent state, they will collapse.

Plate CLXXXVIII. fig. 15.

But should a more precise method be required to determine the quality of the electricity of an electrified body, the following may be used:—First, electrify one of the electrometers C, placed upon the stand fig. 15. either positively, or negatively, at pleasure: touch it, for instance, with an excited glass tube, so that its balls may repel, and stand about two inches distance from one another; then touch the other electrometer C with the electrified body that you desire to examine, so that it may be possessed of the same degree of electricity: lastly, take either of the two electrometers by the top of the glass handle, disengage it from the arm of the stand, and bring it near the other electrometer; if then the balls of one electrometer repel those of the other, you may conclude that they are possessed of the same kind of electricity; but if they attract each other, you may conclude that they have been electrified with contrary electricities; and as you know the electricity of that electrometer, which was first electrified, you will of course know the electricity of the other electrometer, i. e. of the electrified body, with which it was touched.

The above experiment may be also made with the single thread electrometers; for if they are brought near to one another, when their feathers are electrified, they will, if possessed of the same electricity, repel each other, or, if possessed of contrary electricities, they will attract each other.

129 By the light.

While the conductors are thus insulated, if a pointed body (as for instance, the point of a needle or pin), be presented to the back of the rubber, at the distance of about two inches, a lucid pencil of rays will appear to proceed from the point presented, and diverge towards the rubber.

If another pointed body be presented to the prime conductor it will appear illuminated with a star; but if a pointed wire, or other pointed conducting body, be connected with the prime conductor, it will throw out a pencil of rays.

F. Beccaria remarks, that if two equally sharp points are approached to a prime conductor, they will appear luminous at only half the distance at which one of them would have done.

From this experiment may be learned the method of distinguishing the quality of the electricity of an electrified body, by the appearance of the electric light; for if a needle, or any other pointed body, be presented in the dark, with the point towards a body strongly electrified, it will appear illuminated with a star, when that body is electrified positively, and with a pencil or brush, when it is electrified negatively (P).

Principle of Electri city illu trated by experimen

Here it is proper to remark, that when two points (one of which is connected with the prime conductor, or the rubber) are opposed to one another, the appearance of light in both is pretty much the same. Mr Wilcke remarks, that when a point not electrified, is opposed to another point electrified positively, the cones of light, which otherwise would appear upon them, disappear; but that if a positive cone be opposed to a negative cone, they both preserve their own characteristic properties †.

† *Wilcke* p. 240.

Mr Nicholson has given us some valuable observations on the different appearances of the electric light, when proceeding from bodies electrified *positively* or *negatively*.

"The escape of negative electricity from a ball," says Mr Nicholson, "is attended with the appearance of straight sharp sparks, with a hoarse or chirping noise. When the ball was less than two inches in diameter, it was usually covered with short flames of this kind, which were very numerous.

130 Mr Nichol son's experiments on the light produced by positi and negative electricity.

"When two equal balls were presented to each other, and one of them was rendered strongly positive, while the other remained in connection with the earth, the positive brush or ramified spark was seen to pass from the electrified ball: when the other ball was electrified negatively, and the ball, which before had been positive, was connected with the ground, the electricity exhibited the negative flame, or dense, straight, and more luminous sparks from the negative ball; and when the one ball was electrified *plus* and the other *minus*, the signs of both electricities appeared. If the interval was not too great, the long zig-zag spark of the *plus* ball struck the straight plane of the *minus* ball, usually at the distance of about one-third of the length of the latter from its point, rendering the other two-thirds very bright: sometimes, however, the positive spark struck the ball at a distance from the negative flame. These effects are represented in Plate CLXXXIX. figs. 35, 36, and 37.

Plate CLXXXI

"Two conductors of three quarters of an inch diameter, with spherical ends of the same diameter, were laid parallel to each other, at the distance of about two inches, in such a manner as that the ends pointed in opposite directions, and were six or eight inches asunder. These, which may be distinguished by the letters P and M, were successively electrified, as the balls were in the last paragraph. When one conductor P was positive, fig. 39. it exhibited the sparks of that electricity at its extremity, and struck the side of the other conductor M. When the last-mentioned conductor M was electrified negatively, fig. 38. the former being in its turn connected with the earth, the sparks ceased to strike as before, and the extremity of the electrified conductor M exhibited negative signs, and struck the side of the other conductor. And when one conductor was

---

(P) The pencil of light exhibited by a point positively electrified was first seen by Mr Grey, though the difference of the two states was not in his time correctly ascertained.

rinciples Electri-ity illus-rated by periment.

was electrified *plus* and the other *minus*, fig. 40. both signs appeared at the same time, and continual streams of electricity passed between the extremities of each conductor, to the side of the other conductor opposed to it.

"In drawing the long spark from a ball of four inches diameter, I found it of some consequence that the stem should not be too short, because the vicinity of the large prime conductor altered the disposition of the electricity to escape: I therefore made a set of experiments, the result of which showed, that the disposition of balls to receive or emit electricity, is greater when they stand remote from other surfaces in the same state; and that between this greatest disposition in any ball, whatever may be its diameter, every possible less degree may be obtained by withdrawing the ball towards the broader or less convex surface out of which its stem projects, until at length the ball, being wholly depressed beneath that surface, loses the disposition entirely. From these experiments it follows, that a variety of balls is unnecessary in electricity: because any small ball, if near the prime conductor, will be equivalent to a larger ball whose stem is longer.

131 Nichol-'s appa-us by ich the ion of ts is strated.

"From comparing some experiments made by myself many years ago with the present set, I considered a point as a ball of an indefinitely small diameter, and constructed an instrument consisting of a brass ball of six inches diameter, through the axis of which a stem, carlying a fine point, was screwed. When this stem is fixed in the prime conductor, if the ball be moved on its axis in every direction, it causes the fine point either to protrude through a small hole in its external surface, or to withdraw itself; because by this means the ball runs along the stem. The disposition of the point to transmit electricity may thus be made equal to that of any ball whatever, from the minutest size to the diameter of six inches. See fig. 41. A.

"The effect of a positive surface appears to extend farther than that of a negative; for the point acts like a ball, when considerably more prominent, if it be positive, than it will if negative †."

132 Nichol- instru-t for d nguish-in nega-ti from p ive el ricity. P e CXC. 42.

Fig. 42. represents an instrument invented by Mr Nicholson for distinguishing *positive* from *negative* electricity. It consists of two metallic balls, A, B, which may be placed at a greater or less distance from each other, by means of a joint at C, on which the two branches CA, CB move. These branches are of glass covered with varnish. A short point proceeds from one of the balls B towards the other A. If the two balls be placed near the body which is electrified, so that the electric power may pass through them, it may be known whether it is positive or negative, that is, whether it is proceeding *from* or *towards* the electrified body. For, supposing that the electricity passes from A to B, there will be a certain distance of the balls at which a spark will pass between the balls; but this distance will be much shorter when the electricity is passing from B to A. It is evident that this instrument will be of use only when the electricity to be examined is sufficiently strong to give sparks.

33 A arance of light on per.

The appearances of positive and negative electricity are sufficiently distinct in almost every experiment which can be made with the exhibition of electric light. Paper is a good substance for observing the visible passage of the electric power. If a strong positive electric stream be let fall on the flat side of an uninsulated sheet of paper, it will form a beautiful *star* about four inches in diameter, consisting of very distinct radii not ramified. Negative electricity, in perfectly similar circumstances, throws many pointed brushes to the paper, but forms no star upon it. This experiment is by Mr Nicholson, and the cylinder of the machine employed in making it was seven inches in diameter *.

Principles of Electricity illustrated by experiment.

In order to have a more familiar view of the important reciprocal relations of these two forms of electrical excitement, our readers may attend to the following plain facts: 1. That the sparks taken from the respective conductors of a machine, are strongest when taken from both at the same time. This shows a mutual action between the opposite electricities. 2. The power of the spark from either conductor singly is greatest, when the opposite conductor is connected with the ground by conducting matter, such as a metallic chain. This shows that the same relation which exists between the opposite conductors, exists also between either of them, and the ground, but in an inferior degree. The latter therefore maintains an intermediate character, or is habitually in an intermediate state. 3. When the two conductors are connected by a wire, a column of water, or any other conducting body in a strictly continuous position, no electrical phenomena are exhibited; but when short interruptions are formed in this connecting matter, the electric spark instantly makes it appearance at each, showing that electricity is excited, though under the former conditions not displayed. These facts represent the circumstances that occur in all cases in which electricity is excited by friction, the two conductors exhibiting the opposite states of the two bodies between which the friction is performed.

CHAP. V. *Of the different States of Electricity possessed by the two Surfaces of a charged Electric.*

The opposite surfaces of a charged electric are in opposite states, i. e. *one positive, and the other negative.*

134 Positive and negative states of a charged jar proved by the ball electrometer; Fig. 34.

Exper. 1.—Insulate a coated phial, such as is described in fig. 34. without the bells, and charge it by holding the knob *a* to the positive conductor, while the knob *b* communicates with the table. When the phial is charged, hold a pith-ball electrometer to the knob *a*, and the balls will diverge with *positive* electricity, as will appear by presenting them in their diverging state to excited sealing-wax, when they will collapse. Now hold the balls to the knob *b*, which communicates with the outer coating of the phial, and they will diverge with *negative* electricity, as will appear by presenting them to an excited glass tube.

If the jar be charged at the negative conductor, these appearances will be reversed; the balls presented to the knob *a* will diverge with *negative* electricity, and presented to *b*, they will diverge with *positive* electricity.

135 by the appearance of the light.

Exper. 2.—Fix a pointed wire into a hole in the knob *b* of the insulated phial, and fix another wire in the positive conductor. Hold the knob *a* to the point in the dark, a *pencil* of luminous rays will be seen diverging from the point in the conductor to the knob *a*, while a positive conductor, and on turning the cylinder in the similar *pencil* of rays, diverges from the wire fixed in the knob *b*.

---

† *hil. Tns.* for 1p.

* *Nicholson's Phil. Journal*, vol. ii. p. 438.

Principles of Electricity illustrated by experiment.

If the wire is fixed in the negative conductor, a luminous *star* will appear at each point.

Exper. 3.—Fix a pointed wire into a hole in the knob *a*, while another pointed wire is fixed in *b*, as in the last experiment. Present the wire in the knob *a* in the dark, to the positive conductor, and a luminous *star* will appear at the point *a*, while the point at *b* throws out a *pencil* of luminous rays.

If the point at *a* be presented to the negative conductor, the luminous *pencil* will appear at *a* and the luminous *star* at *b*.

Plate CXC. fig. 43.

Exper. 4.—Fig. 43. is an electric jar which serves to illustrate the contrary states of the sides of a Leyden phial while charging: BB is the tinfoil coating; C, a stand which supports the jar; D, a socket of metal, carrying the glass rod EF, a bent brass wire pointed at each end, and fixed at the end of the rod G; this rod is moveable in the spring tube N at pleasure: that tube being fixed by a socket on the top of the glass rod E, the jar is charged by the inside wire, which communicates with the different divisions of the inside coating by horizontal wires.

Place the jar at the conductor as usual; and when charging, a luminous star will appear upon the upper point of the wire at F, clearly showing, according to the commonly received opinion, that the point is then receiving the electric power. From the upper ring of the coating B, on the outside of the jar, a stream or pencil of rays, will at the same time fly off, beautifully diverging from the lower point of the wire E upon the bottom ring of the coating of the jar. When the appearances cease, which they do when the jar is charged, let a pointed wire be presented to the conductor: this will soon discharge the jar silently; during which the point will be illuminated with a small spark, while the upper point of the wire will throw off a pencil of rays diverging towards the upper ring of the coating.

Exper. 5.—Take two equal jars, with a quadrant electrometer attached to the knob of each. Place one in contact with the positive conductor, and the other with the negative. When the machine is turned, both jars will charge to the same height, as will be seen by the equal rising of the electrometer.

Exper. 6.—Charge a jar at the positive conductor; then move it to the negative one: the electrometer will fall by the turning of the machine, till the charge is gone. After this, if the turning be continued, the electrometer will diverge with negative electricity.

136 Course of the electric power in the discharge shewn by the light;

When a charged electric is discharged, the electric power passes from the positive to the negative surface.

Exper. 1.—When a jar has been charged at the positive conductor, take a discharged rod, furnished with pointed extremities, and hold it in such a position, that one point shall be at the distance of about an inch from the knob of the jar, while the other point shall be at nearly the same distance from the outside coating. In this way the jar will be silently discharged, and if the experiment be made in the dark, a luminous *star* will appear at that point which is held to the knob of the jar, and a luminous *pencil* at the point which is held to the outer coating.

If the jar has been charged at the *negative* conductor, the appearance of the light at the points will be reversed; a luminous *pencil* will now appear at the point which is held to the knob of the jar, and a luminous *star* at that which is held at the outer coating.

137 by the direction given to the flame of a taper: Plate CLXXXVIII. fig. 29.

Exper. 2.—Remove the circular piece of wood GH, from the universal discharger, fig. 29.; fix the wires EF, ET, so that their knobs FT may be about two inches distant from one another. Then fix upon the socket from which the board was removed, a small lighted wax-taper so that its flame may be just in the middle between the knobs FT. When the apparatus is thus disposed, if the outside of a charged jar be connected, by means of a chain or other conducting substance, with one of the wires, and the knob of the jar be brought to the other wire, it will be observed, that, on making the discharge which must pass between the knobs FT, the flame of the taper will be driven in the direction of the electric power, i. e. it will be blown towards the knob of that wire which communicates with that surface of the jar which is negatively electrified.

Plate CXC. fig. 44. and 45.

138 by the Leyden vacuum;

Exper. 3.—Fig. 44. and 45. of Plate CXC. represent a small phial coated on the outside, about three inches up, with tin-foil; at the top of the neck of this phial, is cemented a brass cap, having a hole with a valve, and from the cap a wire proceeds a few inches within the phial, terminating in a blunt point. When this phial is exhausted of air, a brass ball is to be screwed on the brass cap, so as to defend the valve, and prevent any air from getting into the exhausted glass. This phial exhibits clearly the direction of the electric power, both in charging and discharging; for if it be held by its bottom, and its brass knob be presented to the prime conductor positively electrified, you will see that the electric power causes a *pencil* of rays to proceed from the wire within the phial, as represented fig. 45. and when it is discharged, a *star* will appear in the place of the pencil, as represented in fig. 44. But if the phial be held by the brass cap, and its bottom be touched with the prime conductor, then the point of the wire, on its inside, will appear illuminated with a *star* when *charging*, and with a *pencil* when *discharging*. If it be presented to a prime conductor electrified negatively, all these appearances, both in charging and discharging, will be reversed.

This experiment of the Leyden vacuum, as it is called, is an invention of the late Mr Henley.

Exper. 4.—Fig. 46. represents an electric jar, whose exterior coating is made up of small pieces of tin-foil placed at a small distance from each other. This jar is to be charged in the usual manner, when small sparks will pass from one piece of tin-foil to the other, in various directions, forming a very pleasing spectacle. The separation of the tin-foil is the cause of this visible passage, from the outside to the table; and the experiment is similar in appearance to that mentioned. If the jar be discharged by bringing a pointed wire gradually to the knob T, the unsealed part of the glass between the wire and knob will be agreeably illuminated, attended by a crackling noise of the sparks. If the jar be suddenly discharged, the whole outside will be illuminated. The jar, used in these experiments, must be very dry.

139 by the double ja

Exper. 5.—Fig. 47. represents two jars, or Leyden phials, placed one over the other, by which various experiments may be made in order to elucidate the theory of electricity. Bring the outside coating of the bottle

Principles of Electricity illustrated by experiment.

A in contact with the prime conductor, and turn the machine till the bottle is charged; then place one ball of the discharging rod upon the coating of B, and with the other touch the knob of the jar A, an explosion will follow; now place one ball of the discharger on the knob of A, and bring the other ball to its coating, and you have a second discharge. Again, apply one ball of the discharger to the coating of B, and carry the other to the coating of A, and it will produce a third discharge. A fourth is obtained by applying the discharger from the coating of A to its knob.

The outer coating of the upper jar communicating with the inside of the under one, conveys the electric power from the conductor to the large jar, which is therefore charged positively: the upper jar does not charge; but when a communication is formed from the outside of A to the inside of B, part of the electric power on the inside of A will be conveyed to the negative coating of B, and the jar will be discharged. The second explosion is occasioned by the discharge of the jar A; but as the outside of this communicates by conducting substances with the positive inside of the jar B, if the ball of the discharging rod remains for a little time after the discharge on the knob of A, part of the electric power of the inside of A will escape, and be replaced by an equal quantity on the outside from the jar B, by which means A is charged a second time; the discharge of this produces the third, and of B the fourth explosion.

140 Mr Brooke's experiments.

Mr Brooke of Norwich brings the following experiments to prove that the opposite surfaces of an electric, while charging, are not necessarily in opposite states of electricity.

"1. Let two pound phials be coated with tin-foil on their outsides, and filled to convenient height with common shot, to serve as a coating withinside, as well as to keep a wire steady in the phials without a stopple in the mouth of them. Let each phial be furnished with a wire about the size of a goose quill, and about ten inches long, and let each wire be sharpened a little at one end, that it may the more easily be thrust down into the shot, so as not to touch the glass anywhere at the mouth of the phials, yet so as to stand steadily in them. Let a metallic ball about six or seven eighths of an inch diameter be screwed on at the other end of each wire: also let there be in readiness a third wire, fitted up like those for the phials, except that another ball of nearly the same size as the former may occasionally be screwed on at the sharpened end of it. I say, instead of suspending the phials from the prime conductor, let one of those above described be charged at the prime conductor, and then set it aside, but let it be in readiness in its charged state; then let the other be placed upon a good insulating stand, and let the third wire also be laid upon the stand, so that its ball, or some part of the wire, may touch the coating of the phial. Let the sharpened end of this wire project five or six inches over the edge of the stand: all of these being now placed close to the edge of a table, hang a pair of cork balls on the sharpened end of the wire, and make a communication from the prime conductor to the ball on the wire on the bottle: on working the machine, the sharpened end of the wire will permit the bottle to be charged although it be insulated; and if the wire be very finely pointed, the bottle may be charged nearly as well as if it were not insulated; I say, on working the machine, the phial will charge, and the cork balls will immediately repel each other; but whilst this phial is charging, take the first phial, which having been previously charged at the same prime conductor in the hand, and while the second phial is charging, present the ball of the first to the cork balls, and they will all repel each other. This plainly proves that the outside of the second bottle is electrified *plus* at the time that it is charging, the same as the inside of the first; and the inside of both the bottles will readily be allowed to charge alike, that is *plus* or *positive*.

"2. Let the second bottle in the last experiment be wholly discharged, and charge it again as before (the first bottle yet remaining charged); and whilst it is charging, let the ball of the first approach the cork balls contiguous with the second, and they will, as before, all repel each other: withdraw the ball of the first, and so long as the machine continues to charge the second bottle higher, the cork balls will continue to repel each other; but cease working the machine, and the cork balls will cease to repel each other till they touch, and will then very soon repel each other again; then let the ball in the first phial approach the cork balls, and they will now be attracted by it, instead of being repelled as above, as in the last experiment. This also plainly shows, that both sides of a Leyden phial are alike at the time it is charging; and at the same time evidently shows, that the difference of the two sides does not take place till after the bottle is charged, or till the machine ceases to charge it higher.

"3. In this experiment, let both of the former bottles be discharged; then let one of them be placed upon the insulating stand. Let a ball be put on over the sharpened end of the third wire, and let it be laid on the stand as before, so as to touch the coating of the phial: place the other phial on the table, so that its ball or wire may touch the ball on the third wire, or any part of the wire itself: make a communication from the ball on the wire of the first phial to the prime conductor: then, by working the machine, both bottles will soon become charged. As soon as they are pretty well charged, and before the machine cease working, remove the second phial from the third wire; after the second phial is removed, cease working the machine as soon as possible; take the third wire, with its two balls, off the stand with the hand, and lay it on the table, so that one of its balls may touch the outside coating of the second phial: remove the first phial off the stand, and place it on the table, so as to touch the ball at the other end of the third wire; then with an insulated discharging rod, make a cummunication from the ball in one bottle to the ball in the other. If the outside of the first phial be negative at the time it is charging, the inside of the second will be the same, and making the above communication would produce an explosion, and both bottles would be discharged; but the contrary will happen, for there will be no explosion, nor will either of the bottles be discharged, although there be a complete communication between their outsides, because the inside of them both will be positive. This is a proof, that considering one side of a phial to be positive and the other negative at the time they are charging is a mistake; as well as that, if any number of bottles be suspended

suspended at the tail of each other, all the intermediate surfaces or sides do not continue so.

"4. Here also let the apparatus be disposed as in the last experiment, till the bottles are highly charged; then with a clean stick of glass, or the like, remove the communication between the balls of the first phial and the prime conductor, before the machine ceases working: then, with an insulated discharging rod, make a communication from the outside to the inside of the first phial; a strong explosion will take place on account of the excess withinside, notwithstanding they are both positive.

"5. This experiment being something of a continuation of the preceding one, immediately after the last explosion takes place, discharge the prime conductor of its electricity and atmosphere; then touch the ball in the first phial with the hand, or any conducting substance that is not insulated; then will the inside coating of the first phial, which at first was so strongly positive, be in the same state as the outside coating of the second, having a communication by the hand, the floor, &c. with each other; that is negative, if any thing can properly be called negative or positive that has a communication with the common stock: but a pair of cork-balls that are electrified either *plus* or *minus* will no more be attracted by either the inside coating of the first phial or the outside coating of the second, than they will by the table on which they stand, or a common chair in the room, while they continue in that situation. Remove the aforesaid communication from the ball of the first phial; touch the ball in the second, as before in the first, or discharge the bottle with the discharging rod, and the ball in the first bottle will immediately become negative; with a pair of cork balls electrified negatively, approach the ball in the first phial, and they will all repel each other, or if the cork balls be electrified positively, they will be attracted. All these circumstances together serve fully to prove what has already been said, not only that the inside of the first phial, which was so strongly positive, may be altered so as to become in the same state as the outside of the second, without discharging the phial, or any more working the machine; but that it may be fairly changed from being positively charged to being negatively charged. If a pair of cork balls are now hung on to the ball of the wire in this phial, by the help of a stick of glass, they will repel each other, being negatively electrified. Make a communication from the outside of the bottle to the table, and replace the communication from the prime conductor to the ball in the bottle; then, upon moderately working the machine to charge the bottle, the cork balls will cease to repel each other till they touch, and will soon repel each other again by being electrified positively. Here the working the machine anew, plainly shows that the inside of the first bottle, which was positive, was likewise changed to negative *."

141 Milner's observations and experiments on the Leyden phial.

The following observations and experiments on the Leyden phial, are taken from a little work by Dr Thomas Milner.

An electric power communicated to any insulated conducting substance has been named simple electrification, in order to distinguish this particular state from that of the charged phial: but it will appear whether this distinction ought to be retained or not, by taking a comparative view of both these cases. And, if the changes which an electrical power in general is capable of making in the electrical state of any substance contained within the sphere of its influence, be taken into consideration, and compared with those which have been observed in the charged phial, it is apprehended that they will not appear to be different in any material circumstance.

142 I. In the charged phial, when the inside has either kind of electricity communicated to it, the outside is found to possess a contrary power. It appears also that either kind of electricity always produces the other on any conducting substance placed within the sphere of influence. And as the same effect is also produced on electrics themselves, in the same situation, and as some portion of the air, supposing no other substance to be near enough, must be unavoidably exposed to such influence, it necessarily follows, that neither power can exist without the other; and, therefore, in every possible case, positive and negative electricity are inseparably united.

II. A phial cannot be fully charged in any way by which the outside acquires a contrary electricity, unless the external coating has a communication by some conductor with the earth. In the same manner a full charge of the contrary electricity cannot readily be procured without a similar communication.

III. In both cases the interposition of an electric body between the contrary powers is absolutely necessary. In one case that body is glass, in the other it is air; and the experiment will not succeed in either, unless both the glass and the air be tolerably free from moisture.

IV. It appears that the influence of electricity acts in the same manner through glass as it does through the air, and produces a contrary power in both cases.

V. A communication of the electric power is more easily made through the fluid yielding substance of the air than through glass, which is so hard and solid a body, as to require a very considerable degree of power to separate its component particles: this, however, sometimes happens, and a hole is made through the glass itself, without design, in attempting to charge a very thin phial as high as possible, in the most favourable state of the atmosphere.

VI. A conducting body receives the strongest charge of the contrary electricity, when it is brought as near as possible to the electric power, without being in the communicating distance. And it is well known that the thinnest phial, if it be strong enough to prevent a communication between the two surfaces, will always receive the highest charge.

VII. The electricity of the external surface of the charged phial cannot be destroyed, so long as the internal surface remains in force, and continues to exert its influence through the glass; because this influence was the cause of the contrary electricity on the external surface, and must therefore preserve it.

VIII. If part of the course which the electric power takes in discharging a phial be through the air, a small part of the charge will always remain; because the whole of the redundancy on one surface is not capable of forcing a passage through the resisting medium of the air, in order to supply the deficiency on the other surface. But if every part of the circuit, from the internal to the external coating, consists of the best conductors, and if the coated surfaces be nearly equal, and directly opposite to each other, the phial will then appear to have retained

---

* *Brooke's Miscellaneous Experiments*, chap. 3.

tained no part of the charge; so far as it is covered with tin-foil; but the parts of it above the coating on both sides will, however, still retain the contrary electricities, after the circuit has been completed. A residue of the charge may also be observed in every other instance of electrification, in which the degree of electricity is sufficient to force a communication between the electrified body and a conductor not insulated, through a small portion of the air: and if the experiment be carefully made, it will appear, that the whole of the redundancy is not capable of passing through the resisting intermediate air, in any case, and therefore a part of the charge must always remain. But here it will be proper to examine more particularly the nature of the charged glass.

143 When a plate of coated glass has been charged, and the circuit between the coatings has been completed, by the mediation of a good conducting substance, no part of the coated surface is supposed to retain any part of the charge; but, according to the commonly received doctrine, the whole of it is said to be discharged; or in other words, to be brought into its natural state, This, however, is not really the case, as will evidently appear from the following experiment; the design of which is to show the effects produced by charging and discharging a plate of glass.

Let the middle of a piece of crown window glass, seven inches square, be placed between two circular plates of brass, about the 16th part of an inch thick, and five inches in diameter. In order to enable these plates to retain a greater degree of power, it will be proper to terminate each of them with a round bead the third part of an inch thick; and the whole of the bead should be formed on one side of the plate, that the other side may remain quite flat, and apply well to the surface of the glass. Let the whole be insulated about four inches above the table, and in a horizontal position, by fastening one end of a cylindrical piece of some good insulating substance to the middle of the under plate, the other end of it being fixed in any convenient stand. Let a like insulating stem be fastened to the middle of the upper plate. Let a brass chain, which may easily be removed, reach from the under plate to the table. In the last place bend a piece of brass wire into such a shape, that it may stand perpendicularly on the upper plate; and let the upper extremity of this wire be formed into a hook, that it may be removed at any time by the assistance of a silk string, without destroying the insulation of the plate.

The glass being thus coated with metal on both sides, and having also a proper communication with the table, will admit of being charged; and both coatings may be separated from the glass, and examined apart, without destroying the insulation of either: for the upper coating may be separated by the means of its own proper stem; and the under coating may be separated by taking hold of the corners of the glass, and lifting the glass itself. As glass readily attracts moisture from the atmosphere, it will therefore be necessary to warm it in the beginning, and to repeat it several times in the course of the experiment, unless the air should be very dry.

4 Excite a smooth glass tube, of the common size, by rubbing it with silk, and apply it repeatedly to the bent wire, until the glass be well charged. Then remove the chain, which reaches from the lower plate to the table, and also the charging wire from the upper plate, by laying hold of its hook with a silk string. It necessarily follows, from considering the quality of the power employed in the present case, that the upper surface of the glass, together with the upper coating, must be electrified positively; and that the under surface and coating must be electrified negatively; but as it is designed in this experiment to examine the powers of chargéd glass, that no virtue may be imputed to the glass but what really belongs to it, let both coatings be separated from it; and after they have been brought to their natural state, by touching them with a conducting body not insulated, let the glass be replaced between them; and whatever effects may be now produced must be ascribed solely to the powers of the charged glass. On bringing a finger near the upper coating, a small electrical spark will appear between the coating and the finger, attended with a snapping noise. Apply a finger in the same manner to the under coating, and the same thing will happen. This effect cannot be produced twice, by two succeeding applications to the same coating; but it may be repeated several hundred times over, in a favourable state of the atmosphere, by alternate applications to the two coatings; and the powers of the glass will be thus gradually weakened.

This part of the experiment may be explained, by observing that the contrary electricities have a natural tendency to produce and to preserve each other, on the opposite sides of a plate of glass; and therefore, the increase or decrease of power, on the other side: and as in charging a plate of glass positively, no gradual addition of electric matter can be made on the upper surface, without a proper conveyance for a proportionable part to pass away from the lower surface; so in this method of discharging it, the electric power cannot be gradually taken away from the upper surface, without adding a proportionable part to the under surface: one operation is the reverse of the other, and so are the effects; one case being attended with an increase and the other with a decrease of power.

Let the glass be again fully charged, and after bringing both coatings to their natural state, as before, let the glass be replaced between them; and on touching the upper coating with a finger, and then separating it from the upper and positive surface of the glass by the insulating stem, this coating will require a weak negative power, which will be sufficient to produce a small spark while the glass is in full force, though after the power of the glass has been reduced, it will give little or no spark: but in both cases, on touching the coatings alternately two or three times, the negative power of this coating, when separated from the positive surface of the glass, will be so considerably increased, as to produce strong negative sparks.—This effect may now be repeated several times, by only touching the upper coating, but the sparks will grow weaker every time; and they may be restored again to nearly their former strength, by alternate applications to both coatings, as before. The same things will also happen to the under coating, in the same circumstances; but with this difference, that the power of the under coating, on being separated from the under and negative surface of the glass, will be positive. And thus a long succession of both positive and negative sparks may be produced in favourable 145 favourable weather, or at any time by keeping the glass moderately warm.

It appears from this part of the experiment, that each of the surfaces of the charged glass has a power of producing a contrary electricity in the coating in contact with it, by a momentary interruption of the insulation. It necessarily follows, in producing these effects, that more electrical matter must have passed away from the upper coating, at the time of touching it, than the same coating could receive from the upper surface of the glass; and therefore the upper coating, by losing some of its natural quantity, will be negatively electrified; and also that more electric matter must have been added to the under coating at the time of touching it, than the under surface of the glass could receive from it; and therefore the under coating, by receiving some addition to its natural quantity, will be positively electrified. It appears further, that the greatest degree of this influential power, which may be consistent with the circumstances of the case, will be produced in either coating by taking care at the same time to bring the opposite coating into a like state of influential electricity: and thus it is evident, that the influential powers of the two coatings have the same relation to each other, as the contrary powers of the glass itself, and will therefore always increase or decrease together.

146 The glass being again well charged, as at first, let a brass wire bent in the form of a staple be brought into contact with the upper and lower coating at the same time. By this the common discharge will be made: but the equilibrium of the coated glass will be only restored in part; for a considerable degree of attraction will happen at the same time between the upper coating and the glass, which has frequently been strong enough to lift a piece of plate glass weighing ten ounces. Neither coating will now show the least external sign of electricity while it is in contact with the glass: but on separating either of them from it, if care be taken to preserve their insulations, the upper coating will be strongly electrified negatively, and the under coating will be strongly electrified positively. Let then both coatings be brought to their natural state, by touching them when separated from the glass, with a conducting body not insulated, and let the glass be replaced between them as before. In this state of things, on touching the upper coating only, and separating it from the glass, it will not be capable of giving any spark; but on touching the coatings alternately five or six times, it will then give a weak spark: and this may now be repeated several times by only touching the upper coating: but on a second application of the bent wire to both coatings at the same time, a second discharge may be perceived, though much weaker than the first, and the coatings will be again brought into the same electrical state as immediately after the first discharge. This may frequently be repeated; and a considerable number of strong negative sparks may be taken from the coating when it is separated from the positive surface of the glass. If the glass in replacing it between the two plates be turned upside down, the electrical powers of both coatings will be changed by the next application of the discharging wire to complete the circuit; and a succession of strong positive sparks may be taken from the coating when it is separated from the negative surface of the glass.

It appears from this part of the experiment, that the coated part of the charged glass was not brought into its natural state by completing the circuit between the coatings, but that it still retained a degree of permanent electricity; that the powers of both coatings were actually changed at the time of the first discharge; and that a succession of the same powers may be produced in the coatings, without renewing the least application of electricity to the glass itself.

147 The whole quantity of electric power added to the glass in charging it, is evidently distinguished into two parts in this experiment. The first part, which is by far the most considerable, appears to have been readily communicated from one surface of the glass to the other, along the bent wire, when it was first brought into contact with both coatings at the same time. The second part of the charge appears to be more permanent, and remains still united with the glass, notwithstanding the circuit has been completed (q). This permanent electricity, as well as the other, must be positive on the upper surface, and negative on the lower surface: because, in the present experiment, the charge was given by a smooth glass tube excited with a silk rubber. Now, the influence of the opposite and permanent powers on the different sides of the glass (each side having a tendency to bring the coating in contact with it into a state of electricity contrary to its own) must assist each other, in causing part of the electric matter naturally belonging to the upper coating to pass away from it to the under coating, along the discharging wire, and at the same time the surcharge to pass the same way. The upper coating, therefore, by losing some part of its natural quantity, must be negatively electrified; and the under coating, by receiving an addition to its natural quantity, must be positively electrified. The whole quantity of electric matter, which the influence of the permanent electricity of the glass is capable of taking from one coating and of adding to the other, bears but a small proportion to the whole charge: and therefore the second and every subsequent discharge must be considerably weaker than the first.

It appears from several of the preceding experiments, that a considerable degree of influential power may be produced at some distance by an electric in full force; and therefore a small excited body of a cylindrical shape was sufficient to answer that purpose: but when the excited electric has been so far weakened that it cannot communicate its own power, nor produce this influential power in any body, unless it be brought

---

(q) Some new terms seem to be wanted in order to express with precision the different parts of the charge. And if that part of it which cannot be destroyed by completing the circuit, should be called *the permanent part of the charge*, or more simply the *charge;* then might the other part, or that which may be destroyed by completing the circuit, be named the *surcharge.*

inciples Electri- y illus- ated by periment.

brought very near or in contact with it, bodies of a cylindrical form must then act to great disadvantage, and a small degree of power only can be produced; because the strength of the influential electricity in this case will be in proportion to the surfaces of the electric and conducting bodies, which are brought near together, or in contact with each other; and therefore a plate of glass in the same circumstances, whether its permanent power be derived from excitation or communication, is enabled from its shape to produce a considerable degree of the influential powers in the coatings in contact with it.

148 w to rge a l with- fric- tn.

It has been very properly recommended to use a particular kind of rubber, and to attend to the state of it, in order to excite glass well; but it will not be necessary to pay the least regard to these circumstances in the following experiments, in which a method will be shown of charging a small phial and a plate of glass at the same time, by a gradual accumulation of power; that power being entirely derived from the glass itself, and with no other degree or kind of friction than is necessarily connected with the form of the experiment.

Place a circle of tin-foil five inches in diameter on the table, between a soft piece of baize and the middle of the same plate of glass that was used in the last experiment, which will thus be coated on the under side: and in order to preserve a proper communication with this coating, let a fillet of tin-foil reach from it beyond the extremity of the glass. The same insulated metal cover is to be used for the upper coating as before. Let a thin ounce phial of glass be filled with brass filings, and coated with tin-foil on the outside to about one inch from the top. Let a large brass wire, the fifth part of an inch in diameter, pass through the cork of the phial into the filings, about an inch of it being left above the cork, and let the upper extremity of this wire be well rounded. This experiment requires, that the whole construction should be well warmed at first; and it will be necessary to repeat it at proper intervals, unless the atmosphere should be very dry.

Taking hold of the wire of the phial with one hand, let it be placed on the upper surface of the glass, and its bottom carried in contact over the middle of the upper surface, as far as the tin-foil coating reaches on the under side: and during this part of the operation, a finger of the other hand must be kept in contact with the fillet of tin-foil. Then lifting the phial by the wire with one hand, let it be placed on the insulated metal cover, suspended in the air with the other hand; and after shifting the hand from the wire to the coating, let the bottom of the phial be placed on the end of the tin-foil fillet. Place the insulated metal cover on the middle of the glass, and touch it with a finger of one hand, while the other hand touches the tin-foil fillet. Now lift the insulated cover by its stem, and bring the head of the cover in contact with the wire of the phial, and a very small spark of light will appear between them. Let this be repeated in the same manner about 15 times, taking care to preserve a proper communication between the coating and the floor. Then taking hold of the phial by the coating, let it be replaced on the insulated cover while it is suspended in the air; and after shifting the hand from the coating to the wire, let it be again placed on the middle of the glass: and let the bottom be again carried in contact over the middle of the glass, holding the wire in one hand, while the other has a proper communication with the tin-foil coating. Let the phial be again returned to the tin-foil fillet as before, and let the insulated cover be applied repeatedly to the wire, immediately after every separation from the glass; and a brighter spark, together with a weak snapping, will now attend each application, if it be carefully observed to touch the cover with one hand before every separation, while the other hand rests on the fillet of tin-foil. By proceeding in this manner, after the third application of the phial to the glass, a very weak shock will be felt in those fingers which are used in completing the circuit of the glass; and after repeating two rounds more in the manner before mentioned, the phial will be fully charged. By applying the coating of the phial when it is in full force to the upper surface as before, the glass plate will get the greatest power it is thus capable of receiving, and will then give a shock as high as the elbows. After this, on attempting to lift the insulated cover, the glass itself will generally be lifted at the same time, with the tinfoil coating adhering to the under surface: but by continuing the separations of the cover from the glass, a succession of strong negative sparks may be produced by the influence of the upper surface; and by turning the glass over, and leaving the tinfoil coating on the baize, a succession of strong positive sparks may be produced by the influence of the other side.

Principles of Electricity illustrated by experiment.

This experiment may be performed more steadily by placing the glass, together with the tinfoil coating and baize, on a plate of metal about one tenth of an inch thick, and of the same square as the glass. The whole may be fastened together by two small holdfasts placed at the opposite corners, which will prevent the glass from being lifted. This plate of metal will be useful in another view; for after it has been sufficiently warmed, by retaining heat well, it will help to keep the glass dry, and consequently fit for use so much the longer. But when it shall be required to show the contrary powers of the opposite sides of the glass, it will be more convenient not to fasten the parts together, and the whole may be kept sufficiently steady, by the operator's keeping down one corner of the glass with a finger, and by placing a proper weight on the opposite corner.

The bottom of the phial cannot be carried in contact over the glass without producing some little degree of friction; from which the power in this experiment is originally derived. The cover will appear on examination to be electrified negatively after every separation from the glass: but as it was touched in completing the circuit between the coatings before every separation, it necessarily follows, that the cover can have only an influential electricity, and consequently that the permanent power of the upper surface of the glass must be positive. The negative power of the cover is communicated to the wire of the phial, by which the inside is electrified negatively and the outside positively; and both these powers will increase with every application, because the circumstances of the phial are favourable to its charging. The phial must be insulated every time it is required to shift the hand from the wire to the coating, or from the coating to the wire;

Principles of Electricity illustrated by experiment.

for without this precaution the phial would be discharged. By applying the outside of the phial to the upper surface of the glass, in the manner above mentioned, the phial will be partly discharged on the surface: and though it must be therefore weakened, the power of the glass will be increased, and consequently enabled to produce a proportionably stronger effect on the brass cover, which by the next round of applications will give the phial a stronger charge than it had before. And thus a very small degree of original power is first generated, and then employed in forming two different accumulations: and by making each of these subservient to the increase of the other, the phial is at last fully charged, and the glass plate acquires such a degree of the surcharge, as to give a pretty smart shock; and after, it remains capable, by the influence of its permanent powers, of producing a succession of positive and negative sparks on the opposite surfaces.

The contrary charge may be given to the phial, by taking hold of the coating, and carrying the wire in contact over the middle of the upper-surface of the glass, and by applying the power of the insulated cover to the coating; for if the operation be conducted in every other respect in the same manner as before, then will the inside be electrified positively, and the outside negatively. The powers of the glass plate will be the same as they were in the former case.

After the phial has been fully charged negatively, by the process of the last experiment, let it be insulated; and taking hold of the wire, let the bottom be held uppermost, and let the hand which holds it rest on the fillet of tinfoil. Apply the insulated cover to the glass, and after touching it with a finger of the other hand, separate it from the glass; and on bringing it towards the coating of the phial, a strong spark will pass between them. After repeating this between 20 and 30 times, the powers of the phial will be destroyed; and by continuing the same operation, they will be inverted; for the inside will be at last fully charged positively, and the outside negatively.

The same effect may be produced by turning the glass over, and by repeatedly applying the influential electricity, produced on that side, to the wire of the phial.

When the phial has been fully charged negatively, as in the last experiment, take hold of the coating of the phial with one hand, and while the other hand rests on the tin-foil fillet, apply the wire to the middle of the upper surface of the glass, as far as the tin-foil coating extends on the other side. By this the powers of the glass plate will be changed.

149 Another, and perhaps a better method of applying the phial, is to place the insulated cover on the surface of the glass, and then holding the phial by the coating in one hand, to apply the wire to the cover, while the other hand touches the fillet of tin-foil; by which a shock will be given, and the same change of powers will be produced in an instant, which before took up some little time. On lifting the insulated cover by its stem immediately after the shock, it will be negative, or have the same power as the inside of the phial; but on replacing the cover, and completing the circuit of the glass plate, the surcharge will be destroyed; another shock will be felt; and the power of the cover, after the next separation, will be positive, or contrary to that of the inside of the phial. Apply this positive power to the wire of the phial as before; and after 15 applications, the powers of the phial will be destroyed; and by still proceeding in the same manner, the powers of the phial will be changed, and the inside will be fully charged positively, and the outside negatively, by 60 applications.

Principles of Electricity illustrated by experiment.

These effects may also be produced by a single application of the coating of the phial to the other side of the glass plate; and by repeated applications of the influential electricity, produced on the same side, to the coating of the phial.

150 If it were simply the object in this experiment to change the powers of the phial, the operation might then be considerably shortened, by completing the circuit of the phial, and consequently destroying the whole surcharge: but it was intended to show what effects might be produced, by opposing the contrary powers to each other; and by doing this it appears that either side of the glass plate can destroy the powers of the phial, and give it a contrary charge; that either side of the phial can also change the powers of the glass plate; and that the powers of the glass plate, thus inverted, can again destroy the powers of the phial, and give it a full charge of the contrary electricity.

Here it may be observed, that, in some cases, the quality of the power may be determined by observation alone. When the phial employed in the two last experiments has been fully charged, it may be known whether the inside be positive or negative from the light which appears at the wire, or from the hissing noise which attends it: for when the phial has been fully charged positively, if the room be sufficiently darkened, a bright luminous appearance may be seen, diverging in separate rays to the distance of an inch, attended with an interrupted hissing noise; and both the light and the noise continue a very short time. But when the phial is fully charged negatively, a weaker and more uniform light appears, which does not extend itself more than the sixth part of an inch, and is attended with a closer and more uniform hissing; and this noise and light always continue longer than the former. Even positive and negative sparks, passing between the insulated cover and a finger, may be distinguished from each other: for the positive sparks are more divided, give less light, make a weaker snapping noise, and affect the finger less sensibly than the negative.

The strongest sparks which can be produced in these experiments, are those that pass between the coating of the phial and the insulated cover, when they possess the contrary powers; but they will be more particularly vigorous if the coating be positive, and the insulated cover negative *.

Chap. VI. *Miscellaneous Experiments with charged Electrics.*

151 Cigna's experiments on charged plates.

Sig. Cigna made some curious experiments on the adhesion of electrified plates of glass. He laid two of these plates well dried, one upon the other as one piece, the lowermost of them being coated on the outside; and, when they were insulated, he alternately rubbed the uppermost plate with one hand, and took a spark from the coating of the lower with the other

---

* *Milner's Experiments and Observations.*

inciples Electri- y illus- ated by periment.

till they were charged; when the coating and both the plates adhered firmly together. Giving a coating to the other side, and making a communication between the two coatings, the usual explosion was produced. But, though the united electric was thus discharged, the plate still cohered, and though no sign of electricity appeared while they were united, they were, when separated, found possessed of opposite states of electricity.

If the two plates were separated before they were discharged, and the coating of each was touched, a spark came from each, and when they were again placed together, they cohered as before, but were not capable of giving a shock †.

If plates of glass, thus coated and electrified, be separated in the dark, flashes of light will be perceived between them. By laying the plates together again, and again separating them successively, the appearance of these luminous flashes may be repeated several times, but always in a weaker degree than the first.

Mr Symmer made several experiments of the same kind before Sig. Cigna. He found that when the two plates were coated only on one side, they were charged as one plate, and the uncoated sides adhered together; but when they were coated each on both sides, they became charged distinctly from each other, and did not adhere.

152 Henles remaks.

Mr Henley, in describing an experiment of this kind, makes the following observation. "Crown glass, that is, the glass commonly used for sash-windows, though so much thinner, succeeds in this experiment as well as the plate-glass; but what is very remarkable, the Dutch plates, when treated in the same manner, have each a positive and a negative surface, and the electricity of both surfaces of both plates is exchanged for the contrary electricity in the discharge. If a clean, dry, uncoated plate of looking-glass be placed between the coated looking-glass plates, or between the plates of crown-glass, it appears, after charging, to be negatively electrified on both sides; but if it be placed between the Dutch plates, it acquires, like them, a positive electricity on one surface, and a negative electricity on the other."

53 Cus expement of ofessor Rman.

A very curious and elegant experiment on the Leyden phial was made by Professor Richman of Petersburgh, whose unfortunate death will be hereafter related.

He coated both sides of a pane of glass, within two or three inches of the edge, and fastened linen threads to the upper part of the coating on both sides; which, when the plate was not charged, hung down in contact with the coating; but setting the plate upright and charging it, he observed, that when neither of the sides was touched by his finger, or any other conductor communicating with the earth, both the threads were repelled from the coating, and stood at an equal distance from it; but when he brought his finger or any other conductor to one of the sides, the thread hanging to that side fell nearer to the coating, while the thread on the opposite side receded as much; and that when his finger was brought into contact with one of the sides, the thread on that side fell into contact with it likewise, while the thread on the opposite side receded to twice the distance at which it hung originally; so that the two threads always hung so as to make the same angle with one another ‡.

Principles of Electricity illustrated by experiment.

154 Magic picture.

One of the most amusing experiments with charged electrics, is that which Dr Franklin calls the *Magic Picture*, and which he describes in the following manner. Having a large mezzotinto print (suppose of the king), with a frame and glass; take out the print and cut a pannel out of it, near two inches distant from the frame all around. If the cut be through the picture, it is not the worse. With thin paste or gum-water, fix the board that is cut off on the inside of the glass, pressing it smooth and close, then fill up the vacancy by gilding the glass well with gold or brass leaf. Gild likewise the inner edge of the back of the frame all round, except the top part, and form a communication between that gilding and the gilding behind the glass; then put in the board and that side is finished. Turn up the glass, and gild the foreside exactly over the back gilding; and when it is dry, cover it, by pasting on the pannel of the picture that has been cut out, observing to bring the correspondent parts of the board and picture together, by which the picture will appear of a piece as at first, only part is behind the glass, and part is before. Lastly, hold the picture horizontally by the top, and place a little moveable gilt crown on the king's head.

If now the picture be moderately electrified, and another person take hold of the frame with one hand, so that his fingers touch its inside gilding, and with the other hand endeavour to take off the crown, he will receive a severe shock, and fail in the attempt.

155 Electrical jack.

On the same principle that the wires of phials charged differently, will attract and repel differently, is made an *electrical wheel*, which, Dr Franklin says, turns with considerable strength, and of which he gives the following description. A small upright shaft of wood passes at right angles through a thin round board, of about twelve inches diameter, and turns on a sharp point of iron, fixed in the lower end; while a strong wire in the upper end, passing through a small hole in a thin brass plate, keeps the shaft truly vertical. About thirty radii of equal length, made of sash-glass, cut in narrow slips, issue horizontally from the circumference of the board; the ends most distant from the centre being about four inches apart. On the end of every one a brass thimble is fixed.

If now the wire of a bottle electrified in the common way, be brought near the circumference of this wheel, it will attract the nearest thimble, and so put the wheel in motion. That thimble, in passing by, receives a spark, and thereby being electrified is repelled, and so driven forwards; while a second being attracted, approaches the wire, receives a spark, and is driven after the first; and so on till the wheel has gone once round; when the thimbles before electrified approaching the wire, instead of being attracted as they were at first, are repelled, and the motion presently ceases.

But if another bottle which had been charged through the coating, be placed near the same wheel, its wire will attract the thimble repelled by the first, and thereby double the force that carries the wheel round; and not only taking out the electric power that had been communicated by the thimbles to the first bottle, but even depriving them of their natural quantity, instead of

---

† Mem. of Acad. Turin, 1765.

‡ Æpini Tentamen, p. 335.

of being repelled when they come again towards the first bottle, they are more strongly attracted; so that the wheel mends its pace, till it goes with great rapidity, 12 or 15 rounds in a minute, and with such strength, that the weight of 100 Spanish, with which it was once loaded, did not seem in the least to retard its motion. This is called an *electrical jack*, and if a large fowl was spitted on the upper shaft, it would be carried round before a fire, with a motion fit for roasting.

But this wheel, like those driven by wind, moves by a foreign force, viz. that communicated to it by the bottles.

156 Self-moving-wheel.

The *self-moving wheel*, though constructed on the same principles, appears more surprising. It is made of a thin round plate of window glass, seventeen inches in diameter, well gilt on both sides, to within two inches of the circumference. Two small hemispheres of wood are then fixed with cement, to the middle of the upper and under sides, centrally opposite, and in each of them a thick strong wire, eight or ten inches long, together making the axis of the wheel. It turns horizontally on a point at the lower end of its axis, which rests on a bit of brass cemented within a glass salt seller. The upper end of its axis passes through a hole in a thin brass plate, cemented to a long and strong piece of glass; which keeps it six or eight inches distant from any non-electric, and has a small ball of wax or metal on its top.

In a circle on the table which supports the wheel, are fixed twelve small pillars of glass, at about eleven inches distance, with a thimble on the top of each. On the edge of the wheel is a small leaden bullet, communicating by a wire with the upper surface of the wheel; and about six inches from it, is another bullet communicating, in like manner, with the under surface. When the wheel is to be charged by the upper surface, a communication must be made from the under surface with the table.

When it is well charged it begins to move. The bullet nearest to a pillar moves toward the thimble on that pillar, and passing by, electrifies it, and then pushes itself from it. The succeeding bullet, which communicates with the other surface of the glass, more strongly attracts that thimble, on account of its being electrified before by the other bullet, and thus the wheel increases its motion, till the resistance of the air regulates it. It will go half an hour, and make one minute with another, twenty turns in a minute, which is six hundred turns in the whole, the bullet of the upper surface giving in each turn, twelve sparks to the thimbles, which makes seven thousand two hundred sparks, and the bullet of the under surface receiving as many from the thimble, these bullets moving in the time near two thousand five hundred feet. The thimbles are well fixed, and in so exact a circle, that the bullets may pass within a very small distance of each of them.

If instead of two bullets you put eight, four communicating with the upper surface, and four with the under surface, placed alternately, (which eight, at about six inches distance, complete the circumference) the force and swiftness will be greatly increased, the wheel making fifty turns in a minute, but then it will not continue moving so long.

These wheels may be applied perhaps to the ringing of chimes, and moving light-made orreries *.

Mr Cavallo gives the following description of an instrument which he calls the *Self-charging Leyden Phial.*

157 Self charging Leyden phial.

Take a glass tube of about eighteen inches in length, and an inch, or an inch and a half, in diameter. It is immaterial whether one of its ends be closed or not. Coat the inside of it with tin-foil, but only from one open extremity of it about as far as its middle; the other part, which remains uncoated, we shall call the naked part of the instrument. Put a cork into the aperture of the coated end, and let a knobbed wire pass through the cork, and come in contact with the coating. The instrument being thus prepared, hold it in one hand by the naked part, and with the other hand clean and dry-rub the outside of the coated part of the tube; but after every three or four strokes you must remove the rubbing hand, and must touch the knob of the wire, and in so doing a little spark will be drawn from it. By this means the coated end of the tube will gradually acquire a charge, which may be increased to a considerable degree. If then you grasp the outside of the coated end of the tube with one hand, and touch the knob of the wire with the other hand, you will obtain a shock, &c.

In this experiment the coated part of the tube answers the double office of electrical machine and of Leyden phial; the naked part of it being only a sort of handle to hold the instrument by. The friction on the outside of the tube accumulates a quantity of positive electricity upon it, and this electricity forces out of the inside a quantity of electricity also positive. Then by taking the spark from the knob, this inside electricity, which is by the coating communicated to the knob through the wire, is removed, consequently the inside remains undercharged or negative, and of course the positive electricity of the outside comes closer to the surface of the glass, and begins to form the charge. By farther rubbing and taking the spark from the knob this charge is increased, &c.

Instead of a tube, this instrument may be constructed with a pane of glass, in which case it will be rather simpler, but it cannot be managed so easily, nor of course can it be charged so high as the tube. A piece of tin-foil must be pasted in the middle of only one surface of the pane, leaving about two inches and a half or three inches of uncoated glass all round. This done, hold the glass by a corner, with the coated side from you, and with the other hand rub its uncoated side, and take the spark from the tin-foil alternately, until you think that the glass may be sufficiently charged; then lay the glass with its uncoated side flat upon one hand, and on turning the tin-foil with the other hand you will receive the shock.

CHAP. VII. *Of the Chemical Effects of the Electric Spark.*

THE Germans were the earliest to apply the electric light to chemical purposes, suggested by its analogy to common fire. By this application of it, that analogy was confirmed and illustrated. The arrangement required for subjecting bodies to this agency, simply consists

---

* *Franklin's Letters.*

ncıples Electri- y illus- ated by eriment.

consists in placing them in an interrupted part of an electric circuit, so as to make the spark pass through them, or in very close contact.

The electric spark sets fire to inflammable bodies.

158 fire ro-

Exper. 1.—*To fire rosin.* Wrap some cotton wool containing as much powdered rosin as it will hold, about one of the knobs of a discharging rod. Then having charged a leaden jar, apply the naked knob of the rod to the external coating, and the rod enveloped by the cotton to the ball of the wire. The act of discharging the jar will set fire to the rosin.

Powdered rosin may even be inflamed, when strewed on the surface of water in a porcelain dish, when the wires between which the spark is produced are placed near the surface of the water, four or five inches distant from each other.

A piece of phosphorus or camphor wrapped in cotton wool, and used in the common way, will be much more easily inflamed.

159 T fire s its.

Exper. 2.—*To fire spirits.* Hang a small ball with a stem to the prime conductor, so that the ball may project below the conductor. Then warm a little ardent spirit, by holding it a short time over a candle in a metallic spoon; hold the spoon about an inch below the ball, and set the machine in motion. A spark will soon issue from the ball and set fire to the spirits.

This experiment succeeds in the very same manner, whether the conductor is electrified positively or negatively, i. e. whether the spark be made to come from the conductor or from the spoon; it being only in consequence of the rapid motion of the spark that the spirits are kindled.

It will be perhaps scarcely necessary to remark, that the more inflammable the spirits are, the more proper they will be for this experiment, as a smaller spark will be sufficient to inflame them; therefore rectified spirit of wine is better than common proof spirit, and æther is better than either.

This experiment may be varied different ways, and may be rendered very agreeable to a company of spectators. A person, for instance, standing upon an electric stool, and communicating with the prime conductor, may hold the spoon with the spirits in his hand, and another person, standing upon the floor, may set the spirits on fire, by bringing his finger within a small distance of it. Instead of his finger he may fire the spirits with a piece of ice; when the experiment will seem much more surprising. If the spoon is held by the person standing upon the floor, and the insulated person brings some conducting substance over the surface of the spirit, the experiment succeeds as well.

Mr Winckler says, that oil, pitch, and sealing-wax, might be lighted by electric sparks, provided those substances were first heated to a degree next to kindling. To these it must be added, that Mr Gralath fired the smoke of a candle just blown out, and lighted it again; and that Mr Boze fired gunpowder, melting it in a spoon, and fired the vapour that rose from it *.

This experiment will succeed better with a charged jar.

o To e hy- dr ous ga ate C. 48.

Exper. 3. *To fire hydrogenous gas.*—Provide a bottle of strong glass with two necks, as *a*, fig. 48. Let a brass cap be fitted to each neck; one of which is furnished with a cock, and through the other a glass tube *s s* is passed, containing a wire projecting beyond the tube at one end, which is terminated by a knob *n*, while the other passing within the bottle turns round so as to come within an inch of the brass through which the glass tube passes. The bottle being thus prepared, fill it with water, and throw up into it equal parts of hydrogen gas and common air, or two parts of hydrogen and one of oxygen gas; fix in the cork, and shake the bottle so as to mix the gases well together. Then bring the knob *n*, near the knob of a charged jar, or a ball of the prime conductor, and the hydrogen will be inflamed with a loud report.

In general the cork will be forced out by the explosion; but if this should not be the case, an opportunity is afforded of proving that the gases have disappeared, and water has been produced by the experiment. On taking out the cork below the surface of water, the water will rush in and fill the bottle, thus shewing that the *gases have disappeared.*

To prove the production of water, it is necessary that the bottle should have been filled with mercury before the gases were introduced. In both cases drops of water will appear within the bottle after the report; but where water has been employed in introducing the gases, this testimony is more equivocal than when *no water* has been used.

The first person who fired inflammable bodies by the electric spark, was Dr Ludolf of Berlin, in 1774, who, by sparks excited by the friction of a glass tube, kindled the ethereal spirits of Frobenius †. Mr Gordon of Erfurd, produced so strong a spark from the back of a cat, as to fire spirit of wine ‡.

161 Inflammable air lamp. Plate CXC. fig. 49.

Exper. 4.—It has been proposed by Sig. Volta to apply the burning of hydrogen gas to economical purposes, in what he called the *inflammable air lamp.*

A, fig. 49. is a glass globe for containing the gas; B a glass bason or reservoir for holding water; D a cock to form a communication between the water and the gas. The water passes into the globe through the metal pipe *g g*, which is fixed to the upper part of the reservoir A; at *s* is a cock to cut off or open a communication between the air and the jar K. N is a small pipe to hold a piece of wax taper; L a brass pillar, on the top of which is a ball of the same metal; *a*, is a pillar of glass with a socket at the top, in which slides the wire *b*, having a ball screwed on the end of it. F, is a cock by which the globe is filled with hydrogen gas, and which afterwards serves to confine the gas and what water falls from B into A.

To use this instrument, having filled the globe with gas, and the reservoir A with water, turn the cocks D and *s*, and water will fall into the globe, forcing up a quantity of gas, which will rise through the pipe K. If now an electric spark be made to pass from the ball *m* to that marked *n*, it will set fire to the inflammable gas which passes through the pipe K. This is done by means of an electrophorus, which, by retaining a constant reservoir of electricity of the easiest application, is extremely convenient for this purpose. Hence instruments of this kind are neatly fitted up, with an electrophorus attached. The gas is thus emitted and kindled in one moment; one motion being sufficient for both effects. To extinguish the lamp, first shut the cock *s*, and then D.

The gas is obtained in the usual way from diluted sulphuric

---

* est. Hi Elect. ex 7.

† *Phil. Trans. Abr.* vol. x.

‡ *Nollet's Researches*, p. 98.

sulphuric acid and iron filings, and the globe is to be filled in the following manner. Having previously filled it with water, place the foot R in a tub of water so that it may be covered, and that the bent glass tube through which the gas is to be introduced, may pass commodiously below the foot. When the gas has driven out nearly all the water, turn the cock F, and the lamp is ready for use.

162 To fire gunpowder.

Exper. 5. *To fire gunpowder.*—Fix a small cartridge on a metallic wire which is fitted to a glass or wooden handle; make a communication between the wire and the ground; then present the cartridge to the knob of a charged Leyden phial, and the gunpowder will be fired.

Plate CXC. fig. 50.

Fig. 50. represents a small cannon, with an ivory touch-hole fitted with a brass pin furnished with a round head. Gunpowder may be fired from this cannon by the electric shock, in the following manner. Charge the cannon with gunpowder as usual; then fill the touch-hole with powder, ram it well down, and push into it the brass pin, so that its end may be near the bottom of the hole. Now make a communication between the outside of a large charged jar, or a battery, and the body of the cannon; then, placing one ball of a discharging rod on the head of the pin, which passes down the touch-hole of the cannon, bring the other to the knob of the jar, and the discharge will fire the cannon.

The electric spark decomposes most of the compound gases, and forms new compounds with their component principles.

163 Action of the electric spark on the gases.

164 Experiments of Dr Priestley.

The first who examined the action of electricity on the gases, was Dr Priestley. In the course of his experiments on air, he found that by means of the electric spark, he could convert the blue colour of a vegetable infusion into red. The instrument used in this experiment, was a glass tube about four or five inches long, and one or two tenths of an inch in diameter in the inside; a piece of wire was put into one end of the tube, and fixed there with cement; a brass ball was fixed on the top of this wire; the lower part of the tube was filled with water, tinged blue with a piece of turnsole or archil. This was easily effected by setting the tube in a vessel of the tinged water, then placing it under a receiver on the plate of an air-pump; exhausting the receiver in part, and then, on letting in the air, the tinged liquor rose in the tube, and the elevation would be in proportion to the accuracy of the vacuum; now taking the tube and vessel from under the receiver, he threw strong sparks on the brass ball from the prime conductor.

When Dr Priestley made this experiment, he perceived, that after the electric sparks had been passed between the wire and the liquor for about a minute, the upper part of the liquor began to look red; in two minutes it was manifestly so, and the red part did not readily mix with the rest of the liquor. If the tube was inclined where the sparks were passed through it, the redness extended twice as far on the lower side as on the upper. In proportion as the liquor became red, it advanced nearer to the wire, so that the air through which the sparks were passed, was diminished; the diminution amounted to about one-fifth of the whole space; after which a continuation of the electric sparks produced no sensible effect.

To determine the cause of the change of colour, Dr Priestley expanded the air in the tube by means of an air-pump, till it expelled all the liquor, and admitted fresh blue colour in its place; but after this, electricity produced no sensible effect on the air or on the liquor; so that it was clear, that the air had been decomposed, and something of an acid nature had been produced. The result was the same with wires of different metals. It was also the same, when, by means of a bent tube, the sparks were made to pass from the liquor in one leg of the tube to the liquor in the other. The air thus diminished, was in the highest degree noxious.

In passing the electric spark through different gases, it appears of different colours. In *carbonic acid gas*, the spark is very white: in *hydrogenous gas*, and *ammoniacal gas*, it appears of a purple or red colour.

Dr Priestley found that the electric spark passed through any kind of oil, produced an *inflammable gas*. He tried it with oil of olives, oil of turpentine, and essential oil of mint. The electric spark, when passed through ether, produces the same effect.

He found that the electric spark, when passed through *ammoniacal gas*, increases the bulk of this gas; so that, by making about two hundred shocks pass through a given quantity of it, the original quantity was sometimes increased one-fourth. If water was admitted to this gas, it absorbed the original quantity, and left about as much gas as was generated by the electricity, and this was a strongly inflammable gas.

Dr Priestley found, that on passing slight electric shocks for about an hour, through an inch of *carbonic acid gas*, confined in a glass tube one tenth of an inch in diameter, when water was admitted to it, only one-fourth of the air was absorbed.

He likewise found, when the electric spark was passed through *carbureted hydrogen gas*, that the inside of the tube in which the gas was confined, was covered with a blackish substance.

Dr Priestley took the simple electric spark from a conductor of a moderate size, for the space of five minutes without interruption, in a quantity of *carbureted hydrogen gas*, without producing any change in the inside of the glass; when immediately after, passing through it only two shocks of a common jar, each of which might be produced in less than a quarter of a minute with the same machine in the same state, the whole of the inside of the tube was completely covered with the black matter.

A large phial, about an inch and a half wide, being filled with this gas, the explosions of a very large jar, containing more than two feet of coated surface, had no effect upon it; from which it seems, that in these cases the force of the shock was not able to decompose the gas.

Several valuable experiments were made by the Hon. Henry Cavendish, of which he gave an account in the 73d volume of the Phil. Trans.

165 Mr Cave dish's exp riments. Plate CXC. fig. 51

The apparatus used in making the experiments was as follows. The air, through which the spark was intended to be passed, was confined in a glass tube M, bent to an angle, as in fig. 51. which, after being filled with quicksilver, was inverted into two glasses of the same fluid as in the figure. The air to be tried was then introduced by means of a small tube, such as is used for thermometers, bent in the manner represented, ed by ABC, fig. 52. the bent end of which, after being previously filled with quicksilver, was introduced, as in the figure, under the glass DEF, inverted into water, and filled with the proper kind of air, the end C of the tube being kept stopped by the finger; then, on removing the finger from C, the quicksilver in the tube descended in the leg BC, and its place was supplied with air from the glass DEF. Having thus got the proper quantity of air into the tube ABC, it was held with the end C uppermost, and stopped with the finger; and the end A, made smaller for that purpose, being introduced into one end of the bent tube M, fig. 51. the air, on removing the finger from C, was forced into that tube by the pressure of the quicksilver in the leg BC. By these means he was enabled to introduce the exact quantity of soap lees, or any other liquor which he wanted to be in contact with the air.

In one case, however, in which he wanted to introduce air into the tube many times in the same experiment, he used the apparatus represented in fig. 53. consisting of a tube AB of a small bore, a ball C, and a tube DE of a larger bore. This apparatus was first filled with quicksilver, and then the ball C and the tube AB were filled with air, by introducing the end A under a glass inverted into water, which contained the proper kind of air, and drawing out the quicksilver from the leg ED by a siphon. After being thus furnished with air, the apparatus was weighed, and the end A introduced into one end of the tube M, and kept there during the experiment; the way of forcing air out of this apparatus into the tube, being by thrusting down the tube ED a wooden cylinder, of such a size as almost to fill up the whole bore, and by occasionally pouring quicksilver into the same tube, to supply the place of that pushed into the ball C. After the experiment was finished, the apparatus was weighed again, which shewed exactly how much air had been forced into the tube M, during the whole experiment; it being equal in bulk to a quantity of quicksilver, whose weight was equal to the increase of weight of the apparatus.

The bore of the tube M used in most of the following experiments, was about one-tenth of an inch; and the length of the column of air, occupying the upper part of the tube, was in general from one and a half to three quarters of an inch.

In order to force an electrical spark through the tube, it was necessary, not to make a communication between the tube and the conductor, but to place an insulated ball at such a distance from the conductor, as to receive a spark from it, and to make a communication between that ball and the quicksilver in one of the glasses, while the quicksilver in the other glass communicated with the ground.

When the electric spark was made to pass through common air, included between short columns of a solution of litmus, the solution acquired a red colour, and the air was diminished conformably to what was observed by Dr Priestley. When lime-water was used instead of the solution of litmus, and the spark was continued till the air could be no farther diminished, not the least cloud could be perceived in the lime-water; but the air was reduced to two-thirds of its original bulk; which is a greater diminution than it could have suffered by mere phlogistication, as that is very little more than one-fifth of the whole.

Principles of Electricity illustrated by experiment.

The experiment was next repeated with some impure oxygen gas. The gas was very much diminished, but without the least cloud being produced in the lime-water, nor was any cloud produced when carbonic acid gas was let up to it; but on the further addition of a little caustic ammonia, a brown sediment was immediately perceived.

Hence we may conclude that the lime-water was saturated by some acid formed during the operation; as in this case it is evident that no earth could have been precipitated by the carbonic acid gas alone, but that the caustic ammonia, on being added, would unite with the carbonic acid, and thus becoming a *carbonate* would precipitate the lime by double affinity; whereas, if the lime had not been saturated with an acid, it would have been precipitated on the addition of carbonic acid gas. As to the brown colour of the sediment, it was probably owing to some of the mercury having been dissolved.

When the impure oxygen gas was confined by soap lees, the diminution proceeded rather faster than when it was confined by lime-water; for which reason, as well as on account of the lixivium containing a large quantity of alkali in proportion to its bulk, it seemed better adapted than lime-water for experiments designed to investigate the nature of the acid produced. Accordingly some experiments were made to determine of what degree of purity the oxygen gas should be, in order to be diminished most readily and in the greatest degree; and it was found that when good oxygen gas was employed, the diminution was but small; when perfectly pure azotic gas was used, no sensible diminution took place; but when five parts of pure oxygen gas and three of common air were employed, almost the whole of the gases were made to disappear. It must be considered that common air consists of one part of oxygen gas mixed with between three and four of azotic gas, so that a mixture of five parts of pure oxygen gas and three of common air, was nearly the same thing as seven parts of oxygen gas and three of azotic gas.

Having made these previous trials, Mr Cavendish introduced into the tube a little soap lees, and then let up some oxygen gas and common air, mixed in the above proportions, which rising to the top of the tube M, distributed the soap lees in the two legs of the tube, as fast as the air contained in it was diminished by the electric spark; continuing to add more of the same mixture till no further diminution took place; after which a little pure oxygen gas, and then a little common air, were added, in order to see whether cessation of diminution was not owing to some imperfection of the proportion of the two kinds of air to each other, but without effect. The lixivium being then poured out of the tube, and separated from the mercury, seemed to be perfectly neutralized, as it produced no change on the colour of paper tinged with the juice of blue flowers. Being evaporated to dryness, a small quantity of salt was left, which was evidently nitre, as appeared by the manner in which paper impregnated with a solution of it burned.

For more satisfaction, he tried this experiment over again,

again, on a larger scale. About five times the former quantity of soap lees were now let up into a tube of a larger bore; and a mixture of oxygen gas and common air, in the same proportions as before, being introduced by the apparatus represented in fig. 53. the spark was continued till no more air could be made to disappear. The liquor when poured out of the tube, smelled evidently of nitrous acid. This salt was found, by the manner in which paper, dipped into a solution of it, burned, to be true nitre. It appeared, by the test of muriate of baryta, to contain no more sulphuric acid than the soap lees themselves often contain, which is in general very little; and there is no reason to think that any other acid entered into it, except the nitric.

By these beautiful experiments was demonstrated one of the most important facts in modern chemistry, viz. that the nitric acid is composed of oxygen and azote.

166
Van Marum's experiments on the gases.

The above experiments of Priestley and Cavendish, were repeated on a large scale by Dr Van Marum, with the powerful machine in Teyler's museum.

For this purpose he used a cylindrical glass receiver five inches long and an inch and a quarter in diameter, into which different sorts of gases were successively inserted, and were confined by quicksilver or water. To a hole made in the bottom of the inverted glass receiver, an iron wire was fastened, the external part of which communicated with a conductor, which being presented to the prime conductor of the machine, received the sparks from it. In this disposition of the apparatus it evidently appears, that the sparks passed through the gas contained in the receiver, by going from the inner extremity of the wire to the quicksilver or water in which the receiver was inverted. With this apparatus it was found, that oxygen gas, obtained from mercurial red precipitate, lost one-twentieth of its bulk; but its quality was not sensibly altered, as appeared from examining it with the eudiometer. This experiment being repeated when the receiver was inverted in lime water, and likewise in the infusion of turnsole, there ensued no precipitation, nor change of colour. On pouring out this air, the usual smell of the electric spark was very sensibly perceived.

Nitrous gas was diminished to more than the half of its original bulk; and in that diminished state, being mixed with common air, it occasioned no red fumes, nor any sensible diminution. It had lost its usual smell, and it extinguished a candle. In passing the sparks through the nitrous gas, a powder was formed on the surface of the quicksilver, which consisted of a portion of that metal dissolved by the nitrous acid.

Hydrogen gas, obtained from iron and diluted sulphuric acid, communicated a slight redness to the tincture of turnsole. The stream of electricity through this air appeared more red, and much larger, than in common air, being everywhere surrounded by a faint blue light.

The inflammable gas, obtained from alcohol and sulphuric acid, was increased to about three times its original bulk, and lost a little of its inflammability.

Carbonic acid gas, from chalk and sulphuric acid, was a little increased in bulk by the action of electricity; but it was rendered less absorbable by water (s).

The gas obtained from sulphuric acid and charcoal was diminished a little, and black spots were formed

---

(s) It was found by C. Monge, who carefully examined the gas produced by passing electric sparks through carbonic acid gas, that it had been rendered inflammable; and that the mercury employed to confine the gas, as well as the wires between which the sparks passed, were oxidated. C. Monge supposed that the carbonic acid employed had undergone no change, but that the water held in solution by it had been decomposed; thus accounting for the oxidation of the metals, and the generation of inflammable gas.

M. Theodore de Saussure, not considering C. Monge's experiments as decisive, repeated them on a larger scale. He caused to circulate for 18 hours, electric sparks in the bulb of a matrass which contained 13 cubic inches of pure carbonic acid gas, and without any mixture of water superabundant to that which it might naturally hold in solution. The mercury in which the inverted matrass was immersed rose to about the half of its neck. After electrization the metallic fluid was found oxidated black, as had been observed by Monge and Priestley; but his conductors, which were of copper, were not sensibly altered. The elastic fluid had experienced a small dilatation, which appeared to him not to exceed the tenth part of a cubic inch. He then made about a grain of water to pass in contact with the aëriform gas contained in the matrass. He let it remain there for several days, without perceiving any dilatation in the volume of the gases, the residue of the operation. He then moistened with a drop of water, which he introduced, the whole inside of the matrass; but in vain: the mercury constantly remained at the same height. He, however, found, on absorbing by potash the residuum of the acid gas, that a cubic inch of carbonic acid gas had disappeared, and had been replaced by a quantity nearly equal, or rather superior, of the inflammable gas. The 20 cubic centimetres occupied, in the neck of the matrass, a column four inches in length; and the acid gas, had the supposed explanation been just, would have been dilated through all that space. He then thought that this inflammable gas did not arise from the decomposition of the water, but from that of the carbonic acid itself, by the metal. He indeed found that this gas was not hydrogen gas, but carbonous gas perfectly pure. He burnt 100 parts of it on mercury with about a third of oxygen gas. He did not perceive water after this combustion, which left for residuum 77 parts of carbonic acid gas.

The dilatation which the latter experiences by electrization may be explained by the different densities of the carbonous gas and the carbonic acid gas. He was not able to verify the observation of C. Monge respecting the dilatation experienced by the carbonic acid gas, after electrization over mercury.

If it was not possible to reduce entirely the acid gas into carbonous gas by these processes, it was because the first strata of metallic oxidation presented an obstacle to further oxidation, by preventing the points of contact. The developement of the carbonous gas produced therefore an analogous effect.

ciples ectri- illus- d by iment.

formed on the inside of the glass receiver. Afterwards it was observed, that only one-eighth part of the electrified gas was absorbed by water. It extinguished a candle, and had very little smell.

Muriatic acid gas seemed to oppose in great measure the passage of the electric sparks, since they would not pass through a greater length than $2\frac{1}{4}$th inches of this air. It was considerably diminished, but the rest was readily absorbed by water.

Fluoric acid gas was neither diminished, nor any other way sensibly altered, by the electric sparks.

Ammoniacal gas, extracted from pure ammonia, was at first almost doubled in bulk; then it was diminished a little; after which it remained without any augmentation or diminution. It became unabsorbable by water; and by the contact of flame it exploded, like a mixture of hydrogen gas and a good deal of common air.

Common air was lastly tried, and it was found to give a little faint redness to the tincture of turnsole; becoming at the same time sensibly deoxidized. The experiment was repeated thrice at different times, and in each time after the electrification it was examined by the admixture of nitrous gas in Mr Fontana's eudiometer, and it was compared with the same gas not electrified; the latter always suffering the greatest diminution. In the first experiment the diminutions were $\frac{145}{500}$ and $\frac{175}{500}$; in the second, $\frac{159}{500}$ and $\frac{194}{500}$; and in the last $\frac{149}{500}$ and $\frac{178}{500}$.

A column of ammoniacal gas obtained by heat from pure ammonia, three inches high, was electrified four minutes, and rose to six inches, but did not rise higher when electrified ten minutes longer. It appears that this air is not expanded more by the powerful electric stream from this machine than by the common spark. Water would not absorb this electrified air, which was in part inflammable.

The tube, being filled to the height of an inch with ammoniacal gas, and inverted in mercury, was electrified four minutes; in which time the tube was filled with eight inches of gas, which proved to be equally inflammable, and as little absorbed by water as the ammoniacal gas.

7
Cu s experiment wit al- loo illed wit ydro- gen s.

The following experiment is very curious. Two balloons, made of the allantoides of a calf, were filled with hydrogen gas, of which each contained about two cubic feet. To each of these was suspended, by a silken thread about eight feet long, such a weight as was just sufficient to prevent it from rising higher in the air; they were connected, the one with the positive, the other with the negative conductor, by small wires about 30 feet in length; and being kept near 20 feet asunder, were placed as far from the machine as the length of the wires would admit. On being electrified, these balloons rose up in the air as high as the wire allowed, attracted each other, and uniting as it were into one cloud, gently descended.

Ele cal air t mo- mete

The rarefaction of air by the electric explosion, is well illustrated by an experiment of Mr Kinnersley, thus described by Mr Cavallo. Fig. 54. Pl. CXC. represents an instrument, which the inventor, Mr Kinnersley, calls the *electrical air thermometer*, it being very useful to observe the effects of the electric explosion upon air. The body of this thermometer consists of a glass tube AB, about ten inches long, and nearly two inches in diameter, and closed air-tight at both ends by two brass caps. Through a hole in the upper cap, a small tube HA, open at both ends, is introduced in some water at the bottom B of the large tube. Through the middle of each of the brass caps, a wire FG, EI, is introduced, having a brass knob within the glass tube, and by sliding through the caps, they may be set at any distance from one another. This instrument is, by a brass ring C, fastened to the pillar of the wooden stand CD, that supports it. When the air within the tube AB is rarefied, it will press upon the water at the bottom of the tube, which will consequently rise in the cavity of the small tube; and as this water rises higher or lower, so it shows the greater or less rarefaction of the air within the tube AB, which has no communication with the external air.

Principles of Electricity illustrated by experiment.

Plate CXC. fig. 54.

If the water, when this instrument is to be used, is all at the bottom of the large tube, (i. e. none of it is in the cavity of the small tube), it will be proper to blow with the mouth into the small tube, and thus cause the water to rise a little in it; where, for better regulation, a mark may be fixed.

Bring the knobs GI of the wires IE, FG, into contact with one another, then connect the ring E or F, with one side of a charged jar, and the other ring with the other side, by which operation a shock will be made to pass through the wires FG, IE, i. e. between the knobs EI. In this case you will observe, that the water in the small tube is not all moved from the mark.

Put the knobs GI, a little distant from one another, and send a shock through them as before, and you will see that the spark between the two knobs, not only displaces, but rarefies considerably the air; for the water will be suddenly pushed almost to the top of the small tube, and immediately it will subside a little, as for instance as far as H; which is occasioned by the sudden displacing and replacing of the air about the place, where the spark appeared within the tube AB. After that the water has subsided suddenly from the first rising, it will then gradually and slowly come down to the mark at which it stood before the explosion; which is the effect of the air that was rarefied, gradually returning to its former temperature.

If this experiment be made in a room, where the degree of heat is variable, then proper allowance must be made for this circumstance, in estimating the event of the experiment; for the electrical air thermometer is affected by heat or cold in general, as well as by that caused by an electric spark.

169
Decomposition of water.

In the year 1789, Messrs Paets, Van Troostwyk, and Deiman, the three associated Dutch chemists, as they are generally called, sent a letter to M. de la Methrie, giving

---

It results then from his observations, that the change which carbonic acid gas undergoes by electrization does not arise from the decomposition of the water, but from the partial decomposition of the carbonic acid gas, which becomes carbonic oxide gas, giving up a part of its oxygen to the metal introduced in those experiments.

Principles of Electricity illustrated by experiment.

giving an account of some experiments, which they, assisted by Mr Cuthbertson, had made on the effect of passing a stream of electricity for a considerable time through water. Their letter was printed in the *Journal de Physique* for that year; but the account is too long to be inserted here; we shall, therefore, copy the following succinct account of the experiment by Dr Pearson.

The apparatus employed was a tube 12 inches in length, and its bore was one-eighth of an inch in diameter, English measure; which was hermetically sealed at one end, and, while it was sealing, an inch and a half of gold or platinum wire was introduced within the tube, and fixed into the closed end, by melting the glass around the extremity of the wire. Another wire of platinum, or of gold, with platinum wire at its extremity, immersed in quicksilver, was introduced at the open end of the tube, which extended to within five-eighths of an inch of the upper wire, which, as was just said, was fixed into the sealed extremity (T).

The tube was filled with distilled water, which had been freed from air by means of Cuthbertson's last improved air-pump, of the greatest rarefying power. As the open end of the tube was immersed in a cup of quicksilver, a little common air was let into the convex part of the curved end of the tube, with the view of preventing fracture from the electrical discharges.

The wire which passed through the sealed extremity was set in contact with a brass insulated ball; and this insulated ball was placed at a little distance from the prime conductor of the electrical machine. The wire of the lower or open extremity, immersed in quicksilver, communicated by a wire or chain with the exterior coated surface of a Leyden jar, which contained about a square foot of coating; and the ball of the jar was in contact with the prime conductor.

The electrical machine consisted of two plates of 31 inches in diameter, and similar to that of Teyler. It possessed the power of causing the jar to discharge itself 25 times in 15 revolutions. When the brass ball and that of the prime conductor were in contact, no air or gas was disengaged from the water by the electrical discharges; but on gradually increasing their distance from one another, the position was found in which gas was disengaged, and which ascended immediately to the top of the tube. By continuing the discharges, gas continued to be disengaged, and ascend, till it reached nearly to the lower extremity of the upper wire; and then a discharge occasioned the whole of the gas to disappear, a small portion excepted, and its place was consequently supplied by water. It forms a curious problem, whence does it happen that hydrogen and oxygen may either be chemically united or chemically decomposed by the same agent?

The residuary portion of gas being let out after each experiment, and the discharges being continued in the same water, this residuary gas was left in smaller and smaller quantity; so that after four experiments, probably made on the same day, it did not amount to more than 1-80th of the bulk of gas which had been produced. If it had been possible to pass electric sparks through this very small quantity of gas a second time, or oftener, it was supposed it would have been diminished still more. But when the tube had been left for a night only filled with water, the residuary gas was in greater quantity than after the last experiment the preceding day (U).

It was concluded that the gas produced by the electrical discharges was oxygen and hydrogen gas, from decompounded water:

1. Because no other gas hitherto known instantly disappears on passing through it an electric spark.

2. The gas obtained must have been the oxygen and hydrogen of decompounded water, because they were in exactly those proportions in which by combination they reproduce water; the trifling residue being considered to be merely a portion of air which had been dissolved in the water.

3. Liquids which are not compounded of hydrogen and oxygen, as sulphuric and nitric acids, afforded gas by the electric discharges, but which did not disappear on passing through it an electric spark; but which did disappear on adding to it nitrous gas over water. Mr Schurer also asserts, on the authority of Mr Van Troostwyk, that even liquid muriatic acid, which contains a very large proportion of water, affords hydrogen gas only, the oxygen being absorbed by the muriatic acid, and becoming oxymuriatic acid.

Dr Pearson repeated the above experiments; and has given an ample detail of the manner in which he conducted his experiments, and of their result. Our limits will not permit us to give the paper of this ingenious chemist at length: we shall therefore present our readers with a brief abstract of it, referring them for the original to Nicholson's Journal for September, October, and November 1797, or the Philosophical Transactions for the same year.

Dr Pearson remarks that electric discharges may be exployed in two manners to decompound water, viz. by what

---

(T) In another part of Mr Van Troostwyk's memoir, it is stated that the distance was an inch and a quarter from the end of the upper wire to the top of the lower wire; and that the distance between the insulated ball and prime conductor was at first three-fourths of an inch, but that afterwards it was increased to an inch. Although the wire fastened into the top of the tube was said to be an inch and a half in length, it is observed, that when a column of three-eighths of an inch of air was collected, it was almost at the extremity of the upper wire. From these and other inaccuracies, it will be made appear, that no one, from the account published, has been able to repeat the experiment.

(U) In at least fifty experiments I have never seen the residue of gas less than one-fortieth of the gas produced, although the water had been freed from air by the most effectual means. But Mr Schurer (Annales de Chimie, tom. v. p. 276.) testifies that he saw Mr Van Troostwyk make the experiment; and that after it was repeated many times, on the same parcel of water, there was no residue at all. I have very good grounds for believing, that this is one of the number of inaccuracies in the account published of this subject.

what has been termed the *interrupted* explosion, which was Mr Van Troostwyk's method, and the *uninterrupted* or *complete* explosion.

The Doctor lays down the following requisites for succeeding in this experiment by the *interrupted* explosion.

1. *The electrical machine must possess sufficient power.* Dr Pearson employed a plate machine, constructed by Cuthbertson, which he considers as preferable to a cylindrical machine.

2. *The Leyden jar must have a sufficient quantity of coated surface.* The Doctor found by experience that the proper quantity was about 150 or 160 square inches, with a proportional prime conductor.

3. *The distance between the insulated ball and the prime conductor must always be less than the distance between the extremities of the wires.*

4. *The extremities of the upper and under wire within the tube must be at a certain distance from one another.* The distance which the Doctor generally found to answer best, was about five-eighths or seven-eighths of an inch.

5. *The upper wire fixed into the closed extremity of the tube must be of a proper length and thickness.* The diameter of the upper wire cannot perhaps be too small, and the smaller the diameter of the tube, the longer this wire may be.

6. *The tubes must be of a proper length and diameter.* The Doctor found the proper length to be nine or ten inches, exclusive of the curved part. The diameter should not be more than one-eighth, or less than one-twelfth of an inch.

To succeed by the *complete* or *uninterrupted explosion*, Dr Pearson used the following apparatus.

1. A tube about four or five inches in length, and one-fifth or one-sixth of an inch in diameter; one end of which was mounted with a brass cap, and into the other, which was hermetically sealed, was fitted a *platinum* wire of about 1-40th of an inch in diameter, extending into the brass cap, so as to be *almost* in contact with it.

2. He also employed a tube five inches long and half an inch wide, either blown into a funnel at one end, or having a brass funnel fitted to it, and inverted in a brass dish; a wire, such as the last, is sealed into the other end, and nearly touches the brass dish.

The proper distance between the wire and dish must be found by trials. In the Doctor's experiments it was about one-twentieth of an inch.

3. The Leyden jar employed must contain about 150 square inches of coating.

4. The distance between the insulated ball and the prime conductor was about half an inch.

From his experiments Dr Pearson draws the following conclusions.

The mere concussion by the electric discharges, appears to extricate not only the air dissolved in water, which can be separated from it by boiling and the air-pump, but also that which remains in water, notwithstanding these means of extricating it have been employed.

The quantity of this air varies in the same, and in different waters, according to circumstances. New-River water from the cistern yielded one-fifth of its bulk of air, when placed by Mr Cuthbertson under the receiver of his most powerful air-pump; but in the same situation, New-River water taken from a tub exposed to the atmosphere for some time yielded its own bulk of air. Hence the gas procured by the first one, two, or even three hundred explosions in water containing its natural quantity of air, diminished very little by an electric spark.

The gas thus separated from water, like atmospherical air, consists of oxygen and nitrogen, or azotic gas; which may be in exactly the same proportions as in atmospherical air: for the water may retain one kind of gas more tenaciously than the other; and on this account the air separated may be better or worse than atmospherical air at different periods of the process for extricating it.

With regard to the gas, which instantly disappears on passing through it an electric spark, its nature is shewn by (*a*) this very property of thus diminishing; and by the following properties:

(*b*) A certain quantity of nitrous gas instantly disappeared, apparently composing nitrous acid, on being added to the gas (*a*).

Oxygen gas being added to the residue after saturation with nitrous gas, and an electric spark being applied to the mixture of gasses, well dried, a considerable diminution immediately took place, and water was produced.

(*c*) Combustion from hydrogen and oxygen gas took place when the tube was about three-fourths full of gas, which was confirmed by passing an electric discharge, under the same circumstances, through a mixture of hydrogen and oxygen gas.

(*d*) Combustion from hydrogen and oxygen gas took place when the points of the compasses were accidentally applied to the part of the tube containing gas; which was confirmed by passing a discharge, under the same circumstances, through a mixture of hydrogen and oxygen gas, while the points of the compasses were applied to the tube.

(*e*) The observations made of the kindling of gas, in small quantities, from time to time, during the process of obtaining it, particularly while it was descending in chains of bubbles, or was adhering to the funnel of the tube, confirm the evidence in favour of this gas being hydrogen and oxygen gas.

By Dr Wollaston's improvement on the method of conducting such experiments, they are now greatly facilitated. Two very fine wires of gold or platinum are inserted in capillary tubes; one extremity of each is previously pointed as fine as possible, and being introduced within the capillary tube to a short distance from its end, the glass is softened by heat till it adheres to the point and covers it. The glass is then gradually ground down till the point of the wire is just uncovered. By confining thus the action of the electricity to a single point, this arrangement prevents the diminution of intensity which would otherwise ensue.

171
Fusion of metals by the electric spark.

The electric spark fuses and oxidates metals. The first experiment to ascertain the action of electricity on metals was, we believe, made by Dr Franklin. The method in which he made the spark fuse metals was by putting thin pieces of them between two panes of glass bound fast together, and sending an electric shock through them. Sometimes the piece of glass by which they were confined, would be shattered to pieces by the discharge,

Principles of Electricity illustrated by experiment.

discharge, and be broken into a kind of coarse sand, which once happened with pieces of thick looking-glass; but if they remained whole, the piece of metal would be missing in several places where it had lain between them, and instead of it, a metallic stain would be seen on both the glasses, the stains on the under and upper glass being exactly similar in the minutest stroke.

A piece of gold-leaf used in this manner appeared not only to have been melted, but even vitrified, as the Doctor thought, or otherwise so driven into the pores of the glass, as to be protected by it from the action of the strongest nitro-muriatic acid. Sometimes he observed that the metallic stains would spread a little wider than the breadth of the thin pieces of metal. True gold, he observed, made a darker stain, somewhat reddish, and silver a greenish stain.

Mr Cavallo gives the following directions for fusing metallic wires.

Connect with the hook, communicating with the outside coating of a battery, containing at least thirty square feet of coated surface, a wire, that is about one-fiftieth part of an inch thick, and about two feet long; the other end of it must be fastened to one end of the discharging rod; this done, charge the battery, and then by bringing the discharging rod near its wires, send the explosion through the small wire, which, by this means, will be made red hot, and melted, so as to fall upon the floor in different glowing pieces. When a wire is melted in this manner, sparks are frequently seen at a considerable distance from it, which are red-hot particles of the metal, that by the violence of the explosion are scattered in all directions. If the force of the battery is very great, the wire will be entirely dispersed by the explosion, so that none of it can afterwards be found.

By repeating this experiment with wires of different metals, and the same force of explosion, it will be found that some metals are more readily fused than others, and some not at all affected; which shows the difference of their conducting power. If it be required to melt such particles of metals, that cannot easily be drawn in wires, as ores, grains of platinum, &c. they may be set in a train upon a piece of wax; this train may be inserted in the circuit, and an explosion may be sent through it, which, if it be sufficiently strong, will melt the metallic particles, as well as the wires: or, if the quantity to be tried be large enough, it may be confined in a small tube of glass.

If a wire be stretched by weights, and a shock be made to pass through it, so as to render it just red hot, the wire after the explosion will be found considerably increased in length; but if the wire be left loose, it will be found after a similar explosion considerably shortened *.

If a wire be melted upon a piece of glass, the glass will after the explosion be found marked with all the prismatic colours.

The wire may be formed into globules by inclosing it in a glass tube about a quarter of an inch in diameter, and sending the charge of a battery through it. The wire thus melted, will run into globules, which will adhere to the inner surface of the tube, and may be easily separated from it. On examination they will be found to be hollow, and are the metal in its least state of oxidation.

Some nicety is required in this experiment, as, if the charge be too small, the globule will not be well formed, and if it be too great, the metal will be so much oxidated as to be dissipated in smoke.

Principl of Elect city illu trated b experime

If a flat piece of metal be fixed upon each of the knobs of the universal discharger, or upon the extremities of the wires that support these knobs, so that their surfaces may come sufficiently near each other for the charge of a battery to be passed between them, and if a discharge be then made, a spot and coloured circles will be formed upon each metallic surface, which are evidently owing to a partial oxidation of the metal.

In order to exhibit coloured rings upon the surface of metals, place a plain piece of any of the metals upon one of the wires of the universal discharger, and upon the other wire fix a sharp-pointed needle, with the point just opposite to the surface of the metal; then connect one wire of the discharger with the outside of a battery, and the other with the discharging rod, &c. In this manner, if explosions be repeatedly sent either from the point to the piece of metal, or from the latter to the former, they will gradually mark the surface of the piece of metal opposite to the point, with circles, consisting of all the prismatic colours; which are evidently occasioned by laminæ of the metal, raised by the force of the explosions.

These colours appear sooner, and the rings are closer to one another, when the point is nearer to the surface of the metal. The number of rings is greater or less, according as the point of the needle is more sharp or more blunt; and they are represented equally well upon any of the metals.

The point of the needle is also coloured to a considerable distance; the colours upon it returning in circles, though not very distinctly. This is an experiment of Dr Priestley.

172 Van M rum's ex perimen on fusin metals.

But the most splendid experiments on the fusion of metals by electricity have been made by Dr Van Marum. He first tried the effect of a battery containing 130 square feet of coated surface. With this extraordinary power, he melted an iron wire 15 feet long and $\frac{1}{151}$ of an inch in diameter; and another time melted a wire of the same metal 25 feet long and $\frac{1}{240}$th of an inch in diameter.

He afterwards added to the battery 90 jars, each of the same size with the former, so that his grand battery now formed a square of 15 feet, and contained 225 square feet of coated glass. He caused wires of different metals to be drawn through the same hole, of one-thirty-eighth part of an inch in diameter, and observed how many inches of each could be melted by the explosion of his battery; taking care in all these experiments to charge it to the same degree as ascertained by his electrometer. The results were as follows:

Of *lead* be melted	120 inches
Of *tin*	120
Of *iron*	5
Of *gold*	$3\frac{1}{2}$
Of *silver*, *copper*, *brass*, not quite a quarter of an inch.	

These several lengths of wire, of the same diameter, melted by equal explosions, indicate, according to our author, the degree in which each metal is fusible by the electrical discharge; and if these be compared with the fusibility of the same metals by fire, a very considerable

---

* Cavallo's Electricity, vol. i. p. 318.

Principles of Electricity illustrated by experiment.

able difference will be observed. According to the experiments of the academicians of Dijon, to melt tin required a heat of 172 degrees of Reaumur's thermometer.

Lead	230
Silver	430
Gold	563
Copper	630
Iron	696 (x).

Thus tin and lead appear to be equally fusible by electricity, but not by fire: and iron, which by fire is less fusible than gold, is much more so by the electrical explosion.

When iron wire is melted by the explosion of the battery, the red-hot globules are thrown to a very considerable distance, sometimes to that of 30 feet; it is however remarkable, that the thicker the wire is which is melted, the further are the globules dispersed; but this is accounted for, by observing that the globules formed by the fusion of the thinner wires, being smaller, are less able to overcome the resistance of the air, and are therefore sooner stopped in their motion.

Two pieces of iron wire being tied together, the fusion extended no further than from the end connected with the inside coating of the jars to the knot; though wire of the same length and thickness, when in one continued piece, had been entirely melted by an equal explosion. The action of electricity in the fusion of metallic wires, increases in the ratio of the square of the increased power. Two jars, charged to any degree, melt four times the length of wire that is melted by one jar. This law varies when any considerable difference exists in the thickness of the jars employed, as thick jars display the same intensity with a comparatively small quantity of electricity.

When a wire was too long to be melted by the discharge of the battery, it was sometimes broken into several pieces, the extremities of which bore evident marks of fusion; and the effect of electricity in shortening wire, was very sensible in an experiment made on 18 inches of iron wire $\frac{1}{55}$th of an inch in diameter, which by one discharge lost a quarter of an inch of its length. An explosion of this battery through very small wires, of nearly the greatest length that could be melted by it, did not entirely discharge the jars. On transmitting the charge through 50 feet of iron wire of $\frac{1}{240}$th of an inch in diameter, the doctor found that the residuum was sufficient to melt two feet of the same wire; but this residuum was much less when the wire was of too great a length to be melted at the first discharge. After an explosion of the battery through 180 feet of iron wire of equal diameter with the former, the residuum was discharged through 12 inches of the same wire which it did not melt, but only blued.

Principles of Electricity illustrated by experiment.

Twenty-four inches of leaden wire $\frac{1}{38}$th of an inch in diameter, were entirely oxidated by an explosion of this battery; the greater part of the lead rose in a thick smoke, the remainder was struck down upon a paper laid beneath it, where it formed a stain which resembled the painting of a very dark cloud. When shorter wires were oxidated, the colours were more varied. In Dr Van Marum's work a plate is given of a stain made by the oxidation of this wire, in which the cloud appears variously shaded with different tints of green, gray, and brown, in a manner of which no adequate description can give an idea.

On discharging the battery through 8 inches of tin wire $\frac{1}{38}$th of an inch in diameter, extended over a sheet of paper, a thick cloud of blue smoke arose, in which a number of filaments of oxide of tin were discernible; at the same time a great number of red-hot globules of tin, falling upon the paper, were repeatedly thrown up again into the air, and continued thus to rebound from its surface for several seconds. The paper was marked with a yellowish clouded stain immediately under the wire, and with streaks or rays of the same colour issuing from it in every direction; some of these formed an uninterrupted line, others were made up of separate spots. In order to be certain that the colour of these streaks was not caused by the paper being scorched, the experiment was several times repeated, when a plate of glass and a board covered with tin were placed to receive the globules. These, however, were stained exactly like the paper. On oxidating five inches of the same kind of wire, the red-hot globules were thrown obliquely to the height of four feet, which afforded an opportunity of observing that each globule, in its course, diffused a matter like smoke, which continued to appear for a little time in the parabolic line described by its flight, forming a track in the air of about half an inch in breadth.

Dr Van Marum attributes the clouded stain, immediately under the wire, to the instantaneous oxidation of its surface; whereas the remainder of the metal is melted into globules, which, while they retain their glowing heat, continue to be superficially oxidated, and during the process, part with this oxide in the form of vapour.

Phenomena something similar to the above, were observed on the oxidation of a wire of equal parts of tin and lead, eight inches long, and $\frac{1}{32}$d of an inch in diameter. This also was melted into red globules, which were repeatedly driven upwards again from the paper on which they fell, and marked it with streaks of the same kind, but of a brown colour, edged with a yellow tinge. Some of these globules, though apparently not less hot, moved with less velocity than others, and were soon stopped in their course by their burning a

---

(x) According to the experiments of Mr Wedgwood with his pyrometer, the following are the degrees of heat, computed in degrees of Fahrenheit's scale, that are required to fuse certain metals.

Brass	3807°	
Swedish copper	4587	
Fine silver	4717	
Fine gold	5237	
Cast iron	39977	*Vid. Phil. Trans.* vol. lxxii.

Principles of Electricity illustrated by experiment.

a hole in the paper. In this case a yellow matter was seen to rise from their surface to the height of one or two lines, and extended itself to the width of a quarter of an inch. This matter continued during five or six seconds to issue from the globules, and formed on their surface a kind of efflorescence, resembling the flowers of sulphur produced by the *solfa-terra*. The globules, from which this efflorescence had issued, were found to be entirely hollow, and to consist only of a thin shell. When this mixed metal is oxidated with a less charge of battery, it leaves a stain upon the paper, something similar to that made by lead, and does not run into globules.

Dr Van Marum has also given plates of the stains made upon paper by the oxidation of iron, copper, brass, silver, and gold. Those made by copper and brass wire, are commonly beautiful, and are variegated with yellow, green, and a very bright brown. Eight inches of gold wire, of $\frac{1}{60}$th of an inch diameter, were, by the explosion, reduced to a purple substance, of which a part rose like a thick smoke, and the remainder on the paper left a stain diversified with different shades of this colour. Gold, silver, and copper, cannot easily be melted into globules. Our author has once accidentally succeeded in this; but it required a degree of electrical force so very particular, that the medium between a charge, which only broke the wire into pieces, and one which entirely oxidated it, could not be ascertained by the electrometer.

Dr Van Marum found, as might be expected, that the electric spark did not oxidate metals when confined in any gas which did not contain oxygen. On exposing wires of lead, tin, and iron, to the electric spark from the discharge of a battery, while the metals were confined in air deprived of oxygen, by the burning of inflammable bodies in it, he found that the first was reduced to a fine powder, which upon trial with nitric acid appeared to be merely lead; the two other metals were melted into small globules. He found that in general metals were not more highly oxidated in pure oxygenous gas than in common air, except that lead was reduced to a fine yellow oxide, perfectly resembling massicot.

In nitrous gas, oxidation took place as easily as in common air or in oxygenous gas.

His method of making these experiments was as follows. He confined the gas in which he was to subject the metal to the explosion, in a glass cylinder six inches high and four inches in diameter, closed at the upper end with a brass plate; from the centre of this plate was suspended the wire on which the experiment was made. The cylinder was set in a pewter dish filled with water; and to prevent its being broken by the expansion of the air, its lower edges were supported by two pieces of wood half an inch high. The lower end of the wire rested on the dish, which was connected with the outside coating of the battery.

On submitting metallic wires to the action of the electric spark while confined in water, he found that the water was decomposed, the metal being oxidated, and a portion of impure hydrogenous gas being disengaged.

Although there was good reason to suppose that the powders produced in the above experiments were real oxides of the metals, yet they had not been proved to be so by any satisfactory evidence, till Mr Cuthbertson carried into execution a series of experiments, by which he has fully proved that metals exploded by the electric spark absorb oxygen from the air, and become oxidated, more readily than when fused by ordinary fire. They are published at length in Nicholson's Journal for July 1801.

The electric discharge was made to act on metals inclosed within a limited quantity of atmospheric air or oxygenous gas, and the changes produced on the gas were accurately examined. When no oxygen was present, the metals were simply fused. When in contact with oxygen, they were converted into oxides of various colours, and the oxygen suffered diminution. When the wire operated on lies on the surface of a plate of glass, a mark is left in the direction of the wire, consisting of a line of pure metal nicely comminuted with a more diffused colour on each side, consisting of the oxide. A beautiful figure is also produced on a surface of paper, and the colours differ from those of oxides produced in the air without the vicinity of such a surface. Mr Singer gives the following view of the results of similar experiments made with a moderate electrical discharge. The length of wire exploded in each experiment was five inches. This table exhibits, in one column, the thickness of the wire in fractions of an inch; in another the number of grains with which the electrometer was loaded; and in another the colour of the figures on paper.

Gold wire	$\frac{1}{180}$	18	Purple and brown.
Silver wire	$\frac{1}{160}$	18	Grey, brown, and green.
Platinum	$\frac{1}{180}$	13	Grey and light brown.
Copper	$\frac{1}{160}$	12	Green, yellow, and brown.
Iron	$\frac{1}{180}$	12	Light brown.
Tin	$\frac{1}{180}$	11	Yellow and grey.
Zinc	$\frac{1}{180}$	17	Dark brown.
Lead	$\frac{1}{180}$	10	Brown and blue grey.
Brass	$\frac{1}{180}$	12	Purple and brown.

The following are Mr Cuthberton's general conclusions:

"From the result of the foregoing experiments, it may be safely concluded that all the ductile metals can by electric discharges be sublimed and converted into proper oxides, by absorbing the oxygen from the atmosphere; and although some of the metals resist the action of common fire, and require different solvents to convert them into oxides, yet they all yield to the action of electricity.

"It is remarkable that platinum, though it resists the action of common fire, is more easily fused by electric discharges than copper, silver, or gold, and seems to be as greedy of oxygen as any of the other metals; but these experiments have not been sufficiently extensive to settle the last-mentioned property.

"It is well known that all metals which are sublimable by common fire, absorb oxygen in different degrees, and likewise in different proportions, according to the degrees of heat employed; this seems to take place also when they are sublimed by electric discharges, but the proper degree of discharge for each metal remains for investigation."

The oxides thus produced consist of several distinct portions, of different degrees of fineness. When a wire is rinciples f Electri- ity illus- rated by xperiment.

is exploded in a receiver, part of the oxide immediately falls to the bottom; but another portion remains suspended in the air for a time, and is then gradually deposited. The difference of colour in a receiver, and in the open atmosphere, may arise from a portion of it being in the latter case always lost.

173 o burn ire in ygen gas.

Exper.—To burn a metallic wire in oxygen gas, by the electric spark.

The apparatus for this experiment is represented at fig. 55. It consists of a glass jar for holding the gas, fitted to the bottom C, so that it may easily be taken out. Into the bottom is fastened a brass knob B, and a wire passes through the top of the jar furnished with a ball at A, and a knob within the jar as D, into which the piece of wire, twisted in a spiral form, is to be inserted.

The jar, thus fitted up with the wire, is to be filled with oxygen gas; and on passing the charge of a small Leyden phial through the wire A, an explosion will take place between the knob B, and the extremity of the small wire, by which this will be inflamed, producing a most brilliant and beautiful appearance. It is only the first explosion kindling the iron that forms the electrical part of the experiment. The combustion is purely chemical, being exactly the same that takes place when the wire is kindled by means of tinder.

174 *When the electric spark is passed through a metallic oxide, the oxide is reduced to a metallic state.*

eccaria ttre dell' ettri- ma.

This was effected by Sign. Beccaria, by making the spark pass between two surfaces of the oxide. In this way he reduced several of the metallic oxides, among others, that of zinc. He also obtained pure mercury, from the red sulphuret or cinnabar †. This may be done by the charge of a very moderate sized jar.

175 illumi- e water.

The electric spark renders bodies luminous, and makes opaque substances appear transparent.

Exper. 1.—Connect one end of a chain with the outside of a charged phial, and let the other end lie on the table. Place the end of another piece of chain at the distance of about a quarter of an inch from the former; and set a glass decanter of water on these separated ends. On making the discharge, the water will appear perfectly luminous.

The electric spark may be rendered visible in water, in the following manner. Take a glass tube of about half an inch diameter, and six inches long; fill it with water, and to each extremity of the tube adapt a cork, which may confine the water; through each cork insert a blunt wire, so that the extremities of the wires within the tube may be very near one another; then on connecting one of these wires with the coating of a small charged phial, and touching the other wire with the knob of it; by which means the shock will pass through the wires, and cause a vivid spark to appear between their extremities within the tube. The charge in this experiment must be very weak, or there will be danger of bursting the tube.

176 illumi- eggs. late XC. . 56.

Exper. 2.—Fig. 56. represents a mahogany stand, so constructed as to hold three eggs at greater or smaller distance, according to the position of the sliding pieces. A chain C is placed at the bottom in such a manner as to touch the bottom of the egg at B with one end, and with its other, the outside coating of a charged jar. The sliding wire A at top is made to touch the upper egg; and the distance of the eggs asunder should not exceed the quarter or eighth part of an inch. The electric spark, being made to pass down by means of the discharging rod through the wire and ball at A, will in a darkened room render the eggs very luminous and transparent.

Principles of Electricity illustrated by experiment.

177

Exper. 3.—Place an ivory ball on the prime conductor of the machine, and take a strong spark, or send the charge of a Leyden phial through its centre, and the ball will appear perfectly luminous: but if the charge be not passed through the centre, it will pass over the surface of the ball and singe it. A spark made to pass through a ball of boxwood, not only illuminates the whole, but makes it appear of a beautiful crimson, or rather fine scarlet colour.

If the same experiment be performed with a piece of pine deal, and the one wire have its point sunk deeper than the other, different colours appear between the points, arising from the different thickness of substance through which the light is transmitted to the eye.

Even good conductors are rendered luminous, by the passage of electricity through them, provided they have sufficient tenuity.

Exper. 4.—If sparks are passed through a silver thread two or three yards long, the one extremity being fixed to a large brass ball placed near to the prime conductor, and the other held in the hand, the whole thread appears faintly luminous.

Gold-leaf or Dutch metal may be rendered luminous by discharging a small Leyden phial through it. A strip of gold-leaf, one-eighth of an inch in breadth, and a yard long, will frequently be illuminated throughout its whole extent, by the explosion of a jar containing two gallons. This experiment may be beautifully diversified, by laying the gold or silver leaf on a piece of glass, and then placing the glass in water; for the whole gold-leaf will appear most brilliantly luminous in the water, by exposing it thus circumstanced to the explosion of a battery.

178 To illuminate Canton's phosphorus.

Exper. 5.—The natural, or, what answers better, the artificial Bolognian stone reduced to powder, (commonly called *Canton's phosphorus*) may be illuminated by the electric spark in a more perfect manner than by the rays of the sun. The method of making this experiment is thus related by Mr Cavallo.

Put some of this powder in a clear glass phial, and stop it with a glass stopper, or a cork and sealing-wax. If this phial be kept in a darkened room (which for this experiment must be very dark) it will give no light; but let two or three strong sparks be drawn from the prime conductor, when the phial is kept at about two inches distant from the sparks, so that it may be exposed to that light, and this phial will receive the light, and afterwards will appear illuminated for a considerable time.

This powder may be stuck upon a board by means of the white of an egg, so as to represent figures of planets, letters, or any thing else, at the pleasure of the operator; and these figures may be illuminated in the dark, in the same manner as the above-described phial.

A beautiful method of expressing geometrical figures with the above powder, is to bend small glass tubes, of about the tenth part of an inch diameter, in the shape of the figure desired, and then to fill them with the phosphoric

phosphoric powder. These may be illuminated in the manner described; and they are not so subject to be spoiled, as the figures represented upon the board frequently are.

The best method of illuminating this phosphorus, and that Mr W. Canton generally used, is to discharge a small electric jar near it.

Paper, after being made dry and rather hot, marble, oyster shells, and most calcareous substances, especially when burned to lime, have the property of being illuminated by the light given by the discharge of a jar, though not so much as the above-mentioned powder.

Put the extremities of two wires upon the surface of a card, or other body of an electric nature, so that they may be in one direction, and about one inch distance from one another; then, by connecting one of the wires with the outside of a charged jar, and the other wire with the knob of the jar, the shock will be made to pass over the card or other body. If the card be made very dry, the lucid track between the wires will be visible upon the card for a considerable time after the explosion. If a piece of common writing paper be used instead of the card, it will be torn by the explosion into very small bits. This experiment may also be performed on the surface of a piece of dry chalk.

When the electric discharge is passed through a lump of sugar, the sugar is rendered perfectly luminous, and will retain the light for a considerable time.

The following tabular view of the effects of the electrical discharge, in producing phosphorescence, with the colour of the light which appears, is given by Mr Singer.

Native sulphate of barytes,	Bright green light.
Native carbonate of barytes,	Do. less brilliant.
Dry acetate of potash,	Brilliant green.
Succinic acid,	Do. more durable.
Loaf sugar,	Do.
Selenite,	Do. but transient.
Calcined oyster shells,	Prismatic colours.
Do. calcined with sulphur,	Durable and bright light.
Rock crystal,	First red, then white.
Quartz,	Dull white.
Borax,	Faint green.
Boracic acid,	Bright green.

179 *Exper.* 6.—But the most remarkable instance of the penetrating power of the electric light, is that related by Dr Priestley. "I laid a chain (says he), which was in contact with the outside of a jar, lightly on my finger, and sometimes kept it at a small distance by means of a thin piece of glass. If I made the discharge at the distance of about three inches, the electric fire was visible on the surface of the finger, giving it a sudden concussion, which seemed to make it vibrate to the very bone; and when it happened to pass on that side of the finger that was opposite the eye, the whole seemed, in the dark, perfectly transparent."

The following is Mr Cavallo's method of making this curious experiment.

Let the extremities of two wires, one of which proceeds from the outside of a charged jar, and another from one branch of the discharging rod, be laid on a table at the distance of one-tenth of an inch from each other; then put the thumb just upon that interruption, pressing it flat down. This done, bring the discharging rod in contact with the knob of the jar, and on making the discharge, the spark which necessarily happens under the thumb will illuminate it in such a manner that the bone and the principal blood-vessels may be easily discerned in it.

In this experiment the operator need not be afraid of receiving a shock; for the discharge of the jar passes from wire to wire, and only affects the thumb with a sort of tremor, which is far from painful.

We have before related Mr Hawkesbee's experiment by which he rendered sealing-wax transparent. Signior Beccaria effected the same by making an electric explosion pass between two plates of sealing-wax, on which some brass-dust was sprinkled. The whole was rendered perfectly luminous and transparent.

180 Spiral tube. Fig. 57.

Exper. 7.—Fig. 57. represents an instrument composed of two glass tubes CD, one within another, and inclosed with two knobbed brass caps A and B. The innermost of these has a spiral row of small round pieces of tin-foil stuck upon its outside surface, and lying at about one-thirtieth of an inch from each other. If this instrument be held by one of the extremities, and its other extremity be presented to the prime conductor, every spark that it receives from the prime conductor will cause small sparks to appear between all the round pieces of tin-foil stuck upon the innermost tube; which in the dark affords a pleasing spectacle, the tube appearing encompassed by a spiral line of fire.

Fig. 58.

Fig. 58. represents several spiral tubes placed round a board, in the middle of which is screwed a glass pillar, and on the top of this pillar is cemented a brass cap with a fine steel point. In this a brass wire turns having a brass ball at each end, nicely balanced on the wire. To make use of this apparatus, place the middle of the turning wire under a ball proceeding from the conductor, so that it may receive a succession of sparks from the ball; then push the wire gently round; and the balls in their relative motions will give a spark to each tube, and thereby illuminate them down to the board, which from its brilliancy and rapid motion, affords a most beautiful and pleasing sight.

181 Luminous word. Fig. 59.

Exper. 8.—The small pieces of tin-foil may be stuck on a flat piece of glass ABCD, fig. 59. so as to represent various fanciful figures. Upon the same principle is the word LIGHT produced, in luminous characters.

Fig. 60.

It is formed by the small separations of the tin-foil pasted on a piece of glass fixed in a frame of baked wood, as represented fig. 60. To use this, the frame must be held in the hand, and the ball G presented to the conductor. The spark then will be exhibited in the intervals composing the word; from whence it passes to the hook at *h*, and thence to the ground by a chain. The brilliancy of this is equal to that of the spiral tubes.

Though many of the following experiments on electric light, may not with strict propriety belong to this chapter, we shall relate them here for the sake of uniformity.

182 Morgan's propositions on electric light.

Mr G. Morgan, in the Philosophical Transactions for 1758, has given a series of propositions respecting the electric light, and illustrated them by experiments. We shall here give the substance of his paper nearly in his own words.

I.

rinciples Electri- y illus- ated by eriment.

I. There is no fluid or solid body, in its passage through which the electric light may not be rendered luminous.

This proposition has been fully illustrated by the foregoing experiments.

183 II. The difficulty of making any quantity of the electrical light visible in any body, increases as the conducting power of that body increases.

Exper. 1.—In order to make the contents of a jar luminous in boiling water, a much higher charge is necessary, than would be sufficient to make it luminous in cold water, which is universally allowed to be the worst conductor.

Exper. 2.—There are various reasons for believing the acids to be very good conductors; if, therefore, into a tube filled with water, and circumstanced as has been already described, a few drops of either of the mineral acids are poured, it will be almost impossible to make the light visible in its passage through the tube.

Exper. 3.—If a string, whose diameter is one-eighth of an inch, and whose length is six or eight inches, is moistened with water, the contents of a jar will pass through it luminously; but no such appearance can be produced by any charge of the same jar, provided the same string be moistened with one of the mineral acids. To the preceding instance we may add the various instances of metals which will conduct the electric power without any appearance of light, in circumstances the same with those in which the same force would have appeared luminous in passing through other bodies, whose conducting power is less.

84 III. That the ease with which the electric light is rendered visible in any particular body, is increased by increasing the rarity of the body. The appearance of a spark, or of the discharge of a Leyden phial, in rarefied air, is well known. But we need not rest the truth of the preceding observation on the several varieties of this fact; similar phenomena attend the rarefaction of ether, of spirits of wine, and of water.

Exper. 4.—Into the orifice of a tube, 48 inches long, and two-thirds of an inch in diameter, cement an iron ball, so as to bear the weight which presses upon it when the tube is filled with quicksilver, leaving only an interval at the open end, which contained a few drops of water. Having inverted the tube, and plunged the open end of it into a bason of mercury, the mercury in the tube stood nearly half an inch lower than it did in a barometer at the same instant, owing to the vapour which was formed by the water. But through this rarefied water, the electrical spark passed as luminously as it does through air equally rarefied.

Exper. 5.—If, instead of water, a few drops of spirits of wine are placed on the surface of the mercury, phenomena, similar to those of the preceding experiment, will be discovered, with this difference only, that as the vapour in this case is more dense, the electrical spark, in its passage through it, is not quite so luminous as it is in the vapour of water.

Exper. 6.—Good ether, substituted in the room of the spirits of wine, will press the mercury down so low as the height of 16 or 17 inches. The electric spark, in passing through this vapour, (unless the force be very great indeed), is scarcely luminous; but if the pressure on the surface of the mercury in the bason, be gradually lessened by the aid of an air-pump, the vapour will become more and more rare, and the electric spark, in passing through it, more and more luminous.

Principles of Electricity illustrated by experiment.

Exper. 7.—It has not been discovered, that any vapour does escape from the mineral acids, when exposed in vacuo. To give them, therefore, greater rarity or tenuity, different methods are found necessary. With a fine camel-hair pencil, dipped in the sulphuric, the nitric, or the muriatic acid, draw upon a piece of glass a line, about one-eighth of an inch broad. In some instances, you must extend this line to the length of 27 inches, and you will find that the contents of an electric battery, consisting of ten pint phials coated, will pass over the whole length of this line with the greatest brilliancy. If, by widening the line, or by laying on a drop of the acid, its quantity be increased in any particular part, the charge, in passing through that part, will not appear luminous. Water, spirits of wine, circumstanced similarly to the acids in the preceding experiments, will be attended with similar, but not equal effects; because, in consequence of the inferiority of their conducting power, it will be necessary to make the line, through which the charge passes, considerably shorter.

IV. The brilliancy or splendour of the electric light, in its passage through any body, is always increased by lessening the dimensions of that body; that is, a spark, or the discharge of a battery, which we might suppose equal to a sphere one quarter of an inch in diameter, will appear much more brilliant, if the same quantity is compressed into a sphere one-eighth of an inch in diameter. This observation is the obvious consequence of many known facts; if the machine be large enough to afford a spark, whose length is nine or ten inches, this spark may be seen sometimes forming itself into a brush, in which state it occupies more room, but appears very faintly luminous: at other times, the same spark may be seen dividing itself into a variety of ramifications, which shoot into the surrounding air. A spark, which in the open air cannot exceed one quarter of an inch in diameter, will appear to fill the whole of an exhausted receiver, four inches wide and eight inches long: but in the former case it is brilliant, and in the latter it grows fainter and fainter, as the size of the receiver increases. This observation is further proved by the following experiments. 185

Exper. 8.—To an insulated ball, four inches in diameter, fix a silver thread, about four yards long. This thread, at the end which is remotest from the ball, must be fixed to another insulated substance. Bring the ball within the striking distance of a conductor, and the spark, in passing from the conductor to the ball, will appear very brilliant; the whole length of the silver thread will appear faintly luminous at the same instant. When the spark is confined within the dimensions of a sphere, one-eighth of an inch in diameter, it will be bright; but when diffused over the surface of air which received it from the thread, its light will be so faint as to be seen only in a dark room. If you lessen the surface of air which receives the spark, by shortening the thread, it will not fail to increase the brightness of the appearance.

Exper. 9.—To prove that the faintness of the electric light in vacuo, depends on the enlarged dimensions of the space through which it is diffused; we have nothing more to do than to introduce two pointed wires

Principles of Electricity illustrated by experiment.

into the vacuum, so that the fluid may pass from the point of the one to the point of the other; when the distance between them is not more than the one-tenth of an inch, in this case we shall find a brilliancy as great as in the open air.

Exper. 10.—Into a Torricellian vacuum, 36 inches long, convey as much air as will fill two inches only of the exhausted tube if it were inverted in water; this quantity of air will afford resistance enough to condense the light, as it passes through the tube, into a spark 38 inches in length. The brilliancy of the spark in condensed air, in water, and in all substances through which it passes with difficulty, depends on principles similar to those which account for the preceding facts.

186 V. That in the appearances of electricity, as well as in those of burning bodies, there are cases in which all the rays of light do not escape; and that the most refrangible rays are those which escape first or most easily. The electrical brush is always of a purple or bluish hue. If you convey a spark through a Torricellian vacuum, made without boiling the mercury in the tube, the brush will display the indigo rays. The spark, however, may be divided and weakened, even in the open air, so as to yield the most refrangible rays only.

Exper. 11.—To an insulated metallic ball, four inches in diameter, fix a wire a foot and a half long; this wire should terminate in four ramifications, each of which must be fixed to a metallic ball half an inch in diameter, and placed at an equal distance from a metallic plate, which must be communicated by metallic conductors with the ground. A powerful spark, after falling on the large ball at one extremity of the wire, will be divided in its passage from the four small balls to the metallic plate. When you examine the division of the spark in a dark room, you will discover some little ramifications, which will yield the indigo rays only: indeed at the edges of all weak sparks the same purple appearance may be discovered. You may likewise observe, that the nearer you approach the centre of the spark, the greater is the brilliancy of its colour.

187 VI. That the influence of different media on electrical light, is analogous to their influence on solar light. Viewed, for example, through a prism, it exhibits all the prismatic colours. This property will help us to account for some very singular appearances.

Exper. 12.—Let a pointed wire, having a metallic ball fixed to one of its extremities, be forced obliquely into a piece of wood, so as to make a small angle with the surface of the wood, and to make the point lie above one-eighth of an inch below the surface. Let another pointed wire, which communicates with the ground, be forced in the same manner into the same wood, so that its point likewise may lie about one-eighth of an inch below the surface, and about two inches distant from the point of the first wire. Let the wood be insulated, and a strong spark, which strikes on the metallic ball will force its passage through the interval of wood which lies between the points, and appear as red as blood. To prove that this appearance depends on the wood's absorption of all the rays but the red; when these points were deepest below the surface, the red only came to the eye through a prism; when they were raised a little nearer the surface, the red and orange appeared; when nearer still, the yellow; and so on, till, by making the spark pass through the wood very near its surface, all the rays were at length able to reach the eye. If the points be only one-eighth of an inch below the surface of soft deal wood, the red, the orange, and the yellow rays will appear as the spark passes through it; but when the points are at an equal depth in a harder piece of wood (such as box) the yellow, and perhaps the orange will disappear. As a farther proof that the phenomena, thus described, are owing to the interposition of the wood, as a medium which absorbs some of the rays, and suffers others to escape, it may be observed, that when the spark strikes very brilliantly on one side of the piece of deal, on the other side it will appear very red. In like manner, a red appearance may be given to a spark which strikes brilliantly over the inside of a tube, merely by spreading some pitch very thinly over the outside of the same tube.

Princip of Elec city illu trated experime

Exper. 13.—Seal a short wire of iron or platinum within one extremity of a glass tube 30 inches long, and projecting a little into its cavity, and screw a ball on the outer end of the wire; fill the tube with mercury, and invert it in a bason of that metal; a vacuum will be formed in the upper part of the tube. A spark which in the open air would pass only through a quarter of an inch, will pass through six inches of this vacuum with facility, with a current if faint. When a little water or ether is introduced to the top of the mercurial column, it expands, occupying the vacuum, and extending the space so as to make the mercury descend. A luminous current of electricity will pass through this vapour, by connecting one end of the tube with the prime conductor while the machine is working, and the other with the ground. Its colours are various. Through some inches of expanded ether, its colour is a beautiful green. The appearances will differ, in some measure, according to the distance at which the eye is placed from the tube; becoming more red by distance, like the light of a distant candle, or a beclouded sun.

Exper. 14.—Dr Priestley long ago observed the red appearance of the spark when passing through hydrogen gas; but this appearance is very much diversified by the quantity of medium, through which you look at the spark. When at a very considerable distance, the red comes to the eye unmixed; but if the eye is placed close to the tube, the spark appears white and brilliant. In confirmation, however, of some of these conclusions, you must observe, that by increasing the quantity of sparks which are conveyed through any portion of hydrogen gas, or by condensing that gas, the spark may be entirely deprived of its red appearance, and made perfectly brilliant. All weak explosions and sparks, when viewed at a distance, bear a reddish hue. Such are the explosions which have passed through water, spirits of wine, or any bad conductor, when confined in a tube whose diameter is not more than an inch. The reason of these appearances seems to be, that the weaker the spark or explosion is, the less is the light which escapes; and the more visible the effect of any medium, which has a power to absorb some of that light.

Chalk, oyster-shells, together with those phosphoric bodies, whose goodness has been very much impaired by long keeping, when finely powdered, and placed within the circuit of an electrical battery, will exhibit, by their scattered particles, a shower of light; but these particles rinciples Electri-ity illus-ated by eriment.

particles will appear reddish, or their phosphoric power will be sufficient only to detain the yellow, orange, and red rays. When spirits of wine are in a similar manner brought within the circuit of a battery, a similar effect may be discovered; its particles diverge in several directions, displaying a most beautiful golden appearance. The metallic oxides are, of all bodies, those which are rendered phosphoric with the greatest difficulty; but even these may be scattered into a shower of red luminous particles by the electric stroke.

The following experiments are given by Mr Cavallo to illustrate the appearance of the electric light in rarefied air.

188 minous nductor. Plate CXC. ig. 61.

Exper. 1.—Fig. 61. represents a prime conductor, invented by Mr Henley, which shows clearly the direction of the electric power passing through it, from whence it is called the *luminous conductor* (Y). The middle part EF of this conductor, is a glass tube about eighteen inches long, and three or four inches in diameter. To both ends of this tube the hollow brass pieces FD, BE, are cemented air-tight, one of which has a point C, by which it receives the electric power, when set near the excited cylinder of the electrical machine, and the other has a knobbed wire G, from which a strong spark may be drawn; and from each of the pieces FD, BE, a knobbed wire proceeds, within the cavity of the glass tube. The brass piece FD, or BE, is composed of two parts, i. e. a cap F cemented to the glass tube, and having a hole with a valve, by which the cavity of the glass tube may be exhausted of air; and the ball D, which is screwed upon the cap F. The supporters of this instrument are two glass pillars fastened in the bottom board H, like the prime conductor represented fig. 16. When the glass tube of this conductor is exhausted of air by means of an air-pump, and the brass ball is screwed on, as represented in the figure, then it is fit for use, and may serve for a prime conductor to an electrical machine.

If the point C of this conductor is set near the excited cylinder of the machine, it will appear illuminated with a star; at the same time the glass tube will appear all illuminated with a weak light; but from the knobbed wire, that proceeds within the glass from the piece FD, a lucid pencil will issue out, and the opposite knob will appear illuminated with a star or round body of light, which, as well as the pencil of rays, is very clear, and discernible among the other light, that occupies the greatest part of the cavity of the tube.

If the point C, instead of being presented to the cylinder, be connected with the rubber of the machine, the appearance of light within the tube will be reversed; the knob which communicates with the piece FD appearing illuminated with a star, and the opposite with a pencil of rays.

If the wires within the tube EF, instead of being furnished with knobs, be pointed, the appearance of light is the same, but it seems not so strong in this, as in the other case.

81 ucting tube.

Exper. 2.—Take a glass tube of about two inches diameter, and about two feet long; fix to one of its ends a brass cap, and to the other a stop-cock, or a valve; then by means of an air-pump exhaust it of air. If this tube be held by one end, and its other end be brought near the electrified prime conductor, it will appear to be full of light, whenever a spark is taken by it from the prime conductor; and much more so, if an electric jar be discharged through it.

Principles of Electricity illustrated by experiment.

This experiment may also be made with the receiver of an air-pump. Take, for instance, a tall receiver, clean and dry, and through a hole at its top insert a wire, which must be cemented air-tight. The end of the wire, that is within the tube, must be pointed, but not very sharp; and the other end must be furnished with a knob. Put this receiver upon the plate of the air-pump, and exhaust it. If now the knob of the wire at the top of the receiver be touched with the prime conductor, every spark will pass through the receiver in a dense and large body of light, from the wire to the plate of the air-pump.

It must be observed, that when the air is very much rarefied, the electric light in it is less dense, though more diffused; and contrarywise.

190 Aurora borealis. Plate CXCII. fig. 62.

Exper. 3.—Take a phial nearly of the shape and size of a Florence flask, such as is represented at fig. 62.

Fix a stop-cock or a valve to its neck, and exhaust it of air as much as it is possible with a good air-pump. If this glass be rubbed in the common manner used to excite electrics, it will appear luminous within, being full of a flashing light, which plainly resembles the aurora borealis, or northern light. This phial may also be made luminous by holding it by either end, and bringing the other end to the prime conductor; in this case all the cavity of the glass will instantly appear full of flashing light, which remains in it for a considerable time after it has been removed from the prime conductor.

Instead of the above-described glass vessel, a glass tube, exhausted of air and hermetically sealed, may be used, and perhaps with greater advantage. The most remarkable circumstance of this experiment is, that if the phial or tube, after it has been removed from the prime conductor (and even several hours after its flashing light hath ceased to appear) be grasped with the hand, strong flashes of light will immediately appear within the glass, which often reach from one of its ends to the other.

191 Visible electric atmosphere. Fig. 63.

Exper. 4.—GI, fig. 63. represents the receiver with the plate of an air-pump. In the middle of the plate IF, a short rod is fixed, having at its top a metal ball B nicely polished, whose diameter is nearly two inches. From the top of the receiver another rod AD with a like ball A proceeds, and is cemented air-tight in the neck C; the distance of the balls from one another being about four inches, or rather more. If, when the receiver is exhausted of air, the ball A be electrified positively, by touching the top D of the rod AD with the prime conductor or an excited glass tube, a lucid atmosphere appears about it, which, although it consists of a feeble light, is yet very conspicuous, and very

---

(Y) An instrument much like this conductor was some yearts ago invented by Dr Watson, with which he made several original experiments upon the electric light.

Principles of Electricity illustrated by experiment.

very well defined; at the same time the ball B has not the least light. The atmosphere does not exist all round the ball A, but reaches from about the middle of it, to a small distance beyond that side of its surface, which is towards the opposite ball B. If the rod with the ball A be electrified negatively, then a lucid atmosphere, like the above described, will appear upon the ball B, reaching from its middle to a small distance beyond that side of it that is towards the ball A; at the same time the negatively electrified ball A remains without any light.

The operator in this experiment must take care not to electrify the ball A too much, as, in that case, a spark will pass from one ball to the other, and the desired effect will not be produced. A little practice, however, will render the experiment very easy and familiar.

This elegant experiment is the invention of Sig. Beccaria.

192 Fig. 64. and 65.

Fig. 64. and 65. represent a curious appearance of the electric light. In fig. 65. the light is seen streaming from a wire within the exhausted receiver of an air-pump. If in this state of things, the hand or a finger be applied to the external part of the receiver, part of the light will approach the finger, as represented in fig. 64.

The electric spark produces changes on most artificial colours.

193 Mr Cavallo's experiments on colours.

Mr Cavallo made several experiments on substances painted with various colours. They were occasioned by his having observed that an electric spark sent over the surface of a card, made a black stroke upon a red spot, from which he was induced to try the effect of sending shocks over cards painted with different water colours. The force employed was generally about one foot and a half of charged surface; and the shocks were sent over the cards while the latter were in a very dry state.

Fig. 66.

"Vermilion was marked with a strong black track, about one-tenth of an inch wide. This stroke is generally single, as represented by AB, fig. 66. Sometimes it is divided into two towards the middle, like EF; and sometimes, particularly when the wires are set very distant from one another, the stroke is not continued, but interrupted in the middle, like GH. It often, although not always, happens, that the impression is marked stronger at the extremity of that wire from which the electric sparks issue, as it appears at E, supposing that the wire C communicates with the positive side of the jar; whereas the extremity of the stroke, contiguous to the point of the wire D, is neither so strongly marked, nor surrounds the wire so much, as the other extremity E.

"Carmine received a faint and slender impression of a purple colour.

"Verdigrise was shaken off from the surface of the card; except when it had been mixed with strong gum-water, in which case it received a very faint impression.

"White lead was marked by a long black track, not so broad as that on vermilion.

"Red lead was marked with a faint mark much like carmine.

"The other colours I tried were orpiment, gamboge, sap green, red ink, ultramarine, Prussian blue, and a few others which were compounds of the above; but they received no impression.

"It having been insinuated that the strong black mark, which vermilion receives from the electric shock, might possibly be owing to the great quantity of sulphur contained in that mineral, I was induced to make the following experiment. I mixed together equal quantities of orpiment and flower of sulphur; and with this mixture, by the help, as usual, of very diluted gum-water, I painted a card; but the electric shock sent over it left not the least impression.

"Desirous of carrying this investigation on colours a little farther, with a particular view to determine something relative to the properties of lamp black and oil, I procured some pieces of paper painted on both sides with oil colours; and sending the charge of two feet of coated glass over each of them, by making the interruption of the circuit upon their surfaces, I observed that the pieces of paper painted with lamp black, Prussian blue, vermilion, and purple brown, were torn by the explosion; but white lead, Naples yellow, English ochre, and verdigrise, remained unhurt.

"The same shock sent over a piece of paper painted very thickly with lamp black and oil left not the least impression. I sent the shock also over a piece of paper unequally painted with purple brown, and the paper was torn where the paint lay very thin, but remained unhurt where the paint lay evidently thicker. These experiments I repeated several times, and with some very little variation, which naturally produced different effects; however, they all seem to point out the following propositions.

"1. A coat of oil paint over any substance, defends it from the effect of such a shock as would otherwise injure it; but by no means defends it from any electric shock whatever.

"2. No one colour seems preferable to the others, if they are equal in substance, and equally well mixed with oil; but a thick coating does certainly afford a better defence than a thinner one.

"By rubbing the above mentioned pieces of paper, I find that the paper painted with lamp-black and oil is more easily excited, and acquires a stronger electricity, than the papers painted with the other colours; and perhaps on this account it may be, that lamp-black and oil might resist the shock somewhat better than the other paints.

"It is remarkable that vermilion receives the black impression when painted with linseed oil nearly as well as when painted with water. The paper painted with white lead and oil receives also a black mark; but its nature is very singular. The track when first made, is almost as dark as that marked on white lead painted with water; but it loses its blackness, and in about an hour's time (or longer, if the paint is not fresh) it appears without any darkness; and when the painted paper is laid in a proper light appears only marked with a colourless track, as if made by a finger nail. I sent the shock also over a piece of board, which had been painted with white lead and oil four years before, and the explosion marked the black track upon this also; this track, however, was not so strong, nor vanished so soon, as that marked upon the painted paper; but in about two days time it also vanished entirely."

rinciples f Electricity illustrated by xperiment.

Chap. VIII. *Of the Mechanical Effects of the Electric Power.*

194 lectric ower rives light odies before it.

The electric power in its passage through the air, drives light bodies before it.

Sig. Beccaria put a narrow piece of silver leaf between two plates of wax, laying it across them, but so that it did not quite reach one of the sides. The discharge being made through this strip of metal, by bringing a wire opposite to the silver at the place where it was discontinued; the silver was found melted, and part of it dispersed all along the track that the electric spark took between the plates of wax, from the silver to the wire.

The following experiment shows the force of the electric explosion in driving the particles of a metal into the pores of glass.

Take two slips of common window glass, about three inches long, and half an inch wide; put a small slip of gold, silver or brass leaf, between them, and tie them together, or press them together between the boards of the press H, belonging to the universal discharger, leaving a little of the metallic leaf out between the glasses at each end; then send a shock through this metallic leaf, and the force of the explosion will drive part of the metal into so close a contact with the glass, that it cannot be wiped off, or even be affected by the common menstrua which otherwise would dissolve it. In this experiment the glasses are often shattered to pieces; but whether they are broken or not, the indelible metallic tinge will always be found in several places, and sometimes through the whole length of both glasses.

Dr Priestley made the following experiments to ascertain this remarkable property of the electric power.

He discharged frequent shocks both of a common jar, and another of three square feet, through trains of brass dust, laid on a stool of baked wood, making interruptions in various parts of the train; and he always found the brass dust scattered in the intervals, so as to connect the two disjoined ends of the train; but then it was likewise scattered nearly as much from almost all other parts of the train, and in all directions.

When small trains were laid, the dispersion was the most considerable, and a light was very visible in the dark, illuminating the whole circuit. It made no difference, in any of these experiments, which way the shock was discharged.

When he laid a considerable quantity of the dust at the ends of two pieces of chain, through which the shock passed at the distance of about three inches from one another, the dust was always dispersed over the whole interval, but chiefly laterally; so that the greatest quantity of it lay in arches, extending both ways, and leaving very little of it in the middle of the path.

Principles of Electricity illustrated by experiment.

The Doctor then insulated a jar of three square feet, and upon an adjoining glass stand laid a heap of brass dust; and at the distance of seven or eight inches, a brass rod communicating with the outside of the jar. Upon bringing another rod communicating with the inside, upon the heap of dust, the heap was dispersed in a beautiful manner, but not one way more than the other. It, however, presently reached the rod communicating with the outside.

Making two heaps, about eight inches asunder, he brought one rod communicating with the inside upon one of them, and another rod communicating with the outside upon the other. Both the heaps were dispersed in all directions, and soon met; presently after which the jar was discharged by means of this dispersed dust, in one full explosion. When the two heaps were too far asunder to promote a full discharge at once, a gradual discharge was made through the scattered particles of the dust.

When one heap of dust was laid in the centre of the stand, and the two rods were made to approach on each side of it, they each attracted the dust from the side of the heap next to them, and repelled it again in all directions. When they came very near the heap, the discharge was made through it, without giving it any particular motion.

An experiment given by Mr Cavallo to prove the direction of the electric power in the discharge of a Leyden phial, will afford a good illustration of our present position. 195

Bend a card, length-ways, over a round ruler, so as to form a channel, or semicircular groove (z): lay this card upon the circular board E of the universal discharger, and in the middle of it put a pith-ball of about half an inch diameter; then at equal distances, about half or three quarters of an inch from the pith-ball, lay the two brass knobs DD. The card being perfectly dry, and rather hot, if you connect, by means of a chain or otherwise, the outside of a charged jar with one of the wires C, and bring the knob of the jar to the other wire C, you will observe, that on making the discharge, which must pass between the knobs DD, and over the card, &c. the pith-ball is always driven in the direction of the electric power; i. e. it is pushed towards that knob which communicates with the negative side of the jar.

It must be observed, that in this experiment the charge of the jar must be just sufficient to pass through the interval in the circuit; the card, or piece of baked wood, must be very dry and clean; and, in short, the disposition of the apparatus, and the performance of this curious experiment, require a degree of nicety that can only be obtained by practice. Without great precaution, it sometimes fails; but when the operator has once got it to succeed, and follows exactly the same method of operating, he may be sure that the event of the experiment will be constantly as above described.

By

(z) Instead of the card, a piece of baked wood may be cut in that shape, and painted over with lamp-black and oil; which will answer better than the card, it being much more steady, and not so liable to attract moisture.

Principles of Electricity illustrated by experiment.

196

By the electric explosion, paper, pasteboard, card, thin glass, and other non-conducting substances, may be perforated or broken.

Exper. 1.—Take a card, a quire of paper, or the cover of a book, and keep it close to the outside coating of a charged jar; put one knob of the discharging rod upon the card, quire of paper, &c. so that between the knob and coating of the jar the thickness of that card or quire of paper only is interposed; lastly, by bringing the other knob of the discharging rod near the knob of the jar, make the discharge, and the electric spark will pierce a hole (or perhaps several) quite through the card or quire of paper. This hole has a bur raised on each side, except the card, &c. be pressed hard between the discharging rod and the jar. If this experiment be made with two cards instead of one, which however must be kept very little distant from one another, each of the cards, after the explosion, will be found pierced with one or more holes, and each hole will have burs on both surfaces of each card. The hole, or holes, are larger or smaller, according as the card, &c. is more damp or more dry. It is remarkable, that if the nostrils are presented to it, they will be affected with a sulphureous, or rather a phosphoreal smell, just like that produced by an excited electric.

If, instead of paper, a very thin plate of glass, rosin, sealing wax, or the like, be interposed between the knob of the discharging rod and the outside coating of the jar, on making the discharge, this will be broken in several pieces: wafers will be dispersed in a curious manner, and several of them broken in pieces.

If the explosion is sent over the surface of a piece of glass, this will be marked with an indelible track, which generally reaches from the extremity of one of the wires to the extremity of the other. In this manner, the piece of glass is very seldom broken by the explosion. But Mr Henley discovered a very remarkable method to increase the effect of the explosion upon the glass; which is by pressing with weights that part of the glass which lies between the two wires (i. e. that part over which the shock is to pass). He put first a thick piece of ivory upon the glass, and placed upon that ivory a weight at pleasure, from one quarter of an ounce to six pounds: the glass in this manner is generally broken by the explosion into innumerable fragments, and some of it is absolutely reduced into an impalpable powder. If the glass is very thick, and resists the force of the explosion, so as not to be broken by it, it will be found marked with the most lively prismatic colours, which are thought to be occasioned by very thin laminæ of the glass, in part separated from it by the shock. The weight laid upon the glass is always shook by the explosion, and sometimes it is thrown quite off from the ivory. This experiment may be most conveniently made with the universal discharger.

Exper. 2.—Place the extremities of two wires, one above and the other below a card, so as to be about an inch distance from each other, taking care that the card be kept steady. Then, make the charge of a Leyden phial pass from one wire to the other, and it will be found, that a luminous track will pass from the end of that wire which is connected with the positive surface of the phial, to the extremity of the other wire, where a hole will be perforated through the card.

Principles of Electricity illustrated by experiment.

This experiment, to which we shall have occasion to refer hereafter, is by Mr Lullin of Geneva.

Mr Symmer made some experiments on the perforation of paper, which we shall mention here, as on them he grounded a principal argument in favour of that theory which he adopted, and of which we shall give an account hereafter.

Exper. 3.—A piece of paper covered on one side with Dutch gilding, and which had been left accidentally between two leaves in a quire of paper, in which a former experiment had been made, was found to have the impression of two strokes upon it, about a quarter of an inch from each other; the gilding was stripped off, and the paper left bare for a little space in both places. In the centre of one of these places was a little round hole, in the other only an indenture or impression, such as might have been made with the point of a bodkin.

Exper. 4—In the middle of a paper book, of the thickness of a quire, Dr Symmer put a slip of tinfoil; and in another of the same thickness, he put two slips of the same sort of foil, including the two middle leaves of the book between them. On passing the explosion through the two different books, the following effects were produced. In the first, the leaves on each side of the tinfoil were pierced, while the foil itself remained unpierced; but at the same time, it might be perceived that an impression had been made on each of its surfaces, at a little distance from one another; and such impressions were still more visible on the paper, and might be traced, as pointing different ways. In the second, all the leaves of the book were pierced, excepting the two that were included between the slips of tinfoil; and in these two, instead of holes, the two impressions in contrary directions were visible. The double impression was considered by this experimenter as an evidence of two fluids moving in opposite directions; but by the interposition of the tinfoil a *double* interruption in the conducting circuit is produced, consequently the paper on each side of it was expanded, causing a double depression in the leaf of tinfoil.

The following experiment shows how easily so hard a substance as glass, may be pierced by the electric spark. It is thus related by Mr Cavallo.

Exper. 5—Let a glass tube of any diameter, and about five or six inches in length, be closed hermetically, or by means of sealing-wax, at one end, and fill about half of it with olive oil; then stop the aperture of it with a cork, and let a wire pass through the cork, and come so far within the tube, as to have its extremity below the surface of the oil. This end of the wire must touch the surface of the glass, for which purpose it must be bent nearly at right angles, which may be easily done before the cork is put upon the tube. Things being thus prepared, bend into a ring the other extremity of the wire, and suspend it, with the tube hanging to it, to the wire at the end of the conductor. Then work the machine, and bring the knuckle of a finger or the knob of a wire near the outside of the tube, just opposite to the extremity of the wire; the consequence of which will be, that a spark will happen between the wire and the knuckle, which makes a hole through the glass.—By turning the wire

Principles f Electri- ity illus- rated by xperiment.

about, or raising and lowering it, many holes may be successively made in the same tube, after the manner above described. The perforation is in this instance rendered much easier by the confinement of the discharge to a single point, and by the obstacle which the non-conducting matter, the olive oil, presents to dispersion.

The same effect will take place when a large quantity of electricity is suddenly transferred to a very limited surface.

Exper. 6.—Charge a very large jar; connect its outside with one only a tenth or twelfth part of its size. Connect their inner coatings by the discharging rod, and the small jar will be broken by the disproportionate quantity of electricity thus transferred to it.

Exper. 7.—Roll up a piece of soft tobacco-pipe clay in a small cylinder, and insert in it two wires, so that their ends without the clay may be about a fifth part of an inch from one another. If a shock be sent through this clay, by connecting one of the wires with the outside of a charged jar, and the other with the inside, it will be inflated by the shock, i. e. by the spark, that passes between the two wires, and, after the explosion, will appear curiously expanded in the interval between the wires. If the shock sent through it is too strong, and the clay not very moist, it will be broken by the explosion, and its fragments scattered in every direction. To make this experiment with a little variation, take a piece of the tube of a tobacco-pipe, abont one inch long, and fill its bore with moist clay; then insert in it two wires, as in the above rolled clay; and send a shock through it. This tube will not fail to burst by the force of the explosion, and its fragments will be scattered about to a great distance. If, instead of the clay, the above-mentioned tube of the tobacco-pipe, or a glass tube (which will answer as well), be filled with any other substance, either electric or non-electric, inferior in conducting power to metal, on making the discharge, it will be broken in pieces with nearly the same force. This experiment is the invention of Mr Lane, F. R. S.

Exper. 8.—Place within a common drinking-glass, nearly full of water, two knobbed wires, bent in such a manner, as that their knobs may be within a little distance of each other in the water. Connect one of these wires with the outside coating of a pretty large jar, and touch the other wire with the knob of it; on making the discharge, the explosion which must pass through the water between the two knobs, will disperse the water, and break the glass with a surprising violence. This experiment requires great caution.—Mr Morgan broke green quart bottles filled with water, when the distance from the wires that conveyed the spark to the sides of the glass exceeded two inches.

Sig. Beccaria contrived a small mortar, into which a drop of water was put, between the extremities of two wires which went through the sides of the mortar, and a wooden ball was applied over the drop of water; then a charged jar being discharged through the wires of the mortar, and consequently through the drop of water, rarefied the latter, and drove the ball out with considerable force. Mr Lullin produced a greater effect by making the discharge through oil instead of water. When passed through air in order to produce an analogous effect, the body to be moved must be fixed somewhat firmly. A cork may for this purpose be fitted over a small column of air, and it will be driven out by the electric spark expanding the air.

Principles of Electricity illustrated by experiment.

CHAP. IX. *Of the Methods of estimating the Degree of Accumulated Electricity in Jars and Batteries.*

197 THE only method of ascertaining the charge of a Leyden phial or of a battery, which we have hitherto mentioned, is that of observing the repulsive force of the charge on the ball of Henley's quadrant electrometer. But it was found (*Vide* 112.) that this was not always a just criterion of the amount of the charge; as, even when the jar was insulated, and consequently could receive no charge, the index of the electrometer still rose as high as if the jar was fully charged. We shall now proceed to describe two methods, which, particularly the last, are much less liable to error. The first depends on the following principle.

198 *The distance of the ball of a discharged rod from the knob of a charged phial or battery necessary to produce an explosion, will be greater in proportion to the degree of accumulated electricity which the jar or battery has received.*

Exper.—Take a Leyden phial, into the knob of which is fixed a quadrant electrometer; communicate to it a small charge, so that the index of the electrometer may point, we shall suppose, at 10°. In making the discharge, it will be found necessary to bring the ball of the discharging rod almost in contact with the knob of the jar. Now charge the jar to 20°, and it will be found that the explosion will take place, when the ball of the discharging rod is at a greater distance from the knob of the jar, than before; and thus, by repeating the experiment with greater charges, it will be observed, that the distance necessary to produce an explosion will increase nearly in proportion to the charge.

199 Lane's electrometer.

On this principle Mr Lane constructed an electrometer, which has been found extremely useful, when it was required to discharge a jar or battery a number of times successively, with the same charge. This instrument has been called Mr Lane's *discharging electrometer*.

The principal part of it consisted originally of a brass ball about an inch and a half in diameter, screwed to a graduated brass rod, and adapted to a proper frame, so that it might be set at any required distance from the prime conductor of the knob of a Leyden phial. The chief use of this instrument is to allow a jar to discharge spontaneously through any proper circuit, without employing a discharging rod, or moving any part of the apparatus, and also to produce successive explosions nearly of the same strength, as observed above. If, for example, the brass ball be placed at the distance of about half an inch from the prime conductor, and a Leyden phial be so situated as to have its knob in contact with the prime conductor, while its outside coating communicates with the ball of the electrometer, it is evident that the communication between the outside and inside of the jar, is interrupted only between the prime conductor and the brass ball, which are half an inch asunder; therefore, in charging the jar, when the charge is become so high as to strike through half an inch

inch of air, the jar will discharge spontaneously, and by keeping the brass ball at the same distance from the prime conductor, and charging the jar successively, the shocks will be nearly of the same strength.

Plate CXCI. fig. 67.

An electrometer of this kind, though not exactly like the original one, is now commonly used by the practitioners of medical electricity, and is delineated in fig. 67. of Plate CXCI. It consists of a glass arm D, which proceeds from the wire of the jar F, and to the extremity E of which a spring socket is cemented, through which a wire passes, which is furnished with a knob B, towards the knob A of the jar, and with an open ring C at its other extremity. Now, as this wire may be slid backwards and forwards, the knob B may be put at any required distance from the knob A, as far as the construction of the instrument will allow. The wire BC is generally marked with divisions which show the distance of the two knobs, when the wire is so situated, as that the required division coincides with the edge of the spring socket; as, for instance, one-tenth, or one quarter of an inch, &c. When the jar F is set against the prime conductor G, as represented in the figure, suppose that the ball B is set at the distance of one-tenth of an inch from the ball A, and that a wire be fixed from the electrometer's ring, to the outside coating of the jar, as shewn by the dotted line CK; then, when the machine is put in motion, the discharge of the jar, as soon as this becomes sufficiently charged, will be made between the knobs AB, and through the wire CK; and it is evident that these discharges will be of the same strength, as long as the distance between AB remains the same.

This instrument is subject to the following inconvenience, viz. that the force of the explosion, after a time, roughens the surface of the brass ball, and thus, for a reason to be explained hereafter, the instrument is useless unless the polish of the ball be again renewed. It is also found that this instrument is not accurate in shewing the exact charge of a jar.

Its principal imperfection arises from that occasional intrusion of particles of dust, or other light conducting matter between the balls rendering its indications fallacious.

200 *The charge of a jar or battery may be most accurately determined by the weight which the repulsive force of the accumulated electricity is able to raise.*

Upon this principle Mr Brooke of Norwich constructed a very valuable electrometer, of which he has given a long and accurate account in his *Miscellaneous Experiments.*

Our limits will not permit us to copy this long description, for which we must therefore refer our readers to Mr Brooke's work. We have, however, the less reason to regret this omission, because we shall presently describe an instrument invented by the late Professor Robison, which appears to us superior to Mr Brooke's both in simplicity and utility.

Mr G. Adams has described an electrometer very similar in principle to that of Mr Brooke, and we shall here copy his description.

201 Electrometer similar to Mr Brooke's. Fig. 68. and 69.

"Fig. 68. and 69. represent an electrometer, nearly similar to that contrived by Mr Brooke. The two instruments are sometimes combined in one, or used separately, as in these figures. The arms FH *fk*, fig. 69. when in use, are to be placed as much as possible out of the atmosphere of a jar, battery, prime conductor, &c. The arm FH and the ball K are made of copper, and as light as possible. The divisions on the arm FH are each of them exactly a grain. They are ascertained at first by placing grain weights on a brass ball which is within the ball L, (this ball is an exact counterbalance to the arm FH and the ball K when the small slide *r* is at the first division) and then removing the slide *r* till it, together with the ball K, counterbalances the ball L and the weight laid on it.

A, fig. 69. is a dial-plate, divided into 90 equal parts. The index of this plate is carried once round, when the arm BC has moved through 90 degrees, or a quarter of a circle. That motion is given to the index by the repulsive power of the charge acting between the ball D and the ball B.

The arm BC being repelled, shews when the charge is increasing, and the arm FH shews what this repulsive power is between two balls of this size in grains, according to the number the weight rests at when lifted up by the repulsive power of the charge: at the same time the arm BC points out the number of degrees to which the ball B is repelled; so that by repeated trials, the number of degrees answering to a given number of grains, may be ascertained, and a table formed from these experiments, by which means the electrometer, fig. 69. may be used without that of fig. 68.

Mr Brooke thinks that no glass, charged (as we call it) with electricity, will bear a greater force, than that whose repulsive power, between two balls of the size he used, is equal to sixty grains; that in very few instances it will stand sixty grains weight; and he thinks it hazardous to go more than 45 grains.

Hence, by knowing the quantity of coated surface, and the diameter of the balls, we may be enabled to say, so much coated surface, with a repulsion between balls of so many grains, will melt a wire of such a size, or kill such an animal, &c.

Mr Brooke thinks, that he is not acquainted with all the advantages of his electrometer; but that it is clear, it speaks a language which may be universally understood, which no other will do; for though other electrometers will shew whether a charge is greater or less, by an index being repelled to greater or smaller distances, or by the charge exploding at different distances, yet the power of the charge is by no means ascertained: but this electrometer shews the force of the repulsive power in grains; and the accuracy of the instrument is easily proved, by placing the weights on the internal ball, and seeing that they coincide with the divisions on the arm FH, when the slide is removed to them.

With his electrometer, Mr Brooke made a set of experiments, with a view to determine exactly the force of batteries of an inferior power, in melting fine metallic wires of different kinds. The following is the substance of these experiments.

202 Mr Brooke's experiments on the force of batteries.

1. With a battery of nine bottles, containing about 16 square feet of coated surface, and charged to 32 grains of repulsion, a shock was eleven times sent through a piece of steel wire twelve inches long and $\frac{1}{100}$th of an inch thick; the wire was shortened an inch and a half, being then about ten inches and a half long; by a twelfth shock, the wire was melted to pieces.

Principles of Electri- ity illus- rated by xperiment.

2. A shock from the same nine bottles charged to the same degree of repulsion, being sent through a piece of steel wire, 12 inches long and $\frac{1}{170}$th of an inch thick, the first time melted the whole of it into small globules.

3. A shock from the same nine bottles charged to the same degree, being sent through a piece of *brass* wire twelve inches long and $\frac{1}{170}$th of an inch thick, melted the whole of it, with much smoke, resembling that from gunpowder; but the metallic part formed itself, in cooling, chiefly into concave hemispherical figures of various sizes.

4. A shock from only eight of the bottles charged to the same degree, did but just melt twelve inches of steel wire $\frac{1}{170}$th of an inch thick, so as to fall into several pieces; these pieces in cooling formed themselves into oblong lumps, joining themselves to each other by a very small part of the wire between each lump which was not melted enough to separate, but appeared like oblong beads on a thread at different distances.

5. A shock from the same eight bottles, charged to the same degree, so perfectly heated twelve inches of *brass* wire about $\frac{1}{170}$th of an inch in diameter, softening it so far as to make it fall down by its own weight, from the forceps by which it was held at each end, upon a sheet of paper placed below to catch it, and when it fell down it was so perfectly flexible that, by falling, it formed itself into a vermicular shape, and remained entire its whole length, which when it was put into the forceps was about 12 inches: but after the shock was passed through it, it sagged so much as to be stretched by its own weight to almost fifteen inches, and by falling on the paper it was flattened throughout its whole length so much, that when it was examined by a magnifier of half an inch focus, it appeared five or six times as broad as it was thick.

6. A shock from nine bottles charged only twenty grains, was sent through a piece of steel wire, of the same length and diameter as in the former experiments, and heated it sufficiently to melt it, so that it separated in several places; and the pieces were formed into beads strung as in experiment 4.

7. A shock from the same nine bottles charged to twenty grains was sent through ten inches of brass wire $\frac{1}{170}$th of an inch diameter; the wire was heated red hot so as to render it very flexible, but it did not separate. It was shortened, however, nearly three-eighths of an inch.

8. A shock from the same nine bottles charged to the same degree, being sent a second time through the last piece of wire, melted it asunder in several places.

9. A shock from nine bottles charged to 30 grains, sent through twelve inches of brass wire $\frac{1}{170}$th of an inch in diameter, acted on it nearly as in experiment 5, except that it was separated in two places, and the pieces when joined measured about sixteen inches and a half long; it was perfectly flattened by its fall on the paper as before.

10. A shock from nine bottles charged to 30 grains, being sent through eight inches and a half of brass wire of the same diameter, wholly dispersed it in smoke, and left nothing remaining to fall on the sheet of paper placed below it.

11. A shock from twelve bottles charged to 20 grains sent through ten inches of steel wire, $\frac{1}{100}$th of an inch in diameter, made it red hot, but did not melt it.

Principles of Electricity illustrated by experiment.

12. A second charge, the same as the last, being sent through the same piece of wire, heated it red hot as before, but did not cause it to separate; the wire was now, however, shortened five-sixteenths of an inch.

13. A shock from the same twelve bottles charged to 25 grains, being sent through the same piece of wire, partly melted it into several pieces, and produced many globules of oxidated metal.

14. With 15 bottles charged to 25 grains, a shock was sent through ten inches of steel wire $\frac{1}{100}$th of an inch in diameter, which melted it at the first time, and dispersed a great part of it about the room.

15. A shock from the same 15 bottles charged to 20 grains, just melted ten inches of steel wire of the same diameter as before, so as to cause it to run into several beautiful globules, nearly as in experiment 13.

16. A shock of 15 bottles charged to 15 grains, being sent through ten inches of steel wire of the same diameter as the last, made the wire barely red hot; but shortened it one-tenth of an inch.

17. The last piece of wire having received a shock from 15 bottles charged to 12 and a half grains, was not made red hot.

18. A shock from the same 15 bottles, charged to 25 grains, was sent through the same piece of wire, and seemingly tore the wire into splinters.

19. Four bottles charged to 30 grains, just melted three inches of steel wire $\frac{1}{170}$th of an inch in diameter, so as to make it fall into pieces.

20. Five bottles charged to 25 grains, melted three inches of such wire as the last into large beautiful globules.

21. With eight bottles charged to 15 grains, three inches of steel wire, $\frac{1}{170}$th of an inch in diameter, were melted as in the last experiment; indeed the appearance and effect were so nearly alike in both cases, that the metal after both experiments might have been said to be the same.

22. The force of ten bottles charged twelve grains and a half rather exceeded experiment 19, but scarcely came up to experiments 20 and 21.

23. Suspecting something wrong in experiment 19, Mr Brooke found, that though his bottles hitherto were as nearly of the same size as he could procure them, yet some of them were a little larger than others, and, which was the case in experiment 19, one of the four was smaller than the other three; so that he repeated the experiment with four bottles more equal in size, charging them to 30 grains, and the fusion was as perfect as in any.

24. A charge to 30 grains, with the last eight bottles, beautifully melted six inches of steel wire $\frac{1}{170}$th of an inch in diameter.

25. A shock from two bottles charged to 45 grains, was sent through one inch of steel wire, of the same diameter as the last, but only changed its colour.

26. With three bottles charged to 40 grains, a shock sent through one inch and a half of steel wire of the above diameter, dispersed it all about the room.

27. Mr Brooke considering that a steel wire of $\frac{1}{100}$th of an inch in diameter, contains nearly twice the quantity of metal which is contained in the same length of

Principles of Electricity illustrated by experiment.

Principle of Electri- city illus- trated by experiment

wire of $\frac{1}{170}$th of an inch in diameter, took three inches of the former, and sent through it a shock from ten bottles, charged to 25 grains. This shock melted it just as the shock from five bottles did in experiment 20.

28. With 20 bottles charged to 12 grains and a half, he melted three inches of steel wire of $\frac{1}{100}$th of an inch in diameter, exactly as in the foregoing experiment.

29. As a steel wire of $\frac{1}{80}$th of an inch diameter contains nearly twice the quantity of metal in the same length, as is contained in a steel wire of $\frac{1}{100}$th, or four times the quantity contained in a steel wire of $\frac{1}{170}$th of an inch diameter; it might from the foregoing experiments be expected, that 20 bottles charged to 25 grains would melt three inches of steel wire of $\frac{1}{80}$th of an inch in diameter: but on a great many trials he could not procure 20 bottles which would bear the discharge when charged to 25 grains; for at the discharge, there was always one or more bottles broken or perforated. He was now reduced to the necessity of being content with bottles of any size, that would bear the required charge, of from one to three gallons each, or that contained from 150 to 300 or more square inches of coated surface each, but all in vain. The only resource left him, as he was not near a glasshouse, was to increase the quantity of surface and not to charge so high, and to proportion the one to the other: it was therefore resolved to adopt a third expedient, i. e. instead of employing about 36 square feet of coating, he added a third, or twelve feet, which made it in all 48 feet; and instead of charging to 25 grains, or rather 24 for the sake of a more easy division by three, he annulled one-third of the charge, leaving sixteen grains, and thus he succeeded perfectly well; for by 48 feet of coated surface charged to 16 grains, three inches of steel wire $\frac{1}{80}$th of an inch in diameter were as curiously melted as in any of the former experiments.

These bottles, thus broken in large discharges, seem always to break or to be perforated nearly in the thinnest, but never in the thickest place, which shows the necessity of the glass being of a considerable thickness.

30. As in experiments 19. and 20. where the coated surface in the former is but half the quantity of that in the latter, and the former is charged to 30, and the latter to 15 grains, to know how high 48 feet of coating must be charged to produce the same effect exactly; and as the coating in four bottles, consisting of a little more than six feet and a half, is contained in 48 feet a little more than seven times; so Mr Brooke tried, by charging 48 feet only to a little more than four grains, or only about one-seventh part so high, as four times seven is 28; that is, but two less than 30: and this had exactly the same effect on the wire, which was $\frac{1}{170}$th of an inch in diameter, and three inches long, as it had upon the former.

31. As the last experiment agreed so exactly with experiments 19. and 20. the next thing tried was to see the effect of 48 feet of coated surface charged to a little more than four grains upon six inches of steel wire, the size of the last; this was made very faintly red.

32. By a repetition of this last experiment, with the same length of the same wire, to see how often the same charge might be sent through it without melting it, and to observe the appearance of the wire after each shock, he found that by the eighth shock it was melted into several pieces. After the first shock, the redness produced became less every time, even the last time, when it was separated. By the first shock, though made little more than fairly red, the wire became so flexible, that by a small addition to its own weight, it seemed to become almost perfectly straight when cooled: at about the third or fourth shock it began to assume a zig-zag appearance; after the sixth shock the surface of it appeared rough; after the seventh shock the surface was very roughly scorified or scaly; and some of the scales had fallen upon a piece of white paper placed at about half an inch distance below it. The eighth shock melted it in three places; and at these places where the angles appeared the sharpest or most acute, a great number of the scales were driven off about the paper, and appeared as in experiment 18; some of them were almost one-tenth of an inch long, and some of them about a third or fourth part of the diameter of the wire in breadth, and very thin; after the seventh shock it was shortened seven-sixteenths of an inch; the wire was $\frac{1}{170}$th of an inch in diameter.

33. Repeating experiment 31. again with the same length of wire of the same diamcter, and the same battery charged to the same degree, in order to observe the method of the wire shortening, having fixed an insulated gauge parallel to it and at the distance of about a quarter of an inch from it: after the first shock, which made the wire fairly red, (holding it fixed at one end, that the shortening might appear all at the other, which was held so that it might either contract or dilate) he observed, that it shortened considerably as it cooled; repeating the shock, it did the same, and so on till it was melted, which was by the eighth shock, as before. At the instant when the shock passed through the wire, it appeared to dilate a little; and after it was at the hottest, it gradually contracted after every stroke, as it cooled, about one-sixteenth of an inch each time; the dilatation was so very trifling, as to bear but a very small proportion to its contraction, and sometimes it was doubtful whether or not it dilated at all; but after all the observations it appeared oftener to dilate, than not.

34. The same 48 feet, negatively charged to a little more than four grains, melted three inches of steel wire $\frac{1}{170}$th of an inch in diameter, the same as the positive charge did in experiment 30.

35. The same battery of 48 feet of coated surface, charged to a little more than eight grains, melted three inches of steel wire, $\frac{1}{100}$th of an inch in diameter. This is very nearly in proportion to experiment 27, but here the charge was negative, and Mr Brooke says the fusion was the most pleasing he had hitherto had; which he attributes to the charge having been probably so well adjusted as to be exactly sufficient to melt the wire and no more: the heat remained for the longest time, and the fused metal ran into the largest globules; probably the long continuance of the heat was owing to the charge being just sufficient, and to the size of the lumps into which the fused metal was formed.

36. This was a repetition of experiment 1. with twelve inches of steel wire $\frac{1}{170}$th of an inch in diameter, but with this difference, that as then only nine bottles were employed, containing about sixteen feet of coated surface, charged to 32 grains, he here used 18 bottles containing about 32 square feet of coating charged

charged to only 16 grains. This was done to observe the progress of the destruction of the wire, as in experiment 32. as well as to prove the similarity of the effect. The wire being the same size, sort of metal, and length, as recited just above; the first shock made it red hot throughout its whole length, attended with smoke and smell, changed its colour to a kind of copperish hue, and shortened it considerably; the second shock made it of a fine blue, but it did not appear red, and shortened it more; at the third shock it assumed a zig-zag appearance, many radii were very visible at the bendings, and the wire continued to shorten till the eleventh shock, when one of the bottles in the second row of the battery was struck through: the fracture was covered over with common cement, and its place supplied by changing place with one in the third row, supposing the mended one to be the weakest; and with the battery in this state he made the twelfth shock, which separated the wire as in experiment 1. but shortened it only one inch.

37. A shock from 48 feet of coated surface, charged to eight grains, sent through three inches of copper wire $\frac{1}{170}$th of an inch in diameter, seven times, gave it the zig-zag appearance, but did not make it much shorter; the eighth shock separated it at one end close to the forceps which held it, but it did not appear to be made at all sensibly red hot, notwithstanding it must have been often so at the place where it was melted; which space was so very small as barely to be perceptible, like as when a point is set upon any flat surface of iron, and a shock from a pound phial sent through, both the point and flat surface where the point rested, if examined with a magnifying glass, will be found to have been melted, and a speck may be seen; but the redness of the metal will scarcely be visible.

38. A shock from 48 feet, charged to 16 grains, was sent through six inches of lead wire $\frac{1}{30}$th of an inch in diameter, and melted it into many pieces.

39. A shock from 48 feet, charged to 15 grains, was sent through six inches of wire like the last, which did not separate it, but made it smoke.

40. A shock like the last, was sent through the same piece of wire a second time, and melted it into several pieces.

The law by which wires resist destruction, in proportion to the diameter of the wire, does not seem to be nearly so equable in the lead as in the steel wire. For a charge of four grains, in experiment 34. melted three inches of lead wire $\frac{1}{60}$th of an inch in diameter; but it took a charge of about three times that power, to destroy three inches of lead wire $\frac{1}{30}$th of an inch in diameter; which is about double the quantity of metal in the same length as in that of $\frac{1}{60}$th of an inch in diameter. Thus, it is easy to find what different resistance a wire of any of the preceding metals, of equal size and length, will make to the electrical stroke.

The length of the electric circuit, in which the different wires were placed, in the foregoing experiments, from the nearest part of the inside to the nearest part of the outside of the battery, exclusive of the length of the said wires, was about eight feet.

41. Two gentlemen coming to see a piece of wire melted by electricity, Mr Brooke proceeded to shew it them, by fixing twelve inches of steel wire $\frac{1}{170}$th of an inch in diameter, and then (supposing the electrometer, and all other things ready placed), to charge the battery, but the electrometer did not move: nevertheless, he continued charging as he supposed; but still the electrometer remained as it was, although he had been charging much longer than would have been necessary, contrary to his design, which was to take a small wire, that a smaller charge might be sufficient. Having been charging a long time, Mr Brooke left off to look about the apparatus, in order to see if all was right: as he was looking, he found there was no communication between the battery and the electrometer, and he heard a slight crackling in the battery, which convinced him that it was charged. Accordingly he made the discharge, expecting nothing unusual; but the wire was dispersed seemingly in a very violent manner. The report was so very loud that their ears were stunned, and the flash of light so very great, that Mr Brooke's sight was quite confused for a few seconds.

203
Cuthbertson's compound electrometer.

Mr Cuthbertson has lately contrived an electrometer, which possesses all the advantages of Mr Brooke's, added to those of Lane and Henley, with which he has ingeniously combined it.

This valuable instrument is thus described by the inventor.

Plate CXCI. fig. 70.

The electrometer is represented in Plate CXCI. fig. 70. GH is a long square piece of wood, about 18 inches long, and six inches broad, in which are fixed three glass supports, DEF, mounted with brass balls, *a b c*. Under the brass ball *a*, is a long brass hook; the ball *c* is made of two hemispheres, the under one being fixed to the brass mounting, and the upper turned with a groove to shut upon it, so that it can be taken off at pleasure. The ball *b* has a brass tube fixed to it, about three inches long, cemented on to the top of F; and the same ball has a hole at the top, of about one-half inch diameter, corresponding with the inside of the tube. AB is a straight brass wire, with a knife-edged centre in the middle, placed a little below the centre of gravity, and equally balanced with a hollow brass ball at each end, the centre, or axis, resting upon a proper shaped piece of brass fixed in the inside of the ball *c*; that side of the hemisphere towards *c* is cut open, to permit the end *c* A of the balance to descend till it touches the ball *a*, and the upper hemisphere C is also cut open to permit the end *c* B to ascend; *i* is a weight, weighing a certain number of grains, and made in the form of a pin with a broad head; the ball B has two holes, one at the top, and the other at the bottom; the upper hole is so wide, as to let the head of the pin pass through it, but to stop at the under one, with its shank hanging freely in *b*; a number of such pins are commonly made to each electrometer of different weights (A); *k* is a common Henley's quadrant electrometer,

---

(A) Instead of the pins, which are found inconvenient, Mr Cuthbertson has lately constructed his electrometer with a sliding piece of brass, so adapted to the arm of the balanced wire, as by sliding near to, or farther from, the centre of gravity, to denote proportional weights.

trometer, and when in use, it is screwed upon the top of *c*.

It is evident, from the construction, that if the foot stand horizontal, and the ball B be made to touch *b*, it will remain in that position without the help of the weight *i*; and if it should by any means receive a very low charge of electric fluid, the two balls *b*, B, will repel each other; B will begin to ascend, and, on account of the centre of gravity being above the centre of motion, the ascension will continue till A rest upon *a*. If the balance be set again horizontal, and a pin *i*, of any small weight, be put into its place in B, it will cause B to rest upon *b*, with a pressure equal to that weight, so that more electric fluid must be communicated than before, before the balls will separate; and as the weight in B is increased or diminished, a greater or less quantity of electric fluid will be required to effect a separation.

When this instrument is to be applied to a jar, or battery, for which purpose it was invented, one end of a wire L, must be inserted into a hole in *b*, and the other end into a hole of any ball proceeding from the inside of a battery, as M (B) : *k* must be screwed upon *c*, with its index towards A; the reason of this instrument being added, is to shew, by the index continuing to rise, that the charge of the battery is increasing, because the other part of the instrument does not act till the battery has received its required charge.

If this instrument be examined with attention, it will be found to consist of three electrometers; and answers three different purposes, namely, a Henley's electrometer, Lane's discharging electrometer, and Brooke's steelyard electrometer; the first not improved, but the two last, which were very defective when first invented, I flatter myself are here brought to perfection. As the only use of Henley's electrometer to this instrument is, as I have said before, to shew, by its continuing to increase in divergency, that the battery continues to receive a still stronger charge, it required no improvement; but Lane's electrometer, in its primitive state, could by no means answer the required purpose for batteries, because the ball intended to discharge the battery, was necessarily placed so near to the ball of the battery, that dust and fibrous particles were always attracted by and adhered between the two balls, so as to retard the charging, and often render a high charge impossible: whereas, in this, they are placed at four inches asunder; and when the desired height of charge is obtained, and not before, the ball of the electrometer moves of itself nearer to the ball which is connected with the outside of the battery, and causes a discharge. The defects in Brooke's steelyard electrometer, were, 1st, that it could not cause a discharge; and, 2dly, the difficulty of observing the first separation of the balls caused great error. If it were not placed in an advantageous light (which the nature of the experiments could not always permit), it would not be seen, without the attention of an assistant, which is sometimes unpleasant, and cannot always be commanded. But the instrument which I have described, requires no attention or assistance; for as soon as the separation takes place between B and *b*, the ball A descends, and discharges the battery of itself.

By this combination and improvements, we possess in the present instrument all that can ever be required of an electrometer; namely, by *k*, we see the progress of the charge; by the separation of B, *b*, we have the repulsive power in weight; and by the ball A the discharge is caused, when the charge has acquired the strength proposed *.

* *Nicholson's Journ.* 4to. vol. ii. p. 528.

204
Col. Haldane's mode of measuring the charge of a battery.

With this electrometer Lieutenant Colonel Haldane has made some very ingenious experiments to determine the *exact* charge of a battery required to produce certain changes in wires of the same kind. His method of estimating the force of the charge is by the number of explosions that it is capable of producing in a jar connected with the outside coating of the battery. Thus, if the battery while charging produces three explosions of the jar, he says, it has received three *measures* of electricity.

205
Breathing into a jar makes it bear a higher charge.

Mr Cuthbertson having observed that when he breathed into a jar, it was thus rendered capable of receiving a higher charge, made the following experiments to ascertain the effect of such increased charge.

Exper. 1.—Prepare the electrometer in the manner shewn in the plate, with the jar M annexed, which contains about 168 square inches of coating (C) : put into B the pin marked 15; take two inches of watch-pendulum wire, fix to each end a pair of spring tongs, as is represented at G *m*; hook one end to *m*, and the other to the wire N, communicating with the outside of the jar; let the uncoated part of the jar be made very clean and dry; and let the prime conductor of an electrical machine, or a wire proceeding from it, touch the wire L: then, if the machine be put in motion, the jar and electrometer will charge, as will be seen by the rising of the index of *k*, and when charged high enough, B will be repelled by *b*, and A will descend and discharge the jar through the wire, which was confined in the tongs, and the wire will be fused and run into balls.

Exper. 2.—Put into the tongs eight inches of the same sort of wire as before; hang one pair of tongs to the hook *m*, and apply the other to the wire which forms the outside communication: take out the pin in B, and put in its stead one marked 30; all the other part of the apparatus remaining as before, and the uncoated part of the jar being previously cleaned and dried: the machine being then put in motion, the jar and electrometer will charge, as is shewn by the rising of the index as before; but as soon as the jar has received a greater quantity of electric power than before, a spontaneous explosion will happen without affecting the balls B *b*, because the discharge will have passed along the uncoated part of the jar from the inside coating to the outside: whence it follows, that, while that jar remains in that clean state, it

---

(B) A chain, or wire, or any body through which the charge is to pass, must be hung to the hook at *m*, and carried from thence to the outside of the battery, as is represented by the line N.

(C) Take out the pin in B, and observe whether the ball B will remain at rest upon *b*; if not turn the adjusting screw at C, till it just remains upon A.

Principles of Electricity illustrated by experiment.

rinciples Electri- ity illus- rated by periment

it is incapable of receiving a charge high enough to affect the balls, or even a higher charge than it had received in the first experiment. Let the uncoated part of the jar be therefore rendered, in a slight degree, damp; which is easily done, by breathing into the inside, through a glass tube; put the machine in motion, and no spontaneous explosion will happen, but the balls B *b* will repel, as in the first experiment, and the discharge will happen from A to *a*, and pass through the wire placed in the circuit; and though it was eight inches, it will be fused in the same degree as two inches in the last experiment, namely, the wire seen red hot the whole length, and then fall into balls.

Very different degrees of fusion are caused by electric discharges, which may cause great mistakes, if not well attended to. It is proper to adhere to the degree above mentioned, and particular care ought to be taken to lay the wire, intended for fusion, straight, without any bendings or angles in it. The wire used in the two last experiments, was that which is commonly called watch-pendulum wire, which is flatted; and as it approaches very near to such a sharp edge as might be supposed to affect the experiment, hy permitting a dissipation of the electric fluid in its passage, round wires were tried, and the result was the same.

206 bison's nparable etrome-

The late Dr Robison contrived an electrometer on similar principles with that of Mr Brooke, but much superior to it in simplicity of construction, and not inferior to any which have been invented in point of accuracy.

Plate CXCI. g. 71.

Fig. 71. exhibits a front view of this instrument, which is thus constructed. A polished brass ball A, a quarter of an inch in diameter, is fixed on the point of a common needle about three inches long, and as slender as can be procured of that length. On the other end of the needle is fixed a ball of *amber*, glass, or other solid non-conducting substance, of about half an inch or three quarters of an inch in diameter. This ball is fixed in such a way as that the needle does not quite reach to its surface, though the ball F must be completely perforated. From the electric ball there passes a slender glass rod, F, E, L, bent at right angles at E, so that the part FE is about three inches long, and the other extremity L is immediately opposite to the centre of the ball A. A piece of amber C, cut so as to have two parallel cheeks, is fixed on the extremity L of the glass rod. For the principal part of the instrument, a strong dry silk thread is to be prepared by holding it perpendicular in melted sealing-wax, till it shall be fully penetrated by the wax, so as to retain a thin coating of it. The thread, thus coated, must be kept extended, so that it may be quite straight, and it must be made perfectly smooth by holding it before a clear fire and rolling it on a smooth plane. It is then to be passed through a small cube of amber, that has two holes drilled in two of its opposite faces perpendicularly about half way to the stalk. By these holes the cube is suspended, so as to move readily, on two fine brass pins, between the cheeks of the piece of amber at L. The waxed thread is about six inches long, and is equally divided by the amber cube. To one end of it, B, is fixed a ball of some conducting substance, as of very thin polished metal, or gilt or burnished cork, a quarter of an inch in diameter. The other extremity, D, passes through a cork ball, so as to move with some friction.

This part of the instrument is so constructed, that when FE is perpendicular to the horizon, and the stalk BD, with its balls, is allowed to hang freely, the ball B just touches the ball A. This position is represented in fig. 71.

Fig. 72.

The ball F is fixed to one end of a glass rod FI, made to pass perpendicularly through the centre of a graduated circle HO, and furnished at its other extremity I with a knobbed handle of boxwood. HK is the stand of the electrometer, in the head of which is a hole in which the rod FI moves smoothly but not easily. Farther, there is adapted to the glass rod FI an index NH that turns round it. This index is so placed as to be parallel to a line LA drawn through the centre of the ball A. Now, as the circle is divided into 360 degrees, 0 being marked above and 90 on the right hand; the index will point out the angle which the line LA makes with the vertical line. It is convenient to have another index on the rod FI turning stiffly round it, and extending considerably beyond the circle.

The method of using this instrument will be shewn when we speak of the law of electric action in the next part.

CHAP. X. *Of the Electrophorus.*

207 Description of the electrophorus.

THE electrophorus is an instrument invented by Signior Volta of Como. It generally consists of two parts; a round plate of metal, or of wood, made perfectly free from points and edges, and covered with tinfoil; as A, fig. 73: and another circular plate of any conducting substance covered with a coating of some resinous electric, generally of lac dissolved in alcohol, melted sealing-wax, pitch, or of sulphur; as B. The first plate is furnished with a glass handle, or with silk strings, so that it may be occasionally insulated: to this plate Volta has given the name of *Scudo.*

Sometimes the apparatus is made in *three* parts, i. e. the resinous electric is formed into a cake independent of the plate B, and this is the most convenient method for experiment. To these three parts Dr Robison has given the following names; viz. the resinous electric he calls the *cake*, the plate B the *sole*, and the plate A the *cover;* and these names we shall adopt for the sake of convenience. For the purpose of exhibiting the appearances which we are about to describe in the most *brilliant* manner, the several parts may be made very thin in proportion to their circumference; but for illustrating the theory of the instrument, which we shall explain in the following part, they should be made of considerable thickness. The *sole* should be provided with an insulating stand.

The general appearances which have been observed with this apparatus may be reduced to the following heads.

1. If the *cake*, after being just formed, be suffered to remain on the *sole*, till it be perfectly cool and hard; while the *sole* is *insulated;* on examination, the whole will be found negatively electric, and on applying the finger to any part of it, especially the *sole*, a spark is produced. If the apparatus be now suffered to remain

Principles of Electricity illustrated by experiment.

at rest, its electricity gradually becomes weaker, and at length entirely disappears. It may, however, be again produced by rubbing the *cake* with a piece of new flannel, or, what is better, a piece of hare or mole skin with the fur on, made dry and warm. If after the cake has been thus *excited*, the *cover* be placed on it, by means of its insulating handle, and if it be again lifted off, *without being touched*, no electricity whatever can be observed in the cover.

2. If, however, the cover while in contact with the cake, be touched with the finger, a smart pungent spark will be obtained from the cover: and if, while the finger touches the cover, the thumb is placed upon the sole, a sensible shock will be felt between the finger and thumb.

3. After the above spark or shock has been obtained, the electricity of the electrophorus disappears, and the apparatus is said to be dead; no signs of electricity appearing in either sole or cover, so long as the latter remains in contact with the cake.

4. But if the cover be raised to some distance from the cake, and in a direction parallel to it, and if the cover be touched while held in this position, a smart spark will appear between it and the finger, and will even strike at some distance. This spark will be more remarkable, if obtained from the upper surface of the cover, especially from its edge, which, if it has not been well rounded, will even throw off sparks into the air. The spark received from the cover under these circumstances is, however, not so pungent as that mentioned in N° 2. resembling a spark from any electrified conductor.

5. When the cover is thus raised from the cake, the former is found *positively* electrified, and the latter, as before, *negatively*.

6. But the electricity of both cover and cake, while in contact, is *negative*.

7. The appearances above described may be repeated for a considerable time, with apparently undiminished vivacity, without re-exciting the cake by friction; the apparatus has been observed to retain its electric power, even for several months. Hence it serves as a kind of electrical magazine, and may be repeatedly employed for charging jars, either *positively*, by imparting to the jar the electric spark from the cover while raised from the cake; or *negatively*, by receiving the sparks from the cover in contact with the cake. From this property of retaining the electric power for so long a time, Signior Volta denominated the apparatus *electrophorus*, or *elettroforo perpetuo*.

8. If before placing the cover on the cake, the sole has been insulated, the same spark may be obtained from the cover, and the same shock may be felt on touching both cake and cover at the same time; but the spark, in this case, is by no means so pungent as that obtained when the sole has not been insulated.

9. If, when the sole has been insulated, the cover be again lifted to a considerable distance from the cake, the sole will be found electrical, and its electricity will be the same as that of the cake, or *negative*.

10. If, after touching both sole and cover, the cover be raised from the cake, by its insulating handle, and again replaced upon the cake, without being touched while separate, the whole apparatus is found to possess no electricity.

Principles of Electricity illustrated by experiment.

11. If both sole and cover be inactive after being joined, they will, when separated, show opposite electricities; the cover being electrified *positively*, and the sole *negatively*.

12. If both cover and sole be rendered inactive while separate, they will, when placed in contact, be found to possess the electricity opposite to that of the cake, i. e. they will together be in a state of positive electricity.

208
Mr Cavallo's experiments on the electrophorus.

It is of little consequence what substance forms the basis to which the electric coating is applied; formerly a glass plate was employed, and this was coated with various resinous electrics. Mr Cavallo, who made several experiments on the construction and phenomena of the electrophorus, found that the most convenient electric was made with the second sort of sealing-wax spread upon a thick glass plate. A plate made by him after this manner, the diameter of which was no more than six inches, was, when once excited, capable of charging a coated phial so strongly, that by the explosion, a card could be perforated; this phial might be charged several times successively, without again exciting the plate. Sometimes the cover, when separated from the plate, was so strongly electrified, that it darted strong flashes towards the table on which the electric plate was laid, and even into the air. "The power of some of my plates," says Mr Cavallo, "is so strong, that sometimes the electric plate adheres to the metal when this is lifted up; nor will they separate even when the metal plate is touched with the finger, or other conductor.

"If, after having excited the sealing-wax," continues he, "I lay the plate with the wax upon the table, and the glass uppermost, i. e. contrary to the common method, then, on making the usual experiment of putting the metal plate on it, and taking the spark, &c. I observe it to be attended with the contrary electricity; that is, if I lay the metal plate upon the electric one, and while in that situation touch it with an insulated body, that body acquires the *positive* electricity, and the metallic, removed from the electric plate, appears to be negative; whereas it would become positive if laid upon the excited wax. This experiment, I find, answers in the same manner, if an electric plate is used which has the sealing-wax coating on both sides, or one of Mr Adams's, which has no glass plate.

"If the brass plate, after being separated from, be presented with the edge towards the wax, lightly touching it, and thus be drawn over its surface, I find that the electricity of the metal is absorbed by the sealing-wax, and thus the electric plate loses part of its power; and if this operation be repeated five or six times, the electric plate loses its power entirely, so that a new excitation is necessary to revive it."

There is one part of Mr Cavallo's experiments upon the electrophorus, which by no means accords with the account of the phenomena given by us in Nos. 8, 9, 10, 11, 12.

"If," says he, "instead of laying the electric plate upon a table, it be placed upon an electric stand so as to

Principles of Electricity illustrated by experiment.

to be accurately insulated, then the metal plate set on it acquires so little electricity, that it can only be discovered by an electrometer.

Plate CXCI. fig. 73.

"Upon an electric stand E, fig. 73, I placed a circular tin plate, nearly six inches in diameter, which, by a slender wire H, communicated with an electrometer of pith-balls G, which was also insulated upon the electric stand F. I then placed the excited electric plate D, of six inches and a quarter in diameter upon the tin plate with the wax uppermost, and on removing my hand from it, the electrometer G, which communicated with the tin plate, i. e. with the under side of the electric plate, immediately opened with negative electricity, &c. *.

It is somewhat extraordinary that so expert an electrician as Mr Cavallo should assert that an insulated electrophorus shows weaker signs of electricity than one uninsulated; whereas, in fact, the electricity in the former case is generally stronger than in the latter, and always so strong as to afford sparks from some part of the apparatus.

209 Mr Morgan's experiments. fig. 74.

Mr G. Morgan has given us some valuable experimental observations on the *Insulated Electrophorus*. His apparatus consists of a rounded piece of wood, AB, fig. 74. with smooth edges and covered with tin-foil, placed on an insulating stand CD. On this board or sole is placed the electric plate or cake; *a b* is a wire with a brass ball from which are hung the electrometer balls *g h*. G represents the *scudo* or *cover*. After relating the usual appearances produced by friction, he proceeds to describe those which arise from connecting the cake with opposite sides of a Leyden phial.

"When the negative surface of a charged phial is placed on the excited surface, by bringing the hand into contact with the opposite side of the phial, a spark is instantly communicated, and the pith-balls *g* and *h*, separate negatively.

If the phial be taken off, and the scudo placed in its room, no change is observable on the subsequent removal of the scudo, provided that no communication has been formed between it and the ground. When such a communication is formed, a charge is communicated, and the scudo and the balls are in opposite states of electricity.

If the positive side of a Leyden phial be placed on the excited surface, the pith-balls separate positively. It must be observed that these experiments are made with a resinous substance.

The appearances of the pith-balls and scudo are materially varied, if the Leyden phial be applied to the electrophorus while the scudo is in contact with its excited surface. If the negative side of the phial be applied, and a spark be taken from the positive, the pith-balls immediately separate negatively; but on taking up the scudo, they immediately close, and as rapidly separate again positively.

If after the phial is removed, the hand be applied to the scudo before it is raised, a small spark strikes into the hand; but on raising the scudo, the balls close and separate instantaneously, and give signs of positive electricity.—If the scudo and the brass plate be connected, either by an insulated or uninsulated discharging rod, the balls close and separate again, and the scudo, upon being raised, receives a vigorous negative spark.

Principles of Electricity illustrated by experiment.

It is obvious that in all the preceding experiments, the brass plate continues unchangeably adherent to the lower surface, while the scudo only, or the conducting substance in connection with the upper surface, is immoveable. It is of importance that we should know the consequences of making both the metallic surfaces moveable.

But this is not an easy matter; it is very difficult to get a resinous substance thin enough, and at the same time firm enough, for the purpose. The perfect laminæ of talc, which I have been able to procure, are too small to be used with any satisfaction; I have therefore had recourse to glass for the purpose. The result of my repeated trials is the following.

Having substituted a glass plate, about twelve inches in diameter, and one-fourth of an inch thick, in the room of the resinous substance, and having rested it on a ground metallic plate, five inches in diameter, and well connected with the pith-balls *g* and *h*, I exposed it to the sparks of a conductor charged positively, and kept my hand at the same time in connexion with the wire *a b*. The plate took a considerable charge; its upper side was unequivocally positive, and its lower side negative. I placed the scudo on the glass thus charged, and approaching it with my hand, I received a spark. I then approached *a b* with my hand, and received another. By alternate approaches of this kind, four or five times repeated, the sparks became weaker and weaker till they disappeared; the scudo was then raised, and was strongly negative; but the pith-ball, on the removal of the scudo, closed and separated positively.

I then made the lower the upper surface; and placing the scudo upon it, formed the communication, as in the preceding part of the experiment; but upon being raised, the scudo was strongly positive, and the balls negative.

But if, previous to the placing the scudo on the glass, the pith-balls be carefully discharged of all adherent electricity, both the upper and lower sides of the glass will be charged with positive electricity, or will give signs of their being in the same state at the same time.

It is observable that the succession of electrics, in the preceding experiments, seems to vary according to the priority of contact given to the wire or the scudo. But though this happens most frequently, yet such anomalies take place as not to justify us in considering this singular connection of diversities as by any means certain †."

Chap. XI. *Observations and Experiments on Excitation and Electrical Machines, with the description of an Electrical Machine in which Silk is employed instead of Glass.*

Mr Nicholson published in the Phil. Trans. for 1789, some valuable observations on the best means of excitation, which we shall here extract.

210 Nicholson's experiments on excitation.

1. A glass cylinder was mounted, and a cushion applied with a silk flap, proceeding from the edge of the cushion over its surface, and thence half round the cylinder. The cylinder was then excited by applying an amalgamed leather in the usual manner. The electricity was received by a conductor, and passed off in sparks.

---

* Cavallo's Electricity, vol. ii.

† Morgan's Lectures, vol. i.

Principles of Electricity illustrated by experiment.

sparks to Lane's electrometer. By the frequency of these sparks, or by the number of turns required to cause spontaneous explosion of a jar, the strength of the excitation was ascertained.

2. The cushion was withdrawn about one inch from the cylinder, and the excitation performed by the silk only. A stream of fire was seen between the cushion and the silk; and much fewer sparks passed between the balls of the electrometer.

3. A roll of dry silk was interposed, to prevent the stream from passing between the cushion and the silk. Very few sparks then appeared at the electrometer.

4. A metallic rod, not insulated, was then interposed instead of the roll of silk, so as not to touch any part of the apparatus. A dense stream of electricity appeared between the rod and the silk, and the conductor gave very many sparks.

5. The knob of a jar being substituted in the place of the metallic rod, it became charged negatively.

6. The silk alone, with a piece of tinfoil applied behind it, afforded much electricity, though less than when the cushion was applied with a light pressure. The hand being applied to the silk as a cushion, produced a degree of excitation seldom equalled by any other cushion.

7. The edge of the hand answered as well as the palm.

8. When the excitation by a cushion was weak, a line of light appeared at the anterior part of the cushion, and the silk was strongly disposed to receive electricity from any uninsulated conductor. These appearances did not obtain when the excitation was by any means made very strong.

9. A thick silk, or two or more folds of silk, excited worse than a single very thin flap. He used the silk which the milliners call Persian.

10. When the silk was separated from the cylinder, sparks passed between them; the silk was found to be a weak negative, and the cylinder in a positive state.

211
The silk flap the principal cause of excitation.

The foregoing experiments show that the office of the silk is not merely to prevent the return of electricity from the cylinder to the cushion, but that it is the chief agent in the excitation; while the cushion serves only to supply the electricity, and perhaps increase the pressure at the entering part. There likewise seems to be little reason to doubt but that the disposition of the electricity to escape from the surface of the cylinder is not prevented by the interposition of the silk, but by a compensation after the manner of a charge; the silk being then as strongly negative as the cylinder is positive; and, lastly, that the line of light between the silk and cushion in weak excitations does not consist of returning electricity, but of electricity which passes to the cylinder, in consequence of its not having been sufficiently supplied during its contact with the rubbing surface.

11. When the excitation was very strong in a cylinder newly mounted, flashes of light were seen to fly across its inside, from the receiving surface to the surface in contact with the cushion, as indicated by the brush figure. These made the cylinder ring as if struck with a bundle of small twigs. They seem to have arisen from part of the electricity of the cylinder taking the form of a charge. This appearance was observed in a 9-inch and a 12-inch cylinder, and the property went off in a few weeks. Whence it appears to have been chiefly occasioned by the rarity of the internal air produced by handling, and probably restored by gradual leaking of the cement.

Principle of Electr city illu trated b experimen

212
State of the insid of a cylin der durin excitatio determin ed.

12. With a view to determine what happens in the inside of the cylinder, recourse was had to a plate machine. One cushion was applied with its silken flap. The plate was 9 inches in diameter and $\frac{2}{10}$ths of an inch thick. During the excitation, the surface opposite to the cushion strongly attracted electricity, which it gave out when it arrived opposite to the extremity of the flap: so that a continual stream of electricity passed through an insulated metallic bow terminating in balls, which were opposed, the one to the surface opposite the extremity of the silk, and the other opposite to the cushion; the former ball showing positive and the latter negative signs. The knobs of two jars being substituted in the place of these balls, the jar applied to the surface opposed to the cushion was charged negatively, and the other positively. This disposition of the back surface seemed, by a few trials, to be weaker, the stronger the action of the cushion, as judged by the electricity on the cushion side.

Hence it follows, that the internal surface of a cylinder is so far from being disposed to give out electricity during the friction by which the external surface acquires it, that it even greedily attracts it.

13. A plate of glass was applied to the revolving plate, and thrust under the cushion in such a manner as to supply the place of the silk flap. It rendered the electricity stronger, and appears to be an improvement of the plate machine.

14. Two cushions were then applied on the opposite surfaces with their silk flaps, so as to clasp the plate between them. The electricity was received from both by applying the finger and thumb to the opposite surfaces of the plate. When the finger was advanced a little towards its correspondent cushions, so that its distance was less than between the thumb and its cushion, the finger received strong electricity, and the thumb none; and, contrarywise, if the thumbs were advanced beyond the finger, it received all the electricity, and none passed to the finger. This electricity was not stronger than was produced by the good action of one cushion applied singly.

15. The cushion in experiment 12. gave most electricity when the back surface was supplied, provided that surface was suffered to retain its electricity till the rubbed surface had given out its electricity.

213
No adva tage gain ed by rub bing two sides of the plate machine.

From the two last paragraphs it appears, that no advantage is gained by rubbing both surfaces; but that a well managed friction on one surface will accumulate as much electricity as the present methods of excitation seem capable of collecting; but that, when the excitation is weak, on account of the electric matter not passing with sufficient facility to the rubbed surface, the friction enables the opposite surface to attract or receive it, and if it be supplied, both surfaces will pass off in the positive state; and either surface will give out more electricity than is really induced upon it, because the electricity of the opposite surface forms a charge. It may be necessary to observe, that I am speaking of the facts or effects produced by friction; but how the rubbing surfaces act upon each other to produce

Principles of Electricity illustrated by experiment.

which the attractive power of the prime conductor is rendered perceptible on a thread or other pendulous body; or, laſtly, the exploſion produced from a certain extent of coated ſurface. The firſt of theſe methods is ſubject to conſiderable variation from the circumſtances mentioned in (88.), and the ſecond is ſubject to modification both from the ſtructure of the leſs eſſential parts of the machine, and from the dimenſions and figure of the apartment in which the experiments are made. The laſt method is therefore moſt generally employed, and according to this, Mr Nicholſon gives the following eſtimate of the comparative power of Van Marum's two machines deſcribed in N° 48, 49.

222 Comparative power of Van Marum's machines.

By 150 turns of his new machine, 90 jars, each containing upwards of a ſquare foot of coated glaſs, were charged ſo that the battery diſcharged itſelf. The great Teylerian machine, with two plates of ſixty-five inches diameter, in its original ſtate, before Dr Van Marum's improved rubbers were applied to it, never charged the ſame battery, in the moſt favourable circumſtances, in leſs than 66 turns. It follows, therefore, that this ſmall and ſimple machine exhibited $\frac{66}{150}$ths, or about $\frac{4}{9}$ths of the power of that great machine in its firſt ſtate; and probably, if the circumſtances had been alike favourable in each, it would have amounted to one half. The doctor has grounded a calculation upon theſe facts; but as he ſtates the rubbed ſurfaces of theſe two machines, probably by ſome miſtake in calculation, to be 1243 and 9636 ſquare inches reſpectively, I ſhall repeat the calculation in this place.

The diameter of the plate is 31 inches, and the length of the cuſhion 9 inches. Then $31.7854 - \overline{31-18}|^{2}.7854 = 522$ ſquare inches rubbed by one cuſhion on one ſide. And $522 \times 4 = 2088$ ſquare inches rubbed by the four cuſhions. Again, in the great machine, the two plates having a diameter of 65 inches, and eight cuſhions of $15\frac{1}{2}$ inches long, $\overline{65}|^{2}.7854 - \overline{65-31}|^{2}.7854 = 2410.4$. And $2410.4 \times 8 = 19283$ ſquare inches rubbed. But the intenſity of the electric power of a machine will be in the compound ratio inverſely of the ſurfaces and number of turns when the charge is the ſame; or $150 \times 2088 : 66 \times 19283 :: 1$ = the intenſity of the larger machine : 4 = the intenſity of the ſmaller.

To have increaſed the power of ſteady excitation four-fold, is certainly an aſtoniſhing acquiſition. This expreſſion, however, of the intenſities appears to be leſs generally uſeful than that of the ratio of the ſurface rubbed, to that which is charged. This laſt expreſſion becomes very ſimple when the latter quantity is reduced to 1, or unity. Thus, in the two machines here mentioned, the rubbed ſurfaces in inches for the battery are $\frac{19283 \times 66}{90 \times 144}$, and $\frac{2088 \times 150}{90 \times 144}$, which are equal to the ſimple numbers 90.5 and 24.0, which reſpectively denote the number of inches rubbed to charge one inch of coated glaſs.

223
ate ma-
hine pre-
rable to
cylindri-
l.

From comparing the effects of his own machines in the higheſt degree of excitation with thoſe produced by the great machine at Haarlem, Mr Nicholſon had been induced to give the preference to the cylinder. From later experience, however, and the account of the effects produced by Van Marum's new machine, Mr Nicholſon has been led to alter his opinion; and he now prefers a plate to a cylinder.

Principles of Electricity illustrated by experiment.

From conſidering the defects of the uſual methods of eſtimating the power of machines, Mr Cuthbertſon was led to propoſe the exploſion of ſteel wire as a proper meaſure; and he has made ſeveral experiments to ſhew that this method is the leaſt liable to error. Mr Nicholſon has given an account of theſe experiments in his Journal for Auguſt 1798; but they ſeem to require a repetition and farther extenſion before they can be received as concluſive.

224 Cuthbertſon's method of meaſuring the power of machines.

225 Subſtitutes for glaſs in electrical machines.

As glaſs, though preferable to all electrics that can be employed for the purpoſes of excitation, from its durability and unchangeable nature, is from its brittleneſs attended with conſiderable expence, various expedients have been thought of to ſubſtitute in its place ſome other electric in the conſtruction of electrical machines.

Dr Ingenhouſz, the inventor of the plate machine, made a variety of experiments for this purpoſe. Paſteboard thoroughly dried and heated, and then ſoaked and varniſhed with a ſolution of amber in linſeed oil, formed plates which were ſtrongly electrified when rubbed with a cat's ſkin or hare's ſkin. He tried baked wood boiled in linſeed oil, but with leſs ſucceſs. A cylinder of ſtrong ſilk velvet, formed by ſtretching that ſubſtance upon two circular wooden diſks, was found to afford conſiderable electrical force when cauſed to revolve againſt a cuſhion covered with hare's ſkin [*]. And laſtly, the ſame philoſopher contrived a portable apparatus for charging a jar by means of a varniſhed ſilk ribband, expoſed to the friction of a rubber attached to the external coating, while the oppoſite electricity of the ſilk was taken off by a metallic part communicating with the inſide.

It was at the beginning of 1784, that M. Walckiers de St Amand undertook to conſtruct a machine, in which a piece of ſilk was made to revolve inceſſantly, and paſs between two pair of rubbers. He made one of ſmall dimenſions, and afterwards a larger one, in which the ſilk was twenty-five feet in length, and five feet broad. In the following year M. Rouland, profeſſor of natural philoſophy in the univerſity of Paris, conſtructed a machine of the ſame kind [†]. As the advantages and effects of theſe machines appear to be conſiderable, we ſhall here inſert the deſcription of the latter from Nicholſon's Journal for December 1798.

226 Deſcription of a ſilk machine. Plate CXCIV. fig. 80.

A, B, fig. 80. is a wooden table four feet and a half long, two feet nine inches wide, and ſomewhat more than an inch and a half thick: its feet are 18 inches long. Upon this table are faſtened by ſtrong wooden ſcrews, *a b c d*, two croſs pieces, each nine inches broad, which carry the uprights C, D, E, F, which laſt are 27 inches in height. At about two-thirds or more of the height of theſe uprights, there are cut notches of an inch ſquare each, in which the axes of the two cylinders G and H turn freely. Theſe axes are parallel to the table and to each other, and are kept in their place by clamps of wood ſcrewed over them. The cylinders G and H are formed of light wood glued together, and covered at the ends by a circular piece, whoſe rounded edges ariſe half an inch above the ſurface of the cylinders themſelves. Their diameter is eight inches; the axes are of box-wood, and are leſs than an inch in diameter, having a ſhoulder which prevents the ends of the cylinders

---

[*] *Phil. Tranſ.* for 1779.

[†] *Deſcription des machines electrique à taffetas par M. Rouland.*

from touching the uprights when turned round; and laſtly, the cylinders are covered with ſerge.

The handle is copper, its radius being ſix inches long.

K, L, is a piece of taffety covered with oily and reſinous matter, of the ſame kind as is uſed in France in the conſtruction of air-balloons, which M. Rouland ſays, renders the ſilk very electrical: the breadth of the ſilk is nearly one inch leſs than the length of the cylinders, and it is wrapped round them with its ends ſewed together.

The whole breadth of the ſilk is taken hold of or pinched between two flattened tin tubes oppoſite each other at M, and two of the ſame kind at N: theſe are the rubbers, and may be made to preſs againſt each other, more or leſs ſtrongly, by means of ſcrews. They are retained by ſtrings of ſilk faſtened to the four uprights of the machine. *v v* are two braſs chains hooked upon the rubbers, and communicating with the earth; *o p* and *q r* are four pieces of taffety, prepared in the ſame manner as the principal piece, ſewed in the direction of their length to the rubbers, and faſtened to each other by their correſponding corners by means of threads of ſilk. The metallic tubes or rubbers are covered with cat's ſkin.

S repreſents the conductor. It is a cylinder of braſs three inches in diameter, 36 inches in length, including the balls at the end, whoſe diameters are four inches: one of theſe balls has a ring, *t*, above it, which ſerves to form a communication between the conductor S and any other conductor.

The upper and lower parts of this cylindrical prime conductor are armed with two plates of braſs *y y*, whoſe length is equal and correſpondent to the breadth of the taffety, which is 26 inches, and 132 inches or 11 feet long: the edges of the plates are about half an inch diſtant from the ſilk, and ſerve inſtead of the metallic points that were uſed by M. Walckiers, but rejected by M. Rouland, becauſe they were apt to ſtick into the ſilk and damage it.

The conductor S is ſuſpended by ſilk ſtrings, faſtened to the uprights of the machine by the hooks and rings *i i*: its ſituation is parallel to the cylinders G, H, and equidiſtant from each. The action of this machine is as follows: The cylinder H is moved rapidly on its axis by means of the handle, and the cylinder G moves of courſe in the ſame direction on the two extremities of its axis, provided the taffety K, L, be properly ſtretched. This tenſion is eaſily obtained; becauſe the croſs pieces to which the uprights C, D, and E, F, are fixed, may be moved nearer or further from each other, and faſtened by means of the ſcrews *a b* and *c d*, which paſs through holes cut in the direction of the table.

The rotation of the cylinders neceſſarily producing a circulation of the taffety, it muſt conſequently be rubbed in its paſſage between the tin tubes covered with cat's ſkin at M and N; and by this friction it obtains what is called the negative electricity, which is communicated from both parts of the ſilk to the common conductor S. But it may be made to electrify poſitively, by removing the rubbers to the middle of the ſilk, ſo that the prime conductor may communicate with them: or, if the two cuſhions be removed to half the diſtance between the revolving cylinders and the prime conductor, poſitive and negative electricity may be had at the ſame time, the rubbers being in a negative ſtate, and the prime conductor in a poſitive ſtate.

The advantages of a machine of this conſtruction beyond thoſe of glaſs are ſtated by the inventor to be, 1. It is not brittle in any part. 2. Its excitation is more ſteady, becauſe it requires no amalgam. 3. Its dimenſions have no limit.

The power of excitation in this way appears to have been very conſiderable. The facts are not related with ſo much detail as could be wiſhed in the report of the academy; but it appears that the negative ſparks from the conductor of Walckiers, which was five feet long, were from 15 to 17 inches in length, very loud and denſe, and very painful to the hand; that pointed bodies emitted very ſenſible ſparks to the conductor; and that a battery of 50 ſquare feet was charged by 30 turns of the machine, which gives 19 feet of ſilk rubbed to charge one foot of glaſs *. In another inſtance, however, it is ſaid, that a ſquare foot was charged by one turn of the machine, which anſwered to 31½ ſquare feet of ſilk. It is not ſaid whether the labour of turning was conſiderable or not.

M. Rouland made ſeveral trials to ſubſtitute plain ſilk inſtead of that which was varniſhed; and he alſo tried woollens and mixed cloth containing goat's hair; but none of theſe anſwered to his ſatisfaction.

CHAP. XII. *Of the Electric Properties of Air.*

227 Heated air ſaid to be a conductor.

WE have ranked air among the electrics, but it will be ſeen by the table of electric ſubſtances given in page 646. that it is but an imperfect electric. We have obſerved at the beginning of this part, that it may even become a conductor by being impregnated with moiſture. It is alſo found that when air is heated to a conſiderable degree, it becomes a conductor; this, according to Cavallo, may be ſhewn by the following experiment. Electrify a common ball electrometer, or the prime conductor with Henley's quadrant electrometer placed upon it; the balls will, of courſe, ſeparate from each other, or the index of the quadrant will denote the degree of electricity communicated to the prime conductor. Now bring a red-hot iron within a ſufficient diſtance of the electrometer or the prime conductor, and it will be found that they ſoon loſe their electricity, it being conducted away by the heated air that ſurrounds the iron: that the heated iron is the cauſe of the loſs of electricity may be proved, by repeating the experiment with the ſame iron when cold, as in this caſe it will be found that the electrometer of the conductor will not loſe its electricity ſo ſoon, unleſs the iron be brought very near.

Mr Read made the following experiment to prove that hot air is not a conductor.

228 This denied by Mr Read.

"It has been," ſays Mr Read, "commonly ſaid, that hot air conducts electricity. With a view to aſcertain this matter, the following experiments were made. To one end of a long piece of wood (which ſerved as a handle), was fixed a glaſs rod fifteen inches long; to the remote end of the glaſs was fixed a pithball electrometer. Having electrified the balls, I held them by the wood handle, and projected them into a large oven, immediately after the fire was drawn out of it; the conſequence was, that when I performed the operation ſlowly, the balls loſt their electricity; but that

---

* See Phil. Journal, i. 87.

that when done quick, with as little delay as poſſible, their electric charge was not diminiſhed. The loſs of electricity in the firſt caſe, was found to have eſcaped along the glaſs into the wooden handle, and ſo to the earth, owing to the great heat the glaſs rod had acquired, by which it became a conductor of the fluids; for until it had cooled a little, the balls could not be charged again.

“ I ſhall lay before the reader one circumſtance more, becauſe it may tend to throw light on what degree of heat the oven was in at the time the obſervations were made. The baker having pointed out to me the hotteſt part of the oven; with a quick motion in and out, I plunged the electrified balls into that part of it, by which one thread ball was burned off, but the remaining ball ſhewed that it ſtill retained its electric charge, becauſe it was ſtrongly attracted on the approach of my finger*.

Air, as an electric, may be electrified either by *excitation* or by *communication*.

229 Means of exciting air. Air may be excited by any circumſtance which tends to produce motion among its particles; as by friction, evaporation, heat and cold, expanſion and contraction, and by any chemical proceſſes in which theſe circumſtances are produced.

230 Friction. 1. That air may be excited by friction was ſufficiently ſhown by the experiments related to demonſtrate the ſenſibility of Bennet's electrometer; by theſe experiments it appeared, that whenever a cloud of duſt, or powder was raiſed in the air ſurrounding the electrometer, the ſlips of gold leaf, by their ſeparation, manifeſted ſigns of electricity, which muſt doubtleſs have been produced by the attraction of the particles of duſt or powder againſt the particles of air.

231 Evaporation. 2. Air may be rendered electrical by the vapour or ſmoke which riſes into it from evaporating or burning ſubſtances. At the end of the firſt part of this article, we noticed, in a general way, Sig. Volta's experiments on the electricity produced by evaporation; we muſt now conſider this ſubject rather more at large. The production of electricity by evaporation, may be ſhown by the following experiments.

Plate XCIV. fig. 81. *Exper.* 1. Upon the cap of Bennet's electrometer *c*, fig. 81. place a metallic cup containing a little water; drop into the water a red hot coal, or a red-hot piece of clean iron; a vapour will ariſe from the water, and the ſtrips of gold leaf *n n* will diverge with ſtrong negative electricity. If, at the ſame time, an iron wire *p*, fixed to a rod of glaſs or ſealing-wax, with a common ball electrometer hanging from its extremity, be held by the glaſs or ſealing-wax in the air, at a little diſtance above the cup, the balls *d* will be found to diverge with poſitive electricity.

Fig. 82. *Exper.* 2. Let there be two of the above electrometers, as A, B, fig. 82.; upon the cap of the electrometer B, place a metallic cup *d*, as in the laſt experiment, and into the cap of the electrometer A, let there be ſcrewed a bent wire *m*, with a piece of tin *s* ſoldered to its other extremity. If now, the electrometer B with its metallic cup be placed immediately below the tin *s*, and a cullender *c*, containing a few live coals, be held over the cup, and if water be poured from the jug upon the coals in the cullender, ſo as to fall into the metal cup, the ſlips of gold leaf in both electrometers will diverge; thoſe of the electrometer B, with negative electricity, and thoſe of the electrometer A, with poſitive electricity.

The experiments on the electricity produced by evaporation, may be very conveniently made by heating the ſmall end of a pretty long tobacco pipe, and pouring water into the bowl of it; the water running down to the heated part, which ſhould be held over the cap of Bennet's electrometer, is ſuddenly expanded into vapour, and the ſlips of gold leaf will ſeparate with negative electricity.

232 The electricity of evaporating bodies not always negative. In the above experiment it has been ſeen, that the electrometer from which the vapour aroſe, was always electrified negatively; from having obſerved this to be always the caſe in his experiments, Sig. M. Volta conſidered it as a general law. Mr Cavallo, however, mentions ſome experiments made by a profeſſor at Mantua, and by himſelf, which ſeem to contradict this ſuppoſition.

All the experiments, (ſays Mr Cavallo), made on evaporation for ſome years after this diſcovery, were attended with reſults conformable to the above-mentioned general law; but two remarkable exceptions have of late been diſcovered, which, beſides their contradicting the ſaid law, ſeem to point out a more intimate connection between the electric fluid and other bodies. The firſt of theſe exceptions was diſcovered and publiſhed three years ago, by a learned profeſſor of the academy of Mantua; the ſecond was very lately diſcovered by myſelf.

The Mantuan profeſſor obſerved, that when water was evaporated by being put in contact with a red-hot piece of ruſty iron, it would leave the iron electrified poſitively; whereas when the experiment was tried with a clean piece of iron, the electricity acquired by the metal would be of the negative kind.

When I firſt attempted to repeat this curious experiment, the reſult did by no means anſwer my expectations; the electricity, which was produced being of the negative, and not of the poſitive kind; but obſerving that ſometimes no ſenſible degree of electricity was produced, though the evaporation was very quick and copious, I began to ſuſpect that the iron, which I had employed, was not ſufficiently covered with ruſt, in conſequence of which two oppoſite ſtates of electricity might poſſibly be produced, viz. the negative from the clean, and the poſitive from the ruſty part of the iron: which two oppoſite ſtates, by counteracting each other, would leave the iron unelectrified. After various repetitions of this experiment, in which the red-hot iron was thrown into the inſulated water, or the water was poured upon the red-hot and inſulated iron, I found that this was actually the caſe.

I procured ſome old iron nails, which had remained expoſed to the atmoſphere for ſeveral years, and of courſe had contracted a very thick coat of ruſt; and on performing the experiment with them, I obtained poſitive electricity, agreeably to the aſſertion of the abovementioned gentleman. The ſame nail very ſeldom would anſwer for more than one experiment; for the action of the fire and of the water generally removed a great deal of the ruſt, and exhibited the naked metal, which would afterwards acquire the negative electricity. Here follows the manner of performing this remarkable experiment.

Inſulate a metallic or earthen plate, and pour a ſmall

---

* *Read's ſummary view of ſpontaneous electricity.*

ſmall quantity of water in it, and let a ſenſible electrometer be connected with the water; then drop a red-hot piece of iron into the plate, and it will be found, that if very ruſty iron be uſed, the electrometer will be opened with poſitive electricity; if the iron be clean, or free from ruſt, the electrometer will acquire the negative electricity; and laſtly, if the iron be partially ruſty, the electrometer will acquire little or no electricity, though in every caſe the evaporation may be equally quick and copious.

The other exception of the above-mentioned general law is ſhown by means of red-hot glaſs, which I chanced to diſcover very lately. The various degrees of electric power that are produced by the evaporation of water from different ſubſtances induced me to diverſify the experiments as much as I could, in order to diſcover, if poſſible, the reaſon why thoſe different effects took place when the evaporation ſeemed to be equally quick and copious. Amongſt other ſubſtances, I tried glaſs, and found that it generally produced little or no electricity. The water was ſometimes poured upon the hot glaſs, but in general the hot glaſs was dropped into the inſulated water, which was contained in a tin cup. However, the difference of effect was found not to be occaſioned by thoſe two different modes of proceeding. Having repeated this experiment a great many times, I at laſt found, that the effect depended on the different nature of the glaſs. If white and clean flint glaſs be made red-hot, and in that ſtate be dropped into the veſſel of water, a quick evaporation will enſue, and the veſſel is electrified poſitively. If the flint glaſs be not very clear, there will not be any electricity generated by the evaporation, &c. And laſtly, if the experiment be tried with more impure glaſs, as the glaſs of which wine bottles are made, the negative electricity will be produced.

In performing this experiment, it is neceſſary to take care that no pieces of coal adhere to the glaſs, which will frequently happen when a piece of glaſs is heated in a common fire; for in that caſe negative electricity will be produced by the evaporation, though the beſt flint glaſs is uſed.

It has frequently happened, in the courſe of my experiments, that no electricity whatever has been produced by the evaporation of water from certain ſubſtances; however, as in thoſe caſes the evaporation was not very copious, I attributed the deficiency of electricity to the weakneſs of the evaporation. But a very remarkable inſtance of this ſort is mentioned in the diſſertation of the above mentioned ingenious profeſſor. He ſlaked 25 pounds weight of quicklime with a ſufficient quantity of water, and though a very copious evaporation took place, yet it was not attended with any electricity. Should any perſon ſuſpect, that the deficiency of electricity in this experiment was owing to the want of burning coals or actual fire, he ſhould conſider, that in other ſimilar proceſſes electricity is produced without any actual fire; thus the evaporation, which is occaſioned by the efferveſcence of iron filings in diluted vitriolic acid, produces negative electricity.

After a careful examination of the above mentioned experiments, the origin of the electricity, which is obſerved in the evaporation of water and other evaporable ſubſtances, whether ſolid or fluid, ſeems not to be reconcileable to the general law already noticed, nor can I form any plauſible theory that can be ſufficient to account for all the phenomena. If the production of electricity in thoſe experiments depended upon the increaſed or diminiſhed capacity of water for holding the electric fluid, it ſhould ſeem to be immaterial whether the water be evaporated in one way or in another, provided the evaporation be made with equal quickneſs and in equal quantities. Were it not known that glaſs or iron made red-hot produces no electricity in cooling, we might ſuſpect, that the electricity, which is produced by the evaporation of water, may be counteracted by the contrary electricity, which is produced by the cooling of glaſs or iron; but it has been obſerved by ſeveral ingenious perſons, that red-hot glaſs and red-hot iron produce no electricity whatever when ſuffered to cool upon inſulated ſtands.

233 Evaporation increaſed by electricity.

It has been found that electricity promotes evaporation. This may be proved by the following

Exper. Upon the prime conductor of an electrical machine, place a ſhallow metallic diſh, as a pewter plate, containing a ſmall quantity of water; and let a ſimilar diſh, containing ſuch a quantity of water as that the two diſhes may exactly counterpoiſe each other, be placed on a table at a diſtance from the machine. Now ſet the machine in motion, and after a certain time has elapſed, place the two diſhes again in the ſcales, and it will be found that the diſh which ſtood on the prime conductor is lighter than the other, evidently ſhowing that more of the water has been evaporated.

This experiment might with more propriety have been given when deſcribing the chemical effects of the electric power.

We ſhall return to this ſubject, under *Atmoſpherical Electricity*, to which the conſideration of the other circumſtances effecting the electricity of air by *excitation*, more properly belongs.

234 Method of electrifying the air of a room.

Air may be electrified by communication in two ways; by *ſimple electrification*, as it is called, or by charging a ſtratum of it ſituated between two conducting ſurfaces.

Exper. 1.—Fix two or three pointed needles into the prime conductor of an electrical machine, and ſet the glaſs in motion ſo as to keep the prime conductor electrified for ſeveral minutes. If now, an electrometer be brought within the air that is contiguous to the prime conductor, it will exhibit ſigns of electricity, and this air will continue electrified for ſome time, even after the machine has been removed into another room. The air, in this caſe, is electrified poſitively; it may be negatively electrified by fixing the needles in the negative conductor while inſulated, and making a communication between the prime conductor and the table, by means of a chain or other conducting ſubſtance.

The air of a room may be electrified in another way. Charge a large jar, and inſulate it; then connect two or more ſharp pointed wires or needles, with the knob of the jar, and connect the outſide coating of the jar with the table. If the jar be charged poſitively, the air of the room will ſoon become poſitively electrified likewiſe; but if the jar be charged negatively, the electricity communicated by it to the air, will become alſo negative. A charged jar being held in one hand, and the flame of an inſulated candle held in the other, being brought near the knob of the jar, will alſo produce the ſame effect.

A ſtratum of air may be charged in the ſame manner as a plate of glaſs, when its oppoſite ſurfaces are placed in contact with metallic plates which ſerve as a coating to the plate of air.

235
Method of
harging a
plate of air.

To perform this experiment, take two circular boards, each three or four feet in diameter, made perfectly ſmooth, and their edges rounded; coat one ſide of each board with tinfoil, ſo that it may be turned up over the edge of the board, and let it be burniſhed ſo as to render it as ſmooth as poſſible. Theſe boards muſt be placed, with their coated ſides parallel to each other, horizontally, and ſo that they may be ſet at a greater or ſmaller diſtance, and they muſt both be inſulated. For this purpoſe, it is moſt convenient to fix one of the boards on a ſtrong ſupport of glaſs or baked wood, and to ſuſpend the other by ſilken ſtrings from the ceiling of the room, from which it may be raiſed or lowered by a proper pulley, ſo as to be placed at the required diſtance from the lower board.

The boards being thus placed in their ſituation, at the diſtance of about an inch from each other, on their being electrified, the ſtratum of air, interpoſed between them, will preſent phenomena ſimilar to thoſe of a plate of glaſs under the ſame circumſtances. On connecting one of the boards with the prime conductor, while the other is inſulated, the air will receive no charge, agreeably to what was remarked of an inſulated Leyden phial. But if, while one of the boards is electrified from the prime conductor, the other be made to communicate with the earth or other conducting bodies, the plate of air will receive a charge, and when the communication between the boards is completed by conductors, an exploſion will take place. The exploſion in this caſe, however, is by no means ſo remarkable as that which is produced from an equal ſurface of coated glaſs, for reaſons which will be explained hereafter.

The experiment of charging a plate of air was firſt made by M. Æpinus and M. Wilcke, who being at Berlin together, jointly made ſeveral experiments.

236
is expe-
hent firſt
de by
pinus
l Wilcke.

They made ſeveral experiments to give the electric ſhock by means of air, and at length ſucceeded by ſuſpending large boards of wood covered with tin, with the flat ſides parallel to one another, and at ſome inches aſunder; for they found, that upon electrifying one of the boards poſitively, the other was always negative. But the diſcovery was made complete and indiſputable by a perſon touching one of the plates with one hand, and bringing his other hand to the other plate; for he then received a ſhock through his body, exactly like that of the Leyden experiment.

With this plate of air, they made a variety of curious experiments. The two metal plates, being in oppoſite ſtates, ſtrongly attracted each other, and would have ruſhed together, if they had not been kept aſunder by ſtrings. Sometimes the electricity of both would be diſcharged by a ſtrong ſpark between them, as when a pane of glaſs burſts with too great a charge. A finger put between them promoted the diſcharge, and felt the ſhock. If an eminence was made on either of the plates, the ſelf diſcharge would always be made through it, and a pointed body fixed upon either of them prevented their being charged at all *.

pini
tamen.

At the end of the table of conductors given in page 646. it was obſerved that a Torricellian vacuum was a non-conductor of electricity. Some experiments were made by Mr Walſh, which proved the perfect impermeability of a vacuum by the electric light. But the moſt complete experiments on this ſubject are thoſe of Mr W. Morgan and Mr Cavallo. The following are Mr Morgan's experiments.

237
Mr Morgan's experiments on the non-conducting power of a perfect vacuum.
Fig. 83.

A mercurial gage B, fig. 83. about 15 inches long, carefully and accurately boiled, till every particle of air was expelled from the inſide, was coated with tin foil, five inches down from its ſealed end (A), and being inverted into mercury through a perforation D, in the braſs cap E, which covered the mouth of the ciſtern H; the whole was cemented together, and the air was exhauſted from the inſide of the ciſtern through a valve C, in the braſs cap E juſt mentioned; which producing a perfect vacuum in the gage B, afforded an inſtrument peculiarly well adapted for experiments of this kind. Things being thus adjuſted, a ſmall wire, F, having been previouſly fixed on the inſide of the ciſtern, to form a communication between the braſs cap E, and the mercury G, into which the gage was inverted; the coated end A was applied to the conductor of an electrical machine; and, notwithſtanding every effort, neither the ſmalleſt ray of light, nor the ſlighteſt charge, could ever be procured in this exhauſted gage. It is well known, that if a glaſs tube be exhauſted by an air-pump, and coated on the outſide, both light and a charge may very readily be procured. If the mercury in the gage be imperfectly boiled, the experiment will not ſucceed; but the colour of the electric light, which, in air rarefied by an exhauſter, is always violet or purple, appears in this caſe of a beautiful green; and what is very curious, the degree of the air's rarefaction may be nearly determined by this means. There have been inſtances known, in a courſe of experiments, where a ſmall particle of air having found its way into the tube B, the electric light became viſible, and as uſual of a green colour; but the charge being often repeated, the gage has at length cracked at its ſealed end, and in conſequence the external air, by being admitted into the inſide, has gradually produced a change in the electric light, from green to blue, from blue to indigo, and ſo on to violet and purple, till the medium has at laſt become ſo denſe, as no longer to be a conductor of electricity. There can be little doubt, from the above experiments, of the non-conducting power of a perfect vacuum; and this fact is ſtill more ſtrongly confirmed by the phenomena which appear upon the admiſſion of a very minute particle of air into the inſide of the gage. In this caſe, the whole becomes immediately luminous, upon the ſlighteſt application of electricity, and a charge takes place, which continues to grow more and more powerful, in proportion as freſh air is admitted, till the denſity of the conducting medium arrives at its maximum, which it always does when the colour of the electric light is indigo or violet. Under theſe circumſtances, the charge may be ſo far increaſed, as frequently to break the glaſs. In ſome tubes, which have not been completely boiled, they will not conduct the electric fluid, when the mercury is fallen very low in them; yet upon letting in air into the ciſtern H, ſo that the mercury ſhall riſe in the gage B, the electricity, which was before latent in the inſide, ſhall now become viſible, and as the mercury continues to riſe, and of conſequence the medium is rendered leſs rare, the light ſhall

grow

grow more and more viſible, and the gage ſhall at laſt be charged, notwithſtanding it has not been near an electrical machine for two or three days. This ſeems to prove, that there is a limit, even in the rarefaction of air, which ſets bounds to its conducting power; or, in other words, that the particles of air may be ſo far ſeparated from each other, as no longer to be able to tranſmit the electricity; that if they are brought within a certain diſtance of each other, their conducting power begins, and continually increaſes, till their approach alſo arrives at its limit, when the particles again become ſo near, as to reſiſt the paſſage of the electricity entirely, without employing violence, which is the caſe in common and condenſed air, but more particularly in the latter.

238 Surpriſing eaſe with which an exhauſted tube may be charged with electricity.

It is ſurpriſing to obſerve, how readily an exhauſted tube is charged with electricity. By placing it at ten or twelve inches from the conductor, the light may be ſeen pervading its inſide, and as ſtrong a charge may ſometimes be procured, as if it were in contact with the conductor. Nor does it ſignify how narrow the bore of the glaſs may be; for even a thermometer tube, having the minuteſt perforation poſſible, will charge with the utmoſt facility; and in this experiment, the phenomena are peculiarly beautiful.

Let one end of a thermometer tube be ſealed hermetically; let the other end be cemented into a braſs cap with a valve, or into a braſs cock, ſo that it may be fitted to the plate of an air-pump. When it is exhauſted, let the ſealed end be applied to the conductor of an electrical machine, while the other end is either held in the hand, or connected to the floor. Upon the ſlighteſt excitation, the electricity will accumulate at the ſealed end, and be diſcharged through the inſide in the form of a ſpark; and this accumulation and diſcharge may be inceſſantly repeated, till the tube is broken. By this means, a ſpark 42 inches long may be procured; and if a proper tube could be found, we might have a ſpark three or four times that length; if, inſtead of the ſealed end, a bulb be blown at that extremity of the tube, the electric light will fill the whole of that bulb, and then paſs through the tube in the form of a brilliant ſpark, as in the foregoing experiment; though in this caſe, the charge, after a few trials, will make a ſmall perforation in the bulb. If, again, a thermometer, filled with mercury, be inverted into a ciſtern, and the air exhauſted in the manner before deſcribed for making the experiment with the gage, a Torricellian vacuum will be produced; and now the electric light in the bulb, as well as the ſpark in the tube, will be of a vivid green; but the bulb will not bear a frequent repetition of charges before it is perforated in like manner as when it has been exhauſted by an air-pump. It can hardly be neceſſary to obſerve, that in theſe caſes the electricity aſſumes the appearance of a ſpark, (F) from the narrowneſs of the paſſage through which it forces its way. If a tube, 40 inches long, be fixed into a globe eight or nine inches in diameter, and the whole be exhauſted, the electricity, after paſſing in the form of a brilliant ſpark throughout the length of the tube, will, when it gets into the inſide of the globe, expand itſelf in all directions, entirely filling it with a violet and purple light, and exhibiting a ſtriking inſtance of the vaſt elaſticity of the electric power.

Mr Morgan concludes his remarks with acknowledging his obligations to Mr Brooke of Norwich for communicating to him his method of making mercurial gages.

239 Mr Brooke's method of making mercurial gages.

Mr Brooke's method of making mercurial gages is nearly as follows: Let a glaſs tube *L* (fig. 84.), ſealed hermetically at one end, be bent into a right angle within two or three inches of the other end. At the diſtance of about an inch or leſs from the angle, let a bulb *K*, of about three-fourths of an inch in diameter, be blown in the curved end, and let the remainder of this part of the tube be drawn out *I*, ſo as to be ſufficiently long to take hold of when the mercury is boiling. The bulb *K* is deſigned as a receptacle for the mercury, to prevent its boiling over; and the bent figure of the tube is adapted for its inverſion into the ciſtern: for by breaking off the tube at *M* within an eighth or a fourth part of an inch of the angle, the open end of the gage may be held perpendicular to the horizon when it is dipped into the mercury in the ciſtern, without obliging us to bring our finger or any other ſubſtance into contact with the mercury in the gage, which never fails to render the inſtrument imperfect. It is neceſſary to obſerve, that if the tube be 14 or 15 inches long, it will be impoſſible to boil it effectually for the experiments mentioned above in leſs than three or four hours, although Mr Brooke ſeems to preſcribe a much ſhorter time for the purpoſe; nor will it even then ſucceed, unleſs the greateſt attention be paid that no bubbles of air lurk behind, which is frequently the caſe: but experience has taught how to guard pretty well againſt this diſappointment, particularly by taking care that the tube be completely dry before the mercury is put into it; for if this caution be not obſerved, the inſtrument can never be made perfect. There is, however, one evil which it is ſufficient to remedy; and that is, the introduction of air into the gage, owing to the unboiled mercury in the ciſtern: for when the gage has been a few times exhauſted, the mercury which originally filled it becomes mixed with that into which it is inverted, and in conſequence the vacuum is rendered leſs and leſs perfect, till at laſt the inſtrument is entirely ſpoiled.

Mr Cavallo's experiments were made with an excellent air-pump, which is deſcribed in the 73d volume of the Philoſophical Tranſactions.

240 Mr Cavallo's experiments on the ſame ſubject.

The following is the reſult of Mr Cavallo's experiments, as given by himſelf.

"From theſe experiments it appears, firſt, that in the utmoſt rarefaction that can be effected by the beſt air-pump, which amounts to about one thouſand, both the electric light and the electric attraction, though very weak, are ſtill obſervable; but, ſecondly, that the attraction and repulſion of electricity become weaker in proportion as the air is more rarefied, and in the ſame manner the intenſity of the light is gradually diminiſhed. Now, by reaſoning on this analogy, we may conclude,

---

(F) By cementing the ſtring of a guitar into one end of the thermometer tube, a ſpark may be obtained, as well as if the tube had been ſealed hermetically.

nciples of ectricity ſtrated experi- ment.

conclude, that both the attraction and the light will ceaſe in a perfect abſence of air; but this will never account for this perfect vacuum ever becoming a non-conductor of electricity; however, the fact ſeems to be fully aſcertained by Mr Walſh and Mr Morgan, and the only thing that remains to be done is to inveſtigate the cauſe of ſo remarkable a property."

Experiments on the action of electrics *in vacuo* had been long ago made by Mr Boyle and Mr Gray; but as the vacuum that they were able to produce was very imperfect, it is not ſurpriſing that they could perceive no difference whether the body was expoſed in the open air or confined within an exhauſted receiver.

CHAP. XIII. *Of the means of aſcertaining ſmall degrees of Electricity.*

241 al elec- meters ſuffi- citly de- e for obſer- ons.

IN the courſe of this part of our article we have already deſcribed many inſtruments for aſcertaining the preſence of electricity; and one of theſe, *Bennet's Electrometer*, has been ſhewn to be exceedingly ſenſible. But on a nicer examination it has been found, that in the courſe of experiments, as well as in obſervations on natural electricity to be related hereafter, the quantity or degree of electricity is ſo minute, as not to be ſenſible by means even of this delicate inſtrument, and is yet capable of being rendered ſufficiently obvious by other means. Theſe means we are now to deſcribe.

Moſt of the means which have been deviſed for rendering ſenſible minute degrees of electricity have been ſuggeſted by the effects of Volta's electrophorus.

242 hod of ten- and cock.

The firſt proceſs employed for this purpoſe was invented by Profeſſor Lichtenberg, and the ſame thought ſeems to have occurred to Dr Klincock of Prague. It was performed by means of two reſinous plates like thoſe of the common electrophorus, and one metallic plate with an inſulating handle. One of the reſinous plates was firſt excited by ſlight friction, and it was then employed to communicate electricity to the metallic plate, which was in its turn made to communicate electricity to the other reſinous plate. The electricity poſſeſſed by this latter plate was now communicated to the metallic plate: this was again conveyed to the firſt reſinous plate, of which it increaſed the electricity by communication. By repeatedly applying the metallic plate to each of the reſinous plates, without bringing them in contact, the electricity at firſt excited was accumulated till it became ſufficiently ſenſible to an ordinary electrometer *.

43 ri- s h led e in- on of 's enſer. city of ctors.

The next method employed was that of the celebrated Volta, or the condenſer. But before we deſcribe the apparatus and the mode of uſing it, it is neceſſary that we ſhould give a brief account of the experiments which led to the invention.

Mr Volta found that conductors of the ſame ſhape were capable of containing more or leſs electricity, as their ſurfaces are *leſs* or *more* influenced by *homologous atmoſpheres*; and that the *capacity* of a conductor of the ſame ſhape and ſurface was increaſed, when, inſtead of being quite *inſulated*, they were, while inſulated, preſented to another conductor not inſulated, and this increaſe became more conſpicuous according as the two conductors were larger, or approached nearer to each other.

Principles of Electricity illuſtrated by experiment.

When an inſulated conductor is thus preſented to any other conductor, Signior Volta calls it a *Conjugate Conductor*.

244 Conjugate conductor.

In order to ſhew by experiment the above-mentioned property or increaſe of capacity in a conductor, take the metal plate of an electrophorus, and holding it by its inſulating handle in the air, electrify it ſo high, as that the index of an electrometer annexed to it might be elevated to 60°; then lowering this metal plate by degrees towards a table or other conducting plain ſurface, you will obſerve that the index of the electrometer will fall gradually from 60° to 50°, 40°, 30°, &c. Notwithſtanding this appearance, the quantity of electricity in the plate remains the ſame, except the ſaid plate be brought ſo near the table as to occaſion a tranſmiſſion of the electricity from the former to the latter; at leaſt the quantity of electricity will remain as much the ſame as the dampneſs of the air, &c. will permit. The decreaſe, therefore, of intenſity is owing to the increaſed capacity of the plate, which is now conjugate, viz. oppoſed to another conducting ſurface. In proof of which, remove gradually the metal plate from the table, and it will be found that the electrometer riſes again to its former ſtation, namely to 60°, excepting the loſs of that quantity of electricity, which during the experiment muſt have been imparted to the air.

The two following experiments will throw more light upon the reciprocal action of the electric atmoſpheres. Firſt, ſuppoſe two flat conductors, electrified both poſitively or both negatively, to be preſented towards, and to be gradually brought near, each other; it will appear, by two annexed electrometers, that the nearer thoſe two conductors come to each other, the more their intenſities will increaſe; which ſhews, that either of the two conjugate conductors has a much leſs capacity now, than when it was ſingly inſulated, and out of the influence of the other.

Secondly, let the preceding experiment be repeated, with this variation only, viz. that one of the flat conductors be electrified poſitively, and the other negatively: the effects then will be juſt the reverſe of the preceding; viz. the intenſities of their electricities will be diminiſhed, becauſe their capacities are increaſed, the nearer the conductors come to each other.

Let us now apply the explanation of this laſt experiment to that of bringing an electrified metal plate towards an uninſulated conducting plane; for as this plane acquires a contrary electricity by the vicinity of the electrified plate, it follows that the intenſity of the electricity of the metal plate muſt be diminiſhed, and in the ſame proportion its capacity is increaſed; conſequently the metal plate in that caſe may receive a greater quantity of electricity.

This property may be rendered ſtill more evident, by inſulating the conducting plane whilſt the electrified plate is very near it, and afterwards ſeparating them; for then both the metal plate and the conducting plane (which may be called the *inferior* plane) will be found electrified, but poſſeſſed of contrary electricities, as may be aſcertained by electrometers.

If the inferior plane be inſulated firſt, and then the electrified plate be brought over it, then the latter will cauſe an endeavour in the former to acquire a contrary electricity, which however the inſulation prevents from taking

---

* *zier's n.* for 17.

taking place; hence the intenſity of the electricity of the plate is not diminiſhed, at leaſt the electrometer will ſhew a very little and almoſt imperceptible depreſſion, which is owing to the imperfection of the inſulation of the inferior plane, and to the ſmall rarefaction and condenſation of the electric fluid, which may take place in different parts of the ſaid inferior plane. But if in this ſituation the inferior plane be touched, ſo as to cut off the inſulation for a moment, then it will immediately acquire the contrary electricity, and the intenſity in the metal plate will be diminiſhed.

If the inferior plane, inſtead of being inſulated, were itſelf a non-conducting ſubſtance, then the ſame phenomena would happen, viz. the intenſity of the electrified metal plate laid upon it would not be diminiſhed. This, however, is not always the caſe; for if the ſaid inferior non-conducting plane be very thin, and be laid upon a conductor, then the intenſity of the electrified metal plate will be diminiſhed, and its capacity will be increaſed by being laid upon the thin inſulating ſtratum, becauſe, in that caſe, the conducting ſubſtance which ſtands under the non-conducting ſtratum acquiring an electricity contrary to that of the metal plate, will diminiſh its intenſity, &c. and the inſulating ſtratum will only diminiſh the mutual action of the two atmoſpheres, more or leſs, according as it keeps them more or leſs aſunder.

The intenſity or electric action of the metal plate, which diminiſhes gradually as it is brought nearer and nearer to a conducting plane not inſulated, becomes almoſt nothing when the plate is nearly in contact with the plane, the compenſation or accidental balance being then almoſt perfect; hence if the inferior plane only oppoſes a ſmall reſiſtance to the paſſage of the electricity (whether ſuch reſiſtance be occaſioned by a thin electric ſtratum, or by the plane's imperfect conducting nature, as is the caſe with dry wood, marble, &c.) that reſiſtance, and the interval, however ſmall, that is between the two planes, cannot be overcome by the weak intenſity of the electricity of the metal plate, which on that account will not dart any ſpark to the inferior plane (except its electricity were very powerful, or its edges not well rounded) and will rather retain its electricity; ſo that, being removed from the inferior plane, its electrometer will nearly recover its former height. Beſides, the electrified plate may even come to touch the imperfectly conducting plane, and may remain in that ſituation for ſome time: in which caſe the intenſity being reduced almoſt to nothing, the electricity will paſs to the inferior plane exceedingly ſlow.

But the caſe will not be the ſame, if, in performing the experiment, the electrified metal plate be made to touch the inferior plane edgewiſe; for then its intenſity being greater than when laid flat, as it appears by the electrometer, the electricity eaſily overcomes the ſmall reſiſtance, and paſſes to the inferior plane, even acroſs a thin electric ſtratum; becauſe the electricity of one plane is balanced by that of the other, only in proportion to the quantity of ſurface which they oppoſe to each other within a given diſtance; whereby, when the metal plate touches the other plane in flat and ample contact, its electricity is not diſſipated.

Hitherto we have conſidered in what manner the action of electric atmoſpheres muſt modify the electricity of the metal plate in various ſituations. We muſt now conſider the effects which take place when the electricity is communicated to the metal plate whilſt ſtanding upon the imperfectly conducting plane; however the explanation of this eaſily follows from what has been ſaid above. Suppoſe, for inſtance, that a Leyden phial or a conductor were ſo weakly electrified, that the intenſity of its electricity were only of half a degree, or even leſs; if the metal plate, when ſtanding upon the proper plane, were touched with that phial or conductor, it is evident that either of them would impart to it a quantity of its electricity, proportional to the plate's capacity, viz. ſo much of it as would make the intenſity of the electricity of the plate equal to that of the electricity in the conductor or phial, ſuppoſed of half a degree; but the plate's capacity, now that it lies upon the proper plane, is above 100 times greater than if it ſtood inſulated in the air; or, which is the ſame thing, it requires 100 times more electricity in order to ſhew the ſame intenſity; therefore, in this caſe, it muſt acquire upwards of a hundred times more electricity from the phial or conductor. It naturally follows, that when the metal plate is afterwards removed from the proper plane, its capacity being leſſened ſo as to remain equal to the hundredth part of what it was before, the intenſity of its electricity muſt become of 50°; ſince, agreeably to the ſuppoſition, the intenſity of the electricity in the phial or conductor was of half a degree *.

Having premiſed thus much reſpecting the *capacity* of conductors, we ſhall now proceed to deſcribe Signior Volta's method of rendering ſenſible minute degrees of electricity.

245
Deſcription of Volta's condenſers.

His method, in ſhort, is to communicate the otherwiſe unobſervable quantity of electricity to the metallic plate of an electrophorus, while ſtanding on an imperfectly inſulating plane; for the capacity of the metallic plate being thus augmented, it will acquire a much greater quantity of electricity than if it ſtood completely inſulated in the air, and when it is again ſeparated from the plane its capacity will be diminiſhed; conſequently, its electricity increaſing at the ſame time, the intenſity of this will be rendered manifeſt either by ſparks or by means of a delicate electrometer.

The particulars neceſſary to be kept in view in this method, are the following. The metal plate muſt be at leaſt ſix inches in diameter, with the edge well rounded, and having a varniſhed glaſs handle, or, inſtead of the glaſs, three ſilken ſtrings. The inferior plane muſt be of a very imperfect conducting nature, as dry marble, very dry and ſlightly varniſhed wood, a common piece of wood covered with oiled ſilk, or ſuch like ſubſtance; but let the ſubſtance be what it will, its ſurface muſt be very ſmooth, and ſuch as to coincide as well as poſſible with the ſurface of the metal plate; on which account, if a marble ſlab be choſen for the inferior plane, it will be proper to fit the metal plate to that of the iron, by grinding one againſt the other. What Mr Cavallo found to be very fit for this purpoſe was a paper drum, conſiſting of a common wooden hoop, ſuch as are uſed for barrels, over which a piece of thick writing paper was paſted, and on the back of which he paſted a piece of tin-foil. The upper ſurface of the paper was varniſhed only once with ſhell-lae diſſolved

---

* *Cavallo's Electricity*, vol. ii.

the course of experiments, as well as in observations on natural electricity to be related hereafter, the quantity or degree of electricity is so minute, as not to be sensible by means even of this delicate instrument, and is yet capable of being rendered sufficiently obvious by other means. These means we are now to describe.

Most of the means which have been devised for rendering sensible minute degrees of electricity have been suggested by the effects of Volta's electrophorus.

242
Method of Lichtenberg and Klincock.

The first process employed for this purpose was invented by Professor Lichtenberg, and the same thought seems to have occurred to Dr Klincock of Prague. It was performed by means of two resinous plates like those of the common electrophorus, and one metallic plate with an insulating handle. One of the resinous plates was first excited by slight friction, and it was then employed to communicate electricity to the metallic plate, which was in its turn made to communicate electricity to the other resinous plate. The electricity possessed by this latter plate was now communicated to the metallic plate: this was again conveyed to the first resinous plate, of which it increased the electricity by communication. By repeatedly applying the metallic plate to each of the resinous plates, without bringing them in contact, the electricity at first excited was accumulated till it became sufficiently sensible to an ordinary electrometer *.

243
xperiments which led the invention of olta's ondenser.

The next method employed was that of the celebrated Volta, or the condenser. But before we describe the apparatus and the mode of using it, it is necessary that we should give a brief account of the experiments which led to the invention.

apacity of nductors.

Mr Volta found that conductors of the same shape were capable of containing more or less electricity, as their surfaces are *less* or *more* influenced by *homologous atmospheres;* and that the *capacity* of a conductor of the same shape and surface was increased, when, instead of being quite *insulated*, they were, while insulated, presented to another conductor not insulated, and this increase became more conspicuous according as the two conductors were larger, or approached nearer to each other.

When an insulated conductor is thus presented to any other conductor, Signior Volta calls it a *Conjugate Conductor*.

244
njugate nductor.

In order to shew by experiment the above-mentioned property or increase of capacity in a conductor, take the metal plate of an electrophorus, and holding it by its insulating handle in the air, electrify it so high, as that the index of an electrometer annexed to it might be elevated to 60°; then lowering this metal plate by degrees towards a table or other conducting plain surface, you will observe that the index of the electrometer will fall gradually from 60° to 50°, 40°, 30°, &c. Notwithstanding this appearance, the quantity of electricity in the plate remains the same, except the said plate be brought so near the table as to occasion a transmission of the electricity from the former to the latter; at least the quantity of electricity will remain as much the same as the dampness of the air, &c. will permit. The decrease, therefore, of intensity is owing to the increased capacity of the plate, which is now conjugate, viz. opposed to another conducting surface. In proof of which, remove gradually the metal plate from the table, and it will be found that the electrometer rises again to its former station, namely to 60°, excepting the loss of that quantity of electricity, which during the experiment must have been imparted to the air.

The two following experiments will throw more light upon the reciprocal action of the electric atmospheres. First, suppose two flat conductors, electrified both positively or both negatively, to be presented towards, and to be gradually brought near, each other; it will appear, by two annexed electrometers, that the nearer those two conductors come to each other, the more their intensities will increase; which shews, that either of the two conjugate conductors has a much less capacity now, than when it was singly insulated, and out of the influence of the other.

Secondly, let the preceding experiment be repeated, with this variation only, viz. that one of the flat conductors be electrified positively, and the other negatively: the effects then will be just the reverse of the preceding; viz. the intensities of their electricities will be diminished, because their capacities are increased, the nearer the conductors come to each other.

Let us now apply the explanation of this last experiment to that of bringing an electrified metal plate towards an uninsulated conducting plane; for as this plane acquires a contrary electricity by the vicinity of the electrified plate, it follows that the intensity of the electricity of the metal plate must be diminished, and in the same proportion its capacity is increased; consequently the metal plate in that case may receive a greater quantity of electricity.

This property may be rendered still more evident, by insulating the conducting plane whilst the electrified plate is very near it, and afterwards separating them; for then both the metal plate and the conducting plane (which may be called the *inferior* plane) will be found electrified, but possessed of contrary electricities, as may be ascertained by electrometers.

If the inferior plane be insulated first, and then the electrified plate be brought over it, then the latter will cause an endeavour in the former to acquire a contrary electricity, which however the insulation prevents from taking place; hence the intensity of the electricity of the plate is not diminished, at least the electrometer will shew a very little and almost imperceptible depression, which is owing to the imperfection of the insulation of the inferior plane, and to the small rarefaction and condensation of the electric fluid, which may take place in different parts of the said inferior plane. But if in this situation the inferior plane be touched, so as to cut off the insulation for a moment, then it will immediately acquire the contrary electricity, and the intensity in the metal plate will be diminished.

If the inferior plane, instead of being insulated, were itself a non-conducting substance, then the same phenomena would happen, viz. the intensity of the electrified metal plate laid upon it would not be diminished. This, however, is not always the case; for if the said inferior non-conducting plane be very thin, and be laid upon a conductor, then the intensity of the electrified metal plate will be diminished, and its capacity will be increased by being laid upon the thin insulating stratum, because, in that case, the conducting substance which stands under the non-conducting stratum acquiring

---

* Rozier's *Journ.* for 780.

Principles of Electricity illustrated by experiment.

ing an electricity contrary to that of the metal plate, will diminish its intensity, &c. and the insulating stratum will only diminish the mutual action of the two atmospheres, more or less, according as it keeps them more or less asunder.

The intensity of electric action of the metal plate, which diminishes gradually as it is brought nearer and nearer to a conducting plane not insulated, becomes almost nothing when the plate is nearly in contact with the plane, the compensation or accidental balance being then almost perfect; hence if the inferior plane only opposes a small resistance to the passage of the electricity (whether such resistance be occasioned by a thin electric stratum, or by the plane's imperfect conducting nature, as is the case with dry wood, marble, &c.) that resistance, and the interval, however small, that is between the two planes, cannot be overcome by the weak intensity of the electricity of the metal plate, which on that account will not dart any spark to the inferior plane (except its electricity were very powerful, or its edges not well rounded) and will rather retain its electricity; so that, being removed from the inferior plane, its electrometer will nearly recover its former height. Besides, the electrified plate may even come to touch the imperfectly conducting plane, and may remain in that situation for some time: in which case the intensity being reduced almost to nothing, the electricity will pass to the inferior plane exceedingly slow.

But the case will not be the same, if, in performing the experiment, the electrified metal plate be made to touch the inferior plane edgewise; for then its intensity being greater than when laid flat, as it appears by the electrometer, the electricity easily overcomes the small resistance, and passes to the inferior plane, even across a thin electric stratum; because the electricity of one plane is balanced by that of the other, only in proportion to the quantity of surface which they oppose to each other within a given distance; whereby, when the metal plate touches the other plane in flat and ample contact, its electricity is not dissipated.

Hitherto we have considered in what manner the action of electric atmospheres must modify the electricity of the metal plate in various situations. We must now consider the effects which take place when the electricity is communicated to the metal plate whilst standing upon the imperfectly conducting plane; however the explanation of this easily follows from what has been said above. Suppose, for instance, that a Leyden phial or a conductor were so weakly electrified, that the intensity of its electricity were only of half a degree, or even less; if the metal plate, when standing upon the proper plane, were touched with that phial or conductor, it is evident that either of them would impart to it a quantity of its electricity, proportional to the plate's capacity, viz. so much of it as would make the intensity of the electricity of the plate equal to that of the electricity in the conductor or phial, supposed of half a degree; but the plate's capacity, now that it lies upon the proper plane, is above 100 times greater than if it stood insulated in the air; or, which is the same thing, it requires 100 times more electricity in order to shew the same intensity; therefore, in this case, it must acquire upwards of a hundred times more electricity from the phial or conductor. It naturally follows, that when the metal plate is afterwards removed from the proper plane, its capacity being lessened so as to remain equal to the hundredth part of what it was before, the intensity of its electricity must become of 50°; since, agreeably to the supposition, the intensity of the electricity in the phial or conductor was of half a degree *.

Having premised thus much respecting the *capacity* of conductors, we shall now proceed to describe Signior Volta's method of rendering sensible minute degrees of electricity.

245 Description of Volta's condensers.

His method, in short, is to communicate the otherwise unobservable quantity of electricity to the metallic plate of an electrophorus, while standing on an imperfectly insulating plane; for the capacity of the metallic plate being thus augmented, it will acquire a much greater quantity of electricity than if it stood completely insulated in the air, and when it is again separated from the plane its capacity will be diminished; consequently, its electricity increasing at the same time, the intensity of this will be rendered manifest either by sparks or by means of a delicate electrometer.

The particulars necessary to be kept in view in this method, are the following. The metal plate must be at least six inches in diameter, with the edge well rounded, and having a varnished glass handle, or, instead of the glass, three silken strings. The inferior plane must be of a very imperfect conducting nature, as dry marble, very dry and slightly varnished wood, a common piece of wood covered with oiled silk, or such like substance; but let the substance be what it will, its surface must be very smooth, and such as to coincide as well as possible with the surface of the metal plate; on which account, if a marble slab be chosen for the inferior plane, it will be proper to fit the metal plate to that of the iron, by grinding one against the other. What Mr Cavallo found to be very fit for this purpose was a paper drum, consisting of a common wooden hoop, such as are used for barrels, over which a piece of thick writing paper was pasted, and on the back of which he pasted a piece of tin-foil. The upper surface of the paper was varnished only once with shell-lac dissolved in alcohol or spirit of wine. This sort of plane has many advantages, viz. it is easily made, and from its lightness is very portable; its surface is perfectly plane, excepting when the hoop is not very strong, for then the contraction of the paper has power sufficient to warp it; and lastly, as the thickness of the paper and of the varnish may be varied at pleasure, and very easily, the plane may be rendered of any required degree of conducting power.

Having such a semi-conducting plane and metallic plate properly constructed, the former is to be laid upon a table, and the latter is to be placed upon it, taking care that the inferior plane be not excited by any degree of friction. If the surface of the inferior plane should have acquired any electricity by accidentally rubbing it, &c. the best way of freeing it of that electricity is to pass it two or three times over the flame of a candle. Now the metallic plate is to be struck five or six times with the corner of a dry handkerchief, a piece of dry flannel or paper, &c.; then it is to be raised from the inferior plane by means of its insulating handle, and presented to an electrometer, when it will be found sensibly electrified. If the metallic plate be

struck

---

* *Cavallo Electricit* vol. ii.

Principles of Electricity illustrated by experiment.

struck while it is not in contact with the semi-conducting plane, it will be found either to possess no electricity or an incomparably smaller degree than it acquires in the other mode.

By this means electricity may be obtained from substances which could hardly be supposed electrified, and that not only in sufficient quantity to ascertain its quality, but even sufficient to afford sparks. Signior Volta has given to this apparatus the name of *condensing apparatus*.

246
Mr Cavallo's improvement of the condenser.

Mr Cavallo, observing that in stroking the metallic plate, in order to obtain electricity from various substances, and especially from the hand, the plate was often moved so as to occasion some friction on the inferior plane, whereby this was excited, and consequently the result of the experiment rendered precarious, thought of the following method of preventing such motion.

Upon a varnished glass handle he cemented a brass tube about six inches long, and three-fourths of an inch in diameter, from the extremity of which proceeded a fine flexible wire about 14 inches long. Now, when the metallic plate was situated upon the inferior plane, he held the glass handle of the brass tube with his left hand, in such a manner as that the end of the wire might touch the plate, the rest remaining in the air. Sometimes, in order to make a better contact, the end of the above-mentioned wire was put into a hole purposely made in the edge of the plate. In this disposition of the apparatus, the substances to be tried are stroked upon the brass tube, and the electricity produced by them is conveyed to the metallic plate by the wire, which being fine and flexible, communicates no motion to the plate.

Another improvement of Mr Cavallo's consists in rendering sensible degrees of electricity still more minute than those which may be discovered by the condensing apparatus.

Notwithstanding the great sensibility of *Volta's condenser*, yet sometimes the electricity acquired by the metallic plate from some substances was so small as not to affect an electrometer sufficiently to ascertain its quality, or even its existence; hence it naturally occurred to Mr Cavallo, that for the same reason for which the metallic plate of the *condensing apparatus* manifested such minute degrees of electricity as could not be otherwise observed, another smaller plate, or small condensing apparatus, might be employed to render the weak electricity of the large metallic plate sensible. Accordingly, he constructed a small plate of about the size of a shilling, having a glass handle covered with sealing-wax; and when the large metallic plate seemed to be so weakly electrified as not to affect an electrometer sensibly, he placed the small plate upon the inferior plane, and touching it with the edge of the large plate; then, after removing the small plate, he took up the small one from the plane, holding it by the extremity of the glass handle, and presenting it to the electrometer, which was generally so much affected by it as to diverge to its utmost limits.

In this manner Mr Cavallo often obtained electricity more than sufficient for ascertaining its quality, from a single stroke of the corner of a handkerchief; viz. the large plate being placed upon the proper plane, was stroked once; then being moved and presented to an electrometer, it appeared not electrified; but by touching the small plate with the edge of it, that small plate acquired thereby electricity sufficient to make an electrometer diverge.

When this secondary condensing apparatus is used, care must be taken to hold the large plate almost vertically while the small plate is touched by it. There is no need of having another inferior plane for the small plate, the large one being sufficient for both; for immediately after taking up the large plate, weakly electrified, with one hand, you lay down the small plate, &c.

The small quantity of electricity that can be discovered by this means is really surprising, and there is hardly any substance, excepting the metals, or those which cannot be subjected to trial, as water and other fluids, which will not produce some electricity when rubbed or stroked against the large plate of the condensing apparatus, and that electricity is afterwards condensed by being communicated to the small plate.

247
Bennet's doubler.

The discovery of Volta's *condenser* led to a discovery no less important, the *doubler*, for which we were first indebted to the Reverend Abraham Bennet of Wirksworth, though the instrument has been much improved by Mr Nicholson and Mr Read.

Plate CXCIV. fig. 85.

The doubler in its first and simplest form consisted of three parts, which are represented at fig. 85. Plate CXCIV. viz. a polished brass plate A, with an insulating handle fixed in its centre; a similar plate B with an insulating handle fixed in its periphery, and the cap of Bennet's gold-leaf electrometer C, which serves as a third plate. The two plates A and B are varnished on the under side, and the handles are made of mahogany, fixed to the plates by means of glass nuts covered with sealing-wax.

248
Manipulation of the doubler.

The method of demonstrating the presence of electricity by means of this apparatus is as follows. Suppose that we have to examine the electricity of the plate C.

1. Place B upon C, and communicate some electricity to the latter, while the plate B is touched with the finger. The consequence will be that C will receive a greater degree of electricity than it would have been capable of acquiring if B had not been present.

2. Remove the communication from C, and take the finger from off B, then raise this latter by its insulating handle, and B and C will exhibit the opposite states of electricity more strongly than when they are in contact.

3. Place A upon B, and touch A with the finger. The consequence will be that A will receive a portion of electricity of a state opposite to that of B, or A will be in the same state of electricity with C.

4. Place B upon C, and touch B with the finger as before, and at the same time apply A edgeways to C. In this situation, A will communicate the greatest part of its electricity to C.

5. Remove A, take the finger from B, and raise B from C. The opposite states of electricity in B and C, will now be stronger than before, on account of the additional electricity afforded by A.

6. Place A upon B again, as in the third stage of the process, and repeat the subsequent manipulations. In each of them the intensity of the electricity is supposed to be doubled, and by proceeding in this manner

for a certain time, the electricity originally communicated to C, though at first too small to affect the strips of gold leaf, will at last become sufficiently sensible to produce a considerable divergence of them.

249 Moveable doubler by Dr Darwin.

Though the above process is sufficiently simple and evident, yet it requires to be learned, and takes up a certain time for its performance. It was therefore desirable that an instrument should be formed which might complete this series of operations by a very simple mechanical movement. The first instrument constructed with this view was contrived by Dr Darwin, and was shown to Mr Nicholson in the month of December 1787. This instrument consisted of four metallic plates, two of which were moveable by wheel-work into positions which required them to be touched by the hand in order to produce the effect. It appeared to Mr Nicholson that the whole operation, including the touching, might be done by a simple combination without wheel-work, by the direct rotation of a winch. This was soon afterwards effected, and communicated by him to the Royal Society in 1788. Mr Nicholson's description of his *revolving doubler*, was first printed in the 78th volume of the Philosophical Transactions, and has been reprinted by Mr Nicholson in his Philosophical Journal for May 1800, from which we have copied it.

250 Nicholson's revolving doubler. Plate CXCV. fig. 86.

Fig. 86. represents the apparatus of the doubler supported on a glass pillar $6\frac{1}{2}$ inches long. It consists of the following parts. Two fixed plates of brass, A and C, are separately insulated and disposed in the same place, so that a revolving plate B may pass very near them, without touching. Each of these plates is two inches in diameter; and they have adjusting pieces behind, which serve to place them accurately in the required position. D is a brass ball, likewise of two inches diameter, fixed on the extremity of an axis that carries the plate B. Besides the more essential purpose this ball is intended to answer, it is so loaded within on one side, that it serves as a counterpoise to the revolving plate, and enables the axis to remain at rest in any position. The other parts may be distinctly seen in fig. 87. The shaded parts represent metal, and the white represent varnished glass. ON is a brass axis, passing through the piece M, which last sustains the plates A and C. At one extremity is the ball D already mentioned; and the other is prolonged by the addition of a glass stick, which sustains the handle L and the piece GH separately insulated. E, F, are pins rising out of the fixed plates A and C, at unequal distances from the axis. The cross-piece GH, and the piece K, lie in one plane, and have their ends armed with small pieces of harpsichord-wire, that they may perfectly touch the pins EF in certain points of the revolution. There is likewise a pin I, in the piece M, which intercepts a small wire proceeding from the revolving plate B.

Fig. 87.

The touching wires are so adjusted, by bending, that when the revolving plate B is immediately opposite the fixed plate A, the cross-piece GH connects the two fixed plates, at the same time that the wire and pin at I form a communication between the revolving plate and the ball. On the other hand, when the revolving plate is immediately opposite the fixed plate C, the ball becomes connected with this last plate, by the touching of the piece K against F; the two plates, A and B, have then no connection with any part of the apparatus. In every other position the three plates and the ball will be perfectly unconnected with each other.

251 Defects of the doubler

Mr Bennet and Mr Cavallo observed, soon after the discovery of the doubler, that it never fails to exhibit an electric state by the mere operation, without any communication of electricity being previously made. Mr Bennet endeavoured to find out a method of depriving the doubler of this inherent electricity, and after a number of trials, he considered the following as the best mode of answering this purpose.

252 Mr Bennet's mode of obviating these.

He connected the plates A and C together by a wire hooked at each end upon two small knobs on the backs of the plates, the middle of the same wire touching the pillar which supports the doubler. Another wire was hooked at one end upon the back of the plate B, and at the other end, to the brass ball which counterbalances this plate. Thus all the plates were connected with the earth, and by turning the handle of the doubler, it might be discharged of electricity in every part of its revolution.

After often trying this method of depriving the doubler, Mr Bennet observed, that its spontaneous discharge was almost always negative. He then touched A and C with a positively charged bottle, and turned the doubler till it produced sparks for a long time together; and after this strong positive charge he hooked on the wires as above, and revolved the plate B about a hundred times, which so deprived the doubler of its positive electricity, that when the wires were taken off, it produced a negative charge at about the same number of revolutions which it required before.

The positively charged bottle was again applied, and the wires being hooked upon the plates as before, B was revolved only fifty times, yet this was found sufficient to deprive it of its positive charge, and in many experiments five or six revolutions were sufficient; but he never thought it safe to stop at so few, and therefore he generally turned the handle 40 or 50 times between every experiment.

Lest electricity adhering to the electrometer should obstruct the above experiments, Mr Bennet did not let it stand in contact with the doubler during its revolutions, but touched the plate A with the cap of the electrometer, after he supposed its electricity was become sufficiently sensible; but lest even this contact should communicate any electricity, he made a cap of shell lac for his electrometer, having a small tin tube in the centre, to which the gold leaf was suspended within the glass, and a bent wire was fixed to the top, which might easily be joined to the plate A of the doubler, and thus the gold leaf was more perfectly insulated, and the electricity could not be diffused over so large a surface. The glass which insulates the plates and cross piece of the doubler was also covered with shell lac [*].

253 Robison's proposal f obviating the errors of the doubler.

Dr Robison conceived that Mr Bennet's original doubler might be freed from error as far as was possible, by employing a thin stratum of air as the intermedium between the three plates. The method which he proposes for effecting this is very ingenious. Stick on one of the plates three very small spherules, made from a capillary tube of glass or from a thread of sealing-wax. The other plate being laid on them, rests on mere points,

---

[*] Bennet New Exp riments.

points, and can scarcely receive any friction, which may disturb the experiment.

Mr Cavallo, finding that Mr Bennet's mode of obviating the inconveniences of the doubler did not succeed with him, constructed a new instrument, which he calls a *collector of electricity*, and a description of which was inserted in the 78th volume of the Philosophical Transactions. It consists of a plate of tin, supported by two upright sticks of glass; on each side of which plate are two frames of wood covered with gilt paper, which do not touch the tin-plate, but stand parallel to it at a little distance. These frames are fastened to the platform of the instrument by hinges; so that if electricity be communicated to the plate, it will receive a large quantity without any considerable intensity, because its capacity is much augmented by the vicinity of the plane of gilt paper on each side. But if these planes be thrown back into the horizontal position, which is easily done by means of their hinges, the electricity, which before was compensated in the plate, will have its intensity greatly increased. An electrometer connected with this plate will therefore show signs of electricity, by means of a communication made between a large stock of electricity, and the tin-plate in its first position, though the intensity of that stock may have been too small to have affected the electrometer without this contrivance.

254
Cavallo's collector of electricity.

It does not appear, in the author's description of this instrument, that it removes the equivocal effect of the doubler; for it is evident that it does not, in its simple process, enter the province of the doubler in which this effect takes place. The doubler requires six or seven turns before it will exhibit spontaneous electricity; at which period the first charge is magnified above twelve thousand times; but his simple instrument will scarcely exceed one hundred times, and therefore requires the electricity to be one hundred and twenty times as strong as that which causes the uncertainty of the doubler. Whence it may be inferred, that the doubler would have acted unequivocally with all such electricities as this instrument is capable of exhibiting *.

255
avallo's
ultiplier
f electri-
ity.
ig. 88.
nd 89.

Mr Cavallo has since constructed another instrument, which he calls a *multiplier of electricity*, and which he considers as quite free from equivocal results.

" The figs. 88. and 89. represent this new instrument, and they are about two-thirds of the real size. QRS is the bottom board, upon which are steadily fixed on the glass sticks H, G, two flat brass plates A and C.—B is a similar brass plate supported by a glass stick I, which is cemented in a hole made in the wooden lever KL, which moves round a steady pin K, that is screwed tight in the bottom board. By moving this lever backwards and forwards, the plate B may be alternately put in the two situations represented by the figures. N is a thick brass wire fixed tight into the bottom board. There is a fourth brass plate D, similar to the other three, which is supported not by glass, but a wire; and this wire is screwed fast to an oblong piece of brass FP, that slides in a groove made for the purpose in the bottom board QRS; so that by applying a finger's nail to the notch on the end F, the sliding piece FP may be drawn out to any length, and the plate D thus removed to any required distance from the fixed plate C. I need not say any thing particular respecting the sockets of those brass plates, they being clearly indicated in the figures, excepting only that the socket of the plate A reaches as high as the top of it, and serves to receive a wire, or other apparatus, on certain occasions.

The parts of this instrument are so adjusted, as that when the lever is in the situation of fig. 88. viz. is pushed as far toward Q as it can go, the plate B comes parallel to the plate A, and about one-twentieth of an inch distant. At the same time the extremity of the wire OM just touches the fixed wire N, and of course renders the plate B uninsulated. But as soon as the lever begins to be moved towards S, the communication of the plate B with the wire N, or with the ground, becomes interrupted, and B remains insulated. And when the lever has been moved as far as it can go towards S, the wire M comes in contact with the plate C, as shown in fig. 89. Then the two plates B and C communicate with each other, though they are otherwise insulated. The fourth plate D being supported by a wire, communicates with the ground; and when the sliding piece PF is pushed home, it stands parallel to, and at about one-twentieth of an inch from the plate C.

When the instrument is situated as in fig. 88. if an electrified body be brought into contact with the plate A, this plate will imbibe a great deal more of that electricity than it would otherwise, because its capacity is increased by the vicinity of the uninsulated plate B, and therefore, if after the communication of that electricity, the plate B, by moving the lever, be removed from that situation, and A be made to touch an electrometer, this will be electrified more sensibly by it, than it would have been by the contact of the original electrified body itself. So far the plate A acts like a condenser, or collector of electricity. But let us now consider the instrument as a multiplier.

When the plate A has received a small quantity of electricity by the contact of any electrified body whatever, and that body is removed, the plate being uninsulated and opposed to the electrified plate A, will, like the metal plate of an electrophorus, acquire the contrary electricity, by either receiving from, or giving to, the ground some electric fluid, according as the plate A happens to be electrified. Thus, suppose that A has been electrified positively, B will become negative, and *vice versa*. If now the lever be pushed towards S, the plate B will remain electrified negatively, the communication with the ground being cut off; and when B comes into the situation represented by fig. 4th, at which time the wire M touches the plate C, the negative electricity of B will go to C, because the capacity of C for holding electricity is considerably augmented by the vicinity of the uninsulated plate D. If after this the lever be moved back again to its first situation, B will be made negative a second time in the same manner as before: and by pushing the lever again towards S, that second charge of negative electricity will be communicated from B to C; and thus, by repeating the operation, which consists in merely moving the lever backwards and forwards, a considerable quantity of negative electricity will be accumulated upon C.

In fact, the action of this instrument resembles very much that of an electrophorus; for the plate A may represent

---

[*] *Nichol-
on's Jour.*
to, vol. i.

Principles of Electricity illustrated by experiment.

present the excited resinous plate, B may represent the metal plate of the electrophorus, and C is a kind of reservoir, into which the successive charges of the plate B are collected.—When a number of those charges or portions of electricity has been communicated to C, if the sliding piece FP be drawn out about an inch, and of course the plate D be removed to the like distance from the plate C, the capacity of the plate C will thereby be much diminished: and therefore if an electrometer be brought into contact with it, the electricity will be manifested: whereas the electricity originally communicated to the plate A, could not have affected an electrometer in any sensible degree.

In using this instrument, 30 or 40 additions of electricity are the utmost number practicable; for after that number the augmentation of the charge upon C will not go any farther; the limit of which is, when the charge of C is increased to such a degree, as to leave a portion of electricity upon B, equal to that portion which B can receive from the action of A.

In this case, let C touch an electrometer as mentioned above, and if the electrometer does not diverge, proceed to a second process; for though its pendulums do not diverge, yet some electricity remains in them, which must not be disturbed, as it will help the effect of the second operations, which is as follows: Push in the slider FP, and go on moving the lever backwards and forwards as before, by which means, after a certain number of additions, the plate C will acquire a second charge, about as high as the former: and if then the slider FP is pulled out, and C brought into contact with the same electrometer, the divergency of the pendulums, which before was either not at all or hardly perceptible, will thereby be rendered more conspicuous: and thus it may be increased still farther by a third and a fourth operation. But if, notwithstanding those repeated operations, the electrometer should be found not to diverge, the quantity of electricity may still be augmented by another method, which is, by communicating that little electricity of C to the plate A of another instrument of the same sort, and proceeding with that in the manner described *."

256 In Nicholson's Journal for September 1804, is a paper by Mr W. Wilson containing a description of an instrument which Mr Wilson calls a *compound condenser of electricity*, and which he considers as an improvement on Mr Cavallo's *multiplier*, answering the purpose of a condenser, a single and double *multiplier*, and a *doubler*. The instrument is very complicated, containing no less than six plates. Like all complicated instruments of this kind, it is of course subject to error from its own spontaneous electricity.

257 Nicholson's spinning condenser.

Mr Nicholson has constructed an instrument for ascertaining small degrees of electricity, without, as he says, a possibility of equivocal result. This instrument he calls the *spinning condenser*, and it is thus described in his Journal for April 1797.

Plate CXCV. fig. 90.

"Fig 90. represents a vertical section of the instrument. A is a metallic vase, having a long steel axis which passes through a hole in the stand H at K, and rests on its pointed end in an adjustable socket at C. The use of the vase is, by its weight, to preserve, for a considerable time, the motion of spinning which is given by the finger and thumb, applied to the knob at the top of the instrument. The shaded parts D and E represent two circular plates of glass nearly 1½ inch in diameter. The upper plate is fixed to the vase, and revolves with it; the lower is fixed to the stand. In the lower plate are inserted two metallic hooks, diametrically opposite each other, at F and G. They are cemented into holes drilled in the edge of the glass, which is near two-tenths of an inch thick. In the upper plate are inserted in the same manner two small tails of the fine flatted wire used in making silver lace. These tails are bended down so as to strike the hooks in the revolution, but in all other positions they remain freely in the air without touching any part of the apparatus. At C is a screw, which by raising or lowering the vase keeps the faces of the glass plates from each other at whatever distance may be required. The faces of the glass plates which are opposed to each other are coated with segments of tin-foil, as represented, fig. 91. and 92. the latter of which represents the upper plate. Each of the tails communicates with the tin-foil coating to which it is contiguous, as does also the hook F with that coating of the lower plate nearest to it. But the hook G is entirely insulated from the whole apparatus, and is intended to communicate only with the electrified body or atmospherical conductor L. The lower coating nearest to G is made to communicate permanently with the stand H, and consequently with the earth.

Plate CXCVI. fig. 91. and 92.

"In this situation, suppose the motion of spinning to be given to the apparatus, and the effects will be these: One of the tails will strike the hook G, by which means the upper coating annexed to that tail will assume the electric state of L by communication. But this state, on account of the proximity of the lower uninsulated plate, to which it is, at that instant, directly opposed, will be as much stronger than that of L, as a charge exceeds simple electrization. The tail G with its plate or coating proceeds onward, and after half a revolution arrives at the situation to touch the hook F. The upper coating, the lower on the side of F, the hook F itself, and tail V, must then constitute one jointly insulated metallic mass, in which no charge subsists, but which is simply electrified by the whole charge received at G. And of this mass the surfaces of the plates themselves, constituting the electric well of Franklin, will throw out all their electricity to the hook and tail. But the coating and its tail instantly pass round, leaving F electrified, and proceed to bring another charge from G and deposit it as before. The balls at F are therefore very speedily made to diverge. It is scarcely necessary to remark, that the two upper coatings do nothing more than double the speed of the operation; one of the tails being employed in collecting, while the other is depositing; and that the gold-leaf electrometer may be advantageously substituted for the cork-balls.

"The instrument I caused to be made was five inches high. The receiving side G was connected with a coated jar of four square feet coating, and the giving side F was connected with Bennet's gold-leaf electrometer. The electrometer was rendered as strongly positive as it was capable of being, and the jar was rendered negative, by giving it as much of that power as was produced by drawing a common stick of sealing-wax once through the hand. In this state the jar was incapable of attracting the finest thread. The vase was

---

* Cavallo's Electricity, vol iii.

Principles of Electricity illustrated by experiment.

was then made to spin; and the effect was, that the leaves of the electrometer first gradually collapsed, and then in the same manner gradually opened, and struck the sides of the glass of the electrometer with negative electricity. The experiment was renewed and repeated with every requisite variation."

258 Three general methods of ascertaining small degrees of electricity;

To conclude, the methods of ascertaining minute degrees of electricity may be reduced to three.

259 by a delicate electrometer;

1. If the absolute quantity of electricity be small and pretty much condensed, as that produced by a small tourmalin when heated, or by a hair when rubbed, the only effectual method of manifesting its presence, and ascertaining its quality, is to communicate it to a very delicate electrometer, i. e. one that is very light and has no great extent of conducting surface.

260 by the collector, multiplier, or condenser;

2. When we wish to ascertain the presence of a considerable quantity of electricity, which is dispersed, or expanded into a great space, and is little condensed, such as the constant electricity of the atmosphere in clear weather, or such as the electricity which remains in a large Leyden phial after the first or second discharge; this may be best ascertained by means of Cavallo's *collector* or *multiplier*, or by the *condenser* with Cavallo's improvement of the same plate.

261 y one of he plates f the oubler and delicate lectrometer.

3. When the electricity to be ascertained is neither very considerable in quantity nor much condensed, such as the electricity of the hair of certain animals, of the surface of chocolate, when cooling, &c. In this case the best method is to apply a metallic plate furnished with an insulating handle, such as one of the plates of the doubler, to the electrified body, and to touch the plate with a finger while it remains for some time in this situation; which done, the plate is to be removed and brought near a sensible electrometer; or its electricity may be communicated to the plate of a small condenser, by which it will be rendered more conspicuous. In this operation care must be taken not to bring the plate too near the body whose electricity is to be examined, lest the friction, likely to happen between the plate and the body, should produce some electricity, the origin of which might he attributed to some other causes.

The increased sensibility of the other instruments now described, is unfortunately accompanied by a tendency to produce the electrical states spontaneously, and thus afford equivocal results.

Chap. XIV. *Miscellaneous and additional Experiments and Observations.*

262 cholson's provement of nnet's ctrometer.

Mr Nicholson, in his Journal for September 1797, proposes what appears to be a valuable improvement in Bennet's electrometer.

"There are (says he) two particulars in which this excellent instrument appears capable of improvement: the first to render it portable, without danger to the gold-leaf, and the second to express its various degrees of electrization by a scale of divisions.

"I have reflected much on the probable means of securing the gold-leaf from fracture by carriage, but hitherto with little prospect of success. There was some hope that a single slip of this gold might be preserved in a sheath or box, with its sides very nearly in contact; but when I placed such a slip upon a gilded piece of wood of the same superficial dimensions, to which it was fastened at one end, its flexibility was such that the leaf very readily slided along the surface of the wood, and became full of folds, by inclining the fastened end a very few degrees lower than the other extremity. There was still less immediate expectation that the slips could be actually and repeatedly confined between two leaves or cushions, as in the book of the gold-beaters, without their being broke by continual agitation. To this, however, my attention will probably be directed when I may again resume this object. In the mean time, I recommend it to other philosophers, as a very desirable improvement in the mineralogical apparatus, and should rejoice to be anticipated by their successful researches.

Principles of Electricity illustrated by experiment.

"The weight of one slip of gold-leaf, in the electrometer of Bennet, is about 1-600th part of a grain; but this, as well as the sensibility of the instrument, must vary not only from the figure and dimensions of the piece, but the nature and thickness of the gold itself*. It seemed, therefore, unnecessary to endeavour to render two of these instruments comparable with each other. All that could be done was, to distinguish the different intensities as shewn by the divergencies of the leaf; or, as I have taken it, the distances at which they strike a pair of uninsulated metallic bars. In Plate CXCVI. fig. 93. A represents the insulated metallic cap, from which, at C, depend the two narrow pointed slips of gold leaf. BB is the glass shade, which serves to support the cap, and defend the leaves from the motion of the surrounding air. DD are two flat radii of brass, which open and shut by means of one common axis, like a pair of compasses. By a contrivance of springs, they are disposed to open when left at liberty; but the micrometer screw E serves to draw a nut, which has two steel bars, with a claw at the end of each, that enters into a correspondent slit, in two small cylindrical pieces to which the radii are fixed respectively. This apparatus is seen in another position in fig. 94. KL represents a piece of brass, which serves as the frame for the work, and fits the lower socket of the electrometer, FF, fig. 3. In this the letters IH indicate the cylindrical pieces which carry the radii, and are seen from beneath. On the side of the nut G, one of the steel drawing pieces is seen; the other being on the opposite side, and consequently not visible. Towards L appear the two reaction springs. The other parts require no verbal description.

Plate CXCVI. fig. 93.

Fig. 94.

"In the common construction of the gold-leaf electrometer, there are two pieces of tin-foil pasted on opposite parts of the internal surface of BB; against which the gold-leaf strikes when its electricity is at the maximum. If the radii DD be left at the greatest opening, our instrument does not then differ from that in common use. But if the divergence produced by the contact of an atmospheric conductor, or any other source of electricity, be so small as to render it doubtful whether the leaves be electrified or not, the radii may then be brought very gradually together by means of the screw, until the increased divergency from their attractive force be sufficient to ascertain the kind of electricity possessed by the leaves. In this and all other cases, the division on the micrometer-head, which stands opposite the fixed index, at the time the leaves strike the radii, will shew the greater or less degree of intensity."

In

---

* *Phil. Journ.* i. 333.

Principles of Electricity illustrated by experiment.

In his Journal for January 1799, he has the following remarks on the glass case of this instrument.

263 His observations on the glass case of this instrument.

"Under all the uncertainties concerning the place occupied by the electric charge of coated glass, though it may seem unfair to make any inference respecting glass which is uncoated, yet, upon the whole, there appears to be a probability that the interposition of naked glass may impede the action of electrified bodies. This question more immediately points at the tube in which the gold-leaf electrometer of Bennet is inclosed. To determine whether the tube of the electrometer does affect the electric state of the included leaf, either by compensation or otherwise, I took a piece of window-glass eighteen inches long, two inches wide, and one-twentieth of an inch thick, which I cleaned very well, and then passed it several times through the hot air over the flame of a candle. In this state one end of the glass was laid gently upon the electrified plate of Bennet's electrometer, and then suddenly raised by a turn of the wrist. It was scarcely possible to discern that the leaves were at all affected, but when the electrometer was in the plus state a very slight collapsion was produced by raising the glass, and the contrary effect was produced when the electrometer was negative. Some days afterwards the experiment was repeated, after the gold-leaf had been changed for other pieces, which were very pointed and delicate in their movements. The result was, that the glass was always shewn by the electrometer to be in a weak positive state; and, when the electricity of the electrometer was made plus, the collapsion was equal to the divergence when it was minus.

"In making these experiments I had previously supposed that the influence of the metallic state of the electrometer would produce somewhat of the nature of a charge upon the glass; and consequently that the intensity of the leaves would have been diminished during the existence of that charge; and also, that in such a case the action of the metal through the glass would be subject to the same diminution as in the series of jars. But as the glass did not appear to act in this manner, it seems proper to conclude that clean glass does not affect the electric state of bodies by its vicinity, and that the divergence of the balls or the gold-leaf in the electrometers of Cavallo and Bennet is not diminished by the tube which surrounds them.

"From a variety of experiments it was clearly ascertained that the metallic coatings, though by their vicinity they may diminish the intensity of the electric state in the leaves, do nevertheless increase the angle of divergence by their attraction.

"When the gold-leaf electrometer is made with a very small tube, its sensibility is somewhat increased by the nearness of the coatings; but the chance of rendering it unserviceable from casual friction, which excites the glass, and causes the gold-leaf to stick to it, together with the less perfect view of the divergence through a tube of small curvature, afford reasons why a diameter of less than an inch should be rejected. Other reasons of convenience indicate that the diameter of the glass should not much exceed this quantity.

"I was once induced to think that the considerable magnitude of the cap of Bennet's electrometer might render it less capable of being acted upon by small quantities of electricity. Experiment did not however give much countenance to this supposition. By trials with heads of different size, the smallest were found to be rather more sensible to extremely minute electricities, and less so to such as were greater. The influence of very weak electricity may produce the opposite state in the whole of a small head, but only in part of a larger; the remaining part of this last assuming the opposite state, and robbing the leaves of part of their intensity. But in higher electricities the whole of the large head may be urged to give electricity to the leaves, in a quantity which the smaller head could not give without acquiring a higher degree of intensity, and consequently more strongly resisting the desired process. It appears therefore that the maximum of effect with a given electricity, acting without communication, will not be obtained but by a head of a definite figure and magnitude."

264 Other methods of imitating the planetary motions.

In N° 82. experiment 5. we described a method of imitating the planetary motions by the motion communicated by the current of air from electrified points; this may be done in various other ways, of which we shall only add the following.

1. From the prime conductor of an electric machine suspend six concentric hoops of metal at different distances from one another, in such a manner as to represent in some measure the proportional distances of the planets. Under these, and at the distance of about half an inch, place a metallic plate, and upon this plate, within each of the hoops, a glass bubble blown very thin and light. On electrifying the hoops, the bubbles will be immediately attracted by them, and will continue to move round the hoops as long as the electrification continues. If the electricity is very strong, the bubbles will frequently be driven off, run hither and thither on the plate, making a variety of surprising motions round their axis; after which they will return to the hoop, and circulate as before; and if the room is darkened, they will all appear beautifully illuminated with electric light.

2. Provide a ball of cork about three quarters of an inch in diameter, hollowed out in the internal part by cutting it in two hemispheres, scooping out the inside, and then joining them together with paste. Having attached this to a silk thread between three and four feet in length, suspend it in such a manner that it may just touch the knob of a charged electric jar, the outside of which communicates with the ground. On the first contact it will be repelled to a considerable distance, and after making several vibrations will remain stationary; but if a candle is placed at some distance behind it, so that the ball may be between it and the bottle, the ball will instantly begin to move, and will turn round the knob of the jar, moving in a kind of ellipsis as long as there is any electricity in the bottle. This experiment is very striking, though the motions are far from being regular; but it is remarkable that they always affect the elliptical rather than the circular form.

In the table of conductors we have placed *flame*, *smoke*, and the *vapour of hot water*. That these vapours are conductors may be shewn from the following experiments.

265 Flame a conductor.

Exper. 1.—Bring the knobs of two metallic discharging rods, communicating the one with the outside, and the other with the inside of a charged phial, opposite each other, each within an inch of the flame of a candle, so that the flame may be in the middle between them. The flame will be seen to spread on each side towards the knobs, and will produce the discharge of the jar.

266 uthbert-on's mode f distin-uishing he two lectrici-ies.

Mr Cuthbertson has proposed a method of distinguishing positive from negative electricity by the flame of a candle. He places the flame of a candle exactly in the middle between two metallic balls at the distance of four inches from each other, so that the centre of the flame is in a line with that of the balls. The balls are about three-fourths of an inch in diameter, and communicate by insulated wires, the one with the *positive* and the other with the *negative* conductor. If the machine be then put in motion, the flame will waver very much, but will seem to incline rather to the *negative* than the *positive* ball. After turning the machine for about 50 revolutions (if the glass be a plate of two feet diameter), the negative ball will begin to grow warm, while the positive still remains cold. After 200 revolutions, the negative ball will become too hot to be touched, while the positive will continue as cold as at first *.

A charged phial may be gradually discharged by passing it for some time backwards and forwards through the flame of a large candle, so that the flame may act alternately on the knob and the outside coating.

267 oke and am con-ctors.

Exper. 2.—Suspend a cork-ball electrometer about four or five feet above the prime conductor of an electrical machine; then turn the winch very gently, and it will be found that the balls do not diverge. Now place a *green* wax taper just blown out in the prime conductor, so that its smoke may ascend towards the balls, and these will diverge a little with the same degree of motion communicated to the machine.

The same effect, but in a less degree, will be produced, if, instead of the taper, a vessel of hot water is placed below the balls, thus shewing that *steam* is a conductor, though inferior to *smoke* in its conducting power.

These experiments are by Mr Henley, and are among several others related by him in the 64th volume of the Philosophical Transactions. His reason for employing a *green* taper, was, that on account of the verdigris which it contained, it occasioned much smoke with little heat.

268 ss and er elec-s be-e con-tors n much ted.

It has been remarked in the Introduction, that glass, though one of the most perfect electrics when cold, becomes a conductor when heated red hot. This is proved by the following experiment, which also shews that other electrics change their nature when heated.

Take a small glass tube of about one-twentieth of an inch in diameter, and above a foot long; close it at one end, and introduce a wire into it, so that it may be extended through its whole length: let two or three inches of this wire project above the open end of the tube, and there fasten it with a bit of cork; tie round the closed end of the tube another wire, which will be separated from the wire within the tube only by the glass interposed between them. In these circumstances endeavour to send a shock through the two wires; i. e. the wire inserted in the glass tube, and that tied on its outside, by connecting one of them with the outside, and touching the other with the knob of a charged jar, and you will find that the discharge cannot be made, unless the tube be broken; because the circuit is interrupted by the glass at the end of the tube, which is interposed between the two wires. But put that end of the tube to which the wire is tied into the fire, so that it may become just red hot, then endeavour to discharge the jar again through the wires, and you will find that the explosion will be easily transmitted from wire to wire, through the substance of the glass, which, by being made red hot, is become a conductor.

Fig. 95.

In order to ascertain the conducting quality of hot resinous substances, oils, &c. bend a glass tube in the form of an arch CEFD, fig. 95. and tie a silk string CD to it, which serves to hold it by when it is to be set near the fire; fill the middle part of this tube with rosin, sealing-wax, &c. then introduce two wires, AE, BF, through its ends, so that they may touch the rosin, or penetrate a little way in it. This done, let a person hold the tube over a clear fire, so as to melt the rosin within it; at the same time, by connecting one of the wires, A or B, with the outside of a charged jar, and touching the other with the knob of the jar, endeavour to make the discharge through the rosin, and you will observe that, while the rosin is cold, no shocks can be transmitted through it: but it becomes a conductor according as it melts, and when totally melted, the shocks will pass through it very freely.

269 Glass and other electries when powdered become conductors.

The electric power of glass may also be destroyed by reducing the glass to powder. This was ascertained by M. Wilcke †, and Dr Priestley ‡; but it has been most satisfactorily proved by M. Van Swinden, in the following experiments.

Exper. 1.—He covered a case of white iron with powdered glass, so as to form a cake about an inch thick, a foot long, and eight inches broad, and he placed above this cake, another plate of iron so as to form a coating. He then attempted to charge this coated plate, but without success; he could produce no shock.

Exper. 2.—Supposing that the conducting power of the glass in the above experiment might arise from some humidity which it had contracted, he dried it in a crucible, and repeated the experiment. In this case, it appeared slightly electric, so long as the machine was worked, but when this was stopped the plate of powdered glass no longer affected the electrometer.

Exper. 3.—Into a jar, coated on the outside, he put a quantity of powdered glass, and having furnished it in other respects like a Leyden phial, he proceeded to examine whether it would receive a charge. He found that it could be completely charged, a proof that the powdered glass acted the part of a conductor §.

By similar experiments M. Van Swinden found that flowers of sulphur acted as a conductor, though more imperfectly than powdered glass.

270 Velocity of the electric shock.

Soon after the discovery of the Leyden phial and shock produced by it, it became a desirable object with electricians to ascertain how far the shock might be conveyed, and how long a time would be required to convey it to any considerable distance.

The French philosophers were the first to appear in this field, but they did little more than excite the English to go far beyond them in these great undertakings. A circuit was made by the former of 900 toises, consisting

---

* Nichol-n's Jour. ov. 1802.

† *Mem. de l'Acad. de Suede*, t. xx.

‡ *Hist. of Electricity*, p. viii. s. 4.

§ *Van Swinden sur d'Analogie de l'Electricité et de Magnetisme*, tom. i. p. 43.

sisting of men holding iron wires betwixt each two, through which the electric shock was sensibly felt. At another time they made the shock pass through a wire two thousand toises in length, that is, near a Paris league, or about two English miles and a half; though part of the wires dragged upon wet grass, went over chasms, hedges, or palisades, and over ground newly ploughed up. Into another chain they took the water of the bason in the Thuilleries, the surface of which was about an acre, and the phial was discharged through it.

Mr Monnier the younger, endeavoured to determine the velocity of the electric power, and for this purpose made the shock pass through an iron wire of 950 toises in length; but he could not observe that it spent a quarter of a second in passing it. He also found, when a wire of 1319 feet, with its extremities brought near together, was electrified, that the electricity ceased at one end the moment it was taken off at the other.

These attempts of the French were succeeded by greater, more numerous, and more accurate experiments performed in this country. The names of the English gentlemen, who, animated with a truly philosophical spirit, were indefatigable in this pursuit, deserve to be honourably recorded.

271 Experiments on this inquiry by Dr Watson and his associates.

The principal agent in this scene was Dr Watson. He planned and directed all the operations, and never failed to be present at every experiment. His chief assistants were Martin Folkes, Esq. president of the Royal Society, Lord Charles Cavendish, Dr Bevis, Mr Graham, Dr Birch, Mr Peter Daval, Mr Trembley, Mr Elliot, Mr Robins, and Mr Short. Many other persons, and some of distinction, gave their attendance occasionally.

Dr Watson, who wrote the history of their proceedings, in order to lay them before the Royal Society, begins by observing (what was verified in all their experiments) that the electric shock is not, strictly speaking, conducted in the shortest manner possible, unless the bodies through which it passes, conduct equally well; for that, if they conduct unequally, the circuit is always formed through the best conductors, though the length of it be ever so great.

The first attempt these gentlemen made, was to convey the electric shock across the river Thames, making use of the water of the river for one part of the chain of communication. This they accomplished on the 14th and 18th of July of 1747, by fastening a wire all along Westminster bridge, at a considerable height above the water. One end of this wire communicated with the coating of a charged phial, the other being held by an observer, who in his other hand held an iron rod, which he dipped into the river. On the opposite side of the river stood a gentleman who likewise dipped an iron rod in the river with one hand, and in the other held a wire, the extremity of which might be brought into contact with the wire of the phial.

Upon making the discharge, the shock was felt by the observers on both sides of the river, but more sensibly by those who were stationed on the same side with the machine; part of the electric fire having gone from the wire down the moist stones of the bridge, thereby making several shorter circuits to the phial, but still all passing through the gentlemen who were stationed on the same side with the machine. This was, in a manner, demonstrated by some persons feeling a sensible shock in their arms and feet, who only happened to touch the wire at the time of one of the discharges, when they were standing upon wet steps which led to the river *.

Upon this and the subsequent occasions, the gentlemen made use of wires in preference to chains, for this, among other reasons, that the electricity which was conducted by chains, was not so strong as that conducted by wires. This, as they well observed, was occasioned by the junctures of the links not being sufficiently close, as appeared by the flashing and snapping at every juncture, where there was the least separation. These lesser snappings being numerous in the whole length of a chain, very sensibly lessened the great discharge at the prime conductor.

Their next attempt was to force the electrical shock to make a circuit of two miles, at the New-river at Stoke Newington. This they performed on the 24th of July 1747, at two places; at one of which, the distance by land was 800 feet, and by water 2000: in the other the distance by land was 2800 feet, and by water 8000. The disposition of the apparatus was similar to what they before used at Westminster bridge, and the effect answered their utmost expectations. But, as in both cases, the observers at both extremities of the chain, which terminated in the water, felt the shock, as well when they stood with their rods fixed into the earth 20 feet from the water, as when they were put into the river; it occasioned a doubt, whether the shock was formed through the windings of the river, or a much shorter way by the ground of the meadow: for the experiment plainly shewed, that the meadow ground, with the grass on it, conducted the electricity very well.

By subsequent experiments, they were fully convinced, that the electricity had not in this case been conveyed by the water of the river, which was two miles in length, but by land, where the distance was only one mile; in which space, however, the electric power must necessarily have passed over the New-river twice, have gone through several gravel pits, and a large stubble field †.

On the 28th of July they repeated the experiment at the same place, with the following variation of circumstances. The iron wire was, in its whole length, supported by dry sticks, and the observers stood upon original electrics; the effect of which was, that they felt the shock much more sensibly than when the conducting wire had lain upon the ground, and when the observers had stood likewise upon the ground, as in the former experiment.

Afterwards, every thing remaining as before, the observers were directed, instead of dipping their rods into the water, to put them into the ground, each 150 feet from the water. They were both smartly struck, though they were distant from each other above 500 feet.

The same gentlemen, pleased with the success of their former experiments, undertook another, the object of which was to determine, whether the electric power could be conveyed through dry ground; and at the same time to carry it through water to a greater distance

---

* *Phil. Trans. Abr.* vol. x. p. 349, &c.

† *Ib.* p. 3

distance than they had done before. For this purpose they pitched upon Highbury-barn, beyond Islington, where they carried it into execution on the 5th of August 1747. They chose a station for their machine almost equally distant from two other stations for observers, upon the New-river, which were somewhat more than a mile asunder by land, and two miles by water. They had found the streets of London, when dry, to conduct very strongly, for about 40 yards; and the dry road at Newington about the same distance. The event of this trial answered their expectations. The electric fire made the circuit of the water, when both the wires and the observers were supported on original electrics, and the rods dipped into the river. They also both felt the shock, when one of the observers was placed in a dry gravelly pit, about 300 yards nearer the machine than the former station, and 100 yards distant from the river; from which the gentlemen were satisfied, that the dry gravelly ground had conducted the electricity as strongly as water.

The last attempt of this kind which these gentleman made, and which required all their sagacity and address in the conduct of it, was to try whether the electric shock was perceptible at twice the distance to which they had before carried it, in ground perfectly dry, and where no water was near, and also to distinguish, if possible, the comparative velocity of electricity, and of sound.

For this purpose they fixed upon Shooter's-hill, and made their first experiment on the 14th of August 1747, a time, when, as it happened, but one shower of rain had fallen during five preceding weeks. The wire communicating with the iron rod, which made the discharge, was 6732 feet in length, and was supported all the way upon baked sticks; as was also the wire which communicated with the coating of the phial, which was 3868 feet long, and the observers were distant from each other two miles. The result of the explosion demonstrated, to the satisfaction of the gentlemen present, that the circuit performed by the electricity was four miles, viz. two miles of wire, and two of dry ground, the space between the extremities of the wires, a distance which, without trial, as they justly observed, was too great to be credited. A gun was discharged at the instant of the explosion, and the observers had stop watches in their hands, to note the moment when they felt the shock; but as far as they could distinguish, the electric power performed that vast circuit instantaneously.

In all the explosions where the circuit was made of any considerable length, it was observed, that though the phial was very well charged, yet that the snap at the gun-barrel made by the explosion was not near so loud as when the circuit was formed in a room; so that a bystander, says Dr Watson, would not imagine from seeing the flash and hearing the report, that the stroke at the extremity of the conducting wire would have been considerable, the contrary of which, when the wires were properly managed, he says, always happened.

Still the gentlemen, unwearied in these pursuits, were desirous of ascertaining, if possible, the absolute velocity of electricity through a certain space; because though in the last experiment, the time of its progress was certainly very small, they were desirous of knowing, small as that time might be, whether it was measurable, and Dr Watson had contrived an excellent method for that purpose.

Accordingly, on the 5th of August 1748, the gentlemen met for the last time at Shooter's-hill; when it was agreed to make an electric circuit of two miles, by several turnings of the wire, in the same field. The middle of this circuit they contrived to be in the same room with the machine, where an observer took in each hand one of the extremities of the wires, each of which was a mile in length. In this excellent disposition of the apparatus, in which the time between the explosion and the shock could be observed with the greatest exactness, the phial was discharged several times; but the observer always felt himself shocked at the very instant of making the explosion. Upon this the gentlemen were fully satisfied, that through the whole length of this wire, which was 12,276 feet in length, the velocity of the electric power was instantaneous *.

Some doubts however may be entertained of the accuracy of these experiments. They have not been repeated in the present improved state of the science, when so much greater precision can be given to them. Even metals, the most perfect conductors, oppose some resistance to the motion of electricity, and a charge will take a short passage through air in preference to a circuit of 20 or 30 feet through thin wire. This fact imparts a degree of uncertainty to the accounts of a transmission of a small charge through a space of four miles.

272 How to spin sealing-wax into threads.

We have noticed the increased evaporation from liquids by means of electricity. The following experiment, which is commonly exhibited by lecturers on electricity, is usually considered of the same kind.

Stick a small piece of sealing-wax on the end of a wire, and set fire to it. Then put an electrical machine in motion, and present the wax just blown out at the distance of some inches from the prime conductor. A number uf extremely fine filaments will immediately dart from the sealing-wax to the conductor, on which they will be condensed into a kind of net-work, resembling wool.

If the wire with the sealing-wax be stuck into one of the holes of the conductor, and a piece of paper be presented at a moderate distance to the wax, just after it has been ignited, on setting the machine in motion, a net-work of wax will be formed on the paper. The same effect, but in a slighter degree, will be produced, if the paper be briskly rubbed with a piece of elastic gum, and the melting sealing-wax be held pretty near the paper immediately after rubbing.

If the paper thus painted, as it were, with sealing-wax, be gently warmed by holding the back of it to the fire, the wax will adhere to it, and the result of the experiment will thus be rendered permanent.

273 To make camphor shoot into ramifications.

A beautiful experiment of the same nature is made with camphor. A spoon holding a piece of lighted camphor is made to communicate with an electrified body, as the prime conductor of a machine; while the conductor continues electrified by keeping the machine in motion, the camphor will throw out ramifications, and appear to shoot like a vegetable.

Soon after the discovery of the electrophorus by Signior Volta, an experiment was made with that instrument by Professor Lichtenberg of Gottingen, that

---

* *Phil. Trans. Abr.* vol. x.

attracted considerable notice. It is thus described by Mr Cavallo.

274 Curious experiment of Professor Lichtenberg.

The electrophorus, that is, a plate of some resinous substance, as sulphur, rosin, gum-lac, &c. is first excited, either by rubbing or otherwise; then a piece of metal of any shape, at pleasure, as, for instance, a three-legged compass, a piece of brass tube, or the like, is set upon the electrophorus, and to this piece of metal, so placed, a spark is given, of the electricity contrary to that of the plate; this done, the piece of metal is removed, by means of a stick of sealing-wax or other electric, and some powder of rosin, kept in a linen bag, is shaken upon the electrophorus: this powder will be found to fall about those points upon the plate, which the piece of metal touched, forming some radiated appearances, much like the common representations of stars; at the same time, upon the greatest part of the plate, that is, besides those stars, there is hardly any powder at all. Now, it is to be remarked, that if the plate be excited negatively, and the spark given to the metal set upon it is positive, the appearance will be as above described; but if, on the contrary, the plate is positive and the spark is negative, then the powder of rosin will be found to fall upon those parts of the plate which in the other case is left uncovered, and to leave the stars clean: in short, it will do just the reverse of what it did in the other case; or, in other words, the powder of rosin will be attracted by those parts only of the electrophorus which are electrified positively.

275 Method of producing various configurations by electricity.

The configurations produced in the above experiment of M. Lichtenberg appeared so curious that they were soon imitated by various electricians, particularly by Mr Cavallo and the Reverend Abraham Bennet, inventor of the doubler. The directions given by this last gentleman are as follows.

To make red figures, take a pound of rasped Brazil wood: put it into a kettle with as much water as will cover it, or rather more; also put in about an ounce of gum arabic and a lump of alum about as big as a large nut; let it boil about two hours, or till the water is strongly coloured; strain off the extract into a broad dish, and set it in an iron oven, where it is to remain till all the water be evaporated, which with me was effected in about twelve hours; but this depends on the heat of the oven, which should not be so hot as to endanger its burning. Sometimes I have boiled the strained extract till it was considerably inspissated before it was placed in the oven, that it might be sooner dry.

When it is quite dry but not burnt, scrape it out of the dish, and grind it in a mortar till it be finely pulverized. In doing this, it is proper to cover the mortar with a cloth, having a hole through, to prevent the powder from flying away and offending the nose, and also to do it out of doors if the weather be dry and calm, that the air may carry away the powder necessarily escaping, and which otherwise is very disagreeable. When ground fine, let it be sifted through muslin or a fine hair-sieve, returning the coarser part into the mortar to be ground again. When the grinding and sifting are finished, the powder is ready for use. The resinous plate I have mostly used was composed of five pounds of rosin, half a pound of bees-wax, and two ounces of lamp-black, melted together, and poured upon a board sixteen inches square, with ribs upon the edges at least half an inch high, to confine the composition whilst fluid: thus the resinous plate was half an inch thick, which is better than a thinner plate, the figures being more distinct. After the composition is cold, it will be found covered with small blisters, which may be taken out by holding the plates before the fire, till the surface be melted; then let it cool again, and upon holding it a second time to the fire, more blisters will appear; but by thus repeatedly heating and cooling the surface, it will at last become perfectly smooth. Some plates were made smaller, and the resinous composition confined to the form of an ellipsis, a circle, or escutcheon, by a rim of tin half an inch broad, and fixed upon a board.

The next thing to be done is to prepare the paper, which is to be softened in water, either by laying the pieces upon each other in a vessel of cold water, or first pouring a little hot water upon the bottom of a large dish, then laying upon it a piece of paper, so that one edge of the paper may lie over the edge of the dish, to remain dry, that it may afterwards be more conveniently taken up. Then pour more hot water upon its upper surface. Upon this place another piece in the same manner, again pouring on more water, and thus proceed till all the pieces are laid in. By using hot water, the paper will be more softened in a few minutes than if it remains in cold water a whole day.

When the figures are to be made, the resinous plate must lie horizontally, whilst the electricity is communicated, if the experiment requires any thing to be placed upon the plate: but it is convenient afterwards to hang it up in a vertical position whilst the powder is projected, lest too much powder should fall where it is not required.

A little of the powder may be taken between a finger and thumb, and projected by drawing it over a brush; or, which is better, a quantity of powder may be put into the bellows and blown towards the plate. When the figure is sufficiently covered with powder, let the plate be again laid horizontally upon a table; then take one of the softened papers out of the water by its dry edge, and lay it carefully between the leaves of a book, pressing the leaves together, and let it lie in this situation about half a minute. Then remove the paper to a dry place in the book, and press it again about the same time, which will generally be sufficient to take off the superfluous moisture. Then take up the paper by the two corners of its dry edge, and place the wet edge a little beyond the figure on the resinous plate, lowering the rest of the piece gradually till it covers the figure without sliding; then lay over it a piece of clean dry paper, and press it gently; let it remain a short time, and then rub it closer to the plate with a cloth, or, which is better, press it down by means of a wooden roller covered with cloth, taking care that the paper be not moved from its first position. When the paper is sufficiently pressed, let it be taken up by its dry edge, and laid upon the surface of a vessel of water with the printed side downwards; by this means the superfluous powder will sink in the water, and the figure will not be so liable afterwards to spread in the paper. After the paper has remained on the water during a few minutes, take it up and place it between the leaves of a book, removing it frequently to a dry place. If it be desired that the paper should be speedi-

ly

ly dry, let the book leaves in which it is to be placed be previously warmed, and by removing it to several places it will be dry much sooner than by holding it near a fire, and without drawing the paper crooked. By the above process, it is obvious, that leather, calico, or linen, as well as paper, may be printed with these figures, and the effects of the diffusion of electricity upon a resinous plate be exhibited to those who have not leisure or inclination to perform the experiments †.

The figures represented in Plate CXCII. were formed much after Mr Bennet's method.

The apparatus used for making them consisted only of a common Leyden phial, and a plate of glass 15 inches square, covered on one side with a varnish of gum-lac dissolved in spirit of wine, and several times laid over. The other side is covered with tin-foil laid on with common paste. When it is to be used, the glass plate is put upon a metallic stand, with the tin-foiled side laid undermost; the phial is to be charged, and the knob drawn over the varnished side. Thus any kind of figure may be drawn, or letters made, as represented in the plate; and from every figure beautiful ramifications will proceed, longer or shorter according to the strength of the charge. On some occasions, however, the charge may be too strong, particularly where we wish to represent letters, so that the whole will be blended into one confused mass. The round figures are formed by placing metallic rings or plates upon the electrical plate; and then giving them a spark from the electrified bottle, or sending a shock through them. The figures may be rendered permanent by blowing off the loose chalk, and clapping on a piece of black sized paper upon them; or if they are wanted of another colour, they may easily be obtained by means of lake, vermilion, rose-pink, or any of the ordinary colours ground very fine. The easiest way of applying them seems to be by a barber's puff bellows.

276 xperiments on e effect oduced electricity on agnetic edles,

We shall conclude this part of our article with noticing the effects produced by electricity on magnetic needles.

These may be stated in the following proposition.

An electric shock communicates a magnetic power to needles, and frequently reverses or destroys that polarity.

277 Dr anklin.

By electricity Dr Franklin frequently gave polarity to needles and reversed them at pleasure. A shock from four large jars, sent through a fine sewing needle, he says, gave it polarity, so that it would traverse when laid on water. What is most remarkable in these electrical experiments upon magnets is, that if the needle, when it was struck, lay east and west, the end which was entered by the electric blast pointed north; but that if it lay north and south, the end which lay towards the north would continue to point north, whether the fire entered at that end or the contrary; though he imagined that a stronger stroke would have reversed the poles even in that situation, an effect which had been known to have been produced by lightning. He also observed, that the polarity was strongest when the needle was struck lying north and south, and weakest when it lay east and west. He takes notice that in these experiments the needle, in some cases, would be finely blued like the spring of a watch, by the electric flame; in which case, the colour given by a flash from two jars only might be wiped off, but that a flash from four jars fixed it, and frequently melted the needles. The jars which the doctor used held seven or eight gallons, and were coated and lined with tin-foil †.

278 By Van Marum.

Dr Van Marum made several experiments on communicating polarity to needles with his very powerful machine. He and his coadjutor tried to give polarity to needles made of watch springs from three to six inches in length, and likewise to steel bars nine inches long, from a quarter of an inch to half an inch broad, and about a line in thickness. The result was, that when the bar or needle was placed horizontally in the magnetic meridian, whichever way the shock entered, the end of the bar that stood toward the north acquired the north polarity, or the power of turning towards the north when freely suspended, and the opposite end acquired the south. If the bar, before it received the shock, had some polarity, and was placed with its poles contrary to the usual direction, then its natural polarity was always diminished, and often reversed; so that the extremity of it, which in receiving the shock looked towards the north, became the north pole, &c.

When the bar or needle was struck standing perpendicularly, its lowest end became the north pole in any case, even when the bar had some magnetism before, and was placed with the south pole downwards. *Cæteris paribus*, the bars seemed to acquire an equal degree of magnetic power, whether they were struck whilst standing horizontally in the magnetic meridian, or perpendicular to the horizon.

When the bar or needle was placed in the magnetic equator, whichever way the shock entered, it never gave it any magnetism; but if the shock was given through its width, then the needle acquired a considerable degree of magnetism, and the end which lay towards the west became the north pole, and the other end the south pole.

If a needle or bar, already magnetic, or a real magnet, was struck in any direction, its power was always diminished. For this experiment, they tried considerably large bars, one being 7,08 inches long, 0,26 broad, and 0,05 thick.

When the shock was so strong in proportion to the size of the needle, as to render it hot, then the needle generally acquired no magnetism at all, or very little.

The experiments were made with the extraordinary power of a battery composed of 135 phials, containing among them about 130 square feet of coated surface.

These experiments, however, prove nothing respecting the nature of the electric fluid, and shew no peculiar relation between it and magnetism: for the very same effects are produced when needles and bars of iron are subjected to mechanical action, as by striking with a hammer in the direction of the dipping needle, the twisting of wires, and various other modes of mechanical operation. The position in which iron receives this magnetic power most readily, is that of the dipping needle. A horizontal position in the magnetic meridian was equally favourable as the vertical position, because both were nearly equally remote from that of the dipping needle.

PART IV.

---

† *Bennet's New Experiments.*

† *Franklin's Letters.*

PART IV.

THEORY OF ELECTRICITY.

CHAP. I. *A Concise View of the Principal Theories of Electricity.*

SECT. I. *Of the Theories of Electricity before the Time of Franklin.*

279 Theory of the early electricians. THE first electricians supposed, that electrical attraction was performed by means of unctuous effluvia emitted by the excited electric. These were supposed to attach themselves to all bodies, and to carry back with them those which were not too heavy. For in that age of philosophy all effluvia were supposed to return to the body from which they had been emitted, since no person could otherwise account for the substance not being sensibly wasted by the constant emission. When these light bodies, on which the unctuous effluvia had fastened, had arrived again at the excited electric, a fresh emission of the effluvia was supposed to carry them back again. But this effect of the effluvia was not thought of, till electrical repulsion had been sufficiently observed.

When the Newtonian philosophy had made some progress, and the extreme subtility of light, and other effluvia of bodies, was demonstrated, so that philosophers were under no apprehension of bodies being wasted by continual emission, the doctrine of *the return of effluvia* was universally given up, as being no longer necessary; and they were obliged to acquiesce in the unknown doctrines of attraction and repulsion, as natural properties of certain bodies, the unknown cause of which they scarcely attempted to explain.

280 Hypothesis of Du Fay. Early in the 18th century, M. du Fay discovered that there were two states of electricity, or, as he supposed, two different kinds of electricity, produced when different electrics were excited. "Chance (says he) has thrown in my way a principle, which casts a new light upon the subject of electricity. The principle is, that there are two distinct kinds of electricity, very different from one another; one of which I call vitreous, the other resinous electricity. The first is that of glass, rock crystal, precious stones, hairs of animals, wool, and many other bodies. The second is that of amber, copal, gum lac, silk, thread, paper, and a vast number of other substances. The characteristics of these two electricities are, that they repel themselves, and attract each other. Thus a body possessed of the vitreous electricity, repels all other bodies possessed of the vitreous, and, on the contrary, attracts all those possessed of the resinous electricity. The resinous also repels the resinous, and attracts the vitreous. From this principle one may easily deduce the explanation of a great number of other phenomena; and it is probable that this truth will lead us to the discovery of many other things."

This discovery of M. du Fay was the origin of a theory of electricity, which is commonly called the *theory of two fluids*, and which we shall presently consider more at length.

281 Hitherto attraction and repulsion were the only electrical phenomena which had been observed; and to the explanation of these, the above general theories appeared sufficiently competent. But when electricity began to shew itself in a greater variety of appearances, and to make itself sensible to the smell, the sight, the touch and the hearing; when bodies were not only attracted and repelled, but made to emit strong sparks of fire, attended with a considerable noise, a painful sensation, and a strong phosphorical smell, electricians were obliged to make their systems more complex, in proportion as the facts accumulated. It was then generally supposed that the electric power, which now began to assume the name of the *electric fluid*, was the same with the chemical principle of fire; though some thought it was a fluid *sui generis*, which very much resembled that of fire; and others, with M. Boulanger at their head, thought that the electric fluid was nothing more than the finer parts of the atmosphere, which crowded upon the surfaces of electric bodies, when the grosser parts had been driven away by the friction of the rubber.

282 Electric matter discovered to come from the earth. During this time, it was imagined, that the electric matter was produced from the electric body by friction; but by a discovery of Dr Watson's, it became universally believed, that the glass globes and tubes served only to set the fluid in motion, and by no means to produce it. He was led to this discovery by observing, that, upon rubbing the glass tube, while he was standing upon cakes of wax or rosin (in order, as he expected, to prevent any discharge of the electric matter upon the floor), the power was, contrary to his expectation, so much lessened, that no snapping could be observed upon another person's touching any part of his body; but that, if a person not electrified held his hand near the tube while it was rubbed, the snapping was very sensible. The event was the same when the globe was whirled in similar circumstances. For, if the man who turned the wheel, and who, together with the machine, was suspended upon silk, touched the floor with one foot, the electric fire appeared upon the conductor; but if he kept himself free from any communication with the floor, little or no fire was produced.—He observed, that only a spark or two would appear between his hand and the insulated machine, unless he at the same time formed a communication between the conductor and the floor; but that then there was a constant and copious flow of the electric matter observed between them. From these, and some other experiments of a similar kind, the Doctor discovered what he called the *complete circulation* of the electric matter. When he found, that by cutting off the communication of the glass globe with the floor, all electric operations were stopped, he concluded that the electric fluid was conveyed from the floor to the rubber,

rubber, and from thence to the globe. For the same reason, seeing the rubber, or the man who had a communication with it, gave no sparks but when the conductor was connected with the floor, he as naturally concluded, that the globe was supplied from the conductor, as he had before concluded that it was supplied from the rubber. From all this he was at last led to form a new theory of electricity, namely, that in electric operations, there was both an *afflux* of electric matter to the globe and the conductor, and likewise an *efflux* of the same electric matter from them. Finding that a piece of leaf silver was suspended between a plate electrified by the conductor, and another communicating with the floor, he reasons from it in the following manner: "No body can be suspended in equilibrio but by the joint action of two different directions of power; so here the blast of electric ether from the floor setting through it, drives the silver towards the plate electrified. We find from hence, likewise, that the draught of electric ether from the floor is always in proportion to the quantity thrown by the globe over the gun barrel (the prime conductor at that time made use of), or the equilibrium by which the silver is suspended could not be maintained. Some time after, however, the Doctor retracted this opinion concerning the afflux and efflux, and supposed that all the electric phenomena might be accounted for from the excess or diminution of the quantity of electric matter contained in different bodies. This is the theory that was more fully explained by Franklin. It has been disputed whether Dr Watson or Franklin was the original contriver of this theory. It is possible that Watson may have formed the idea independently of Franklin; but certainly to this latter able and acute philosopher is due the merit of having framed and applied the hypothesis of positive and negative electricity, which, with some modification, has been since almost universally adopted.

283 Dr Watson's theory of afflux and efflux.

284 Difficulty concerning the direction of the electric fluid.

One great difficulty with which the first electricians were embarrassed was to ascertain the direction of the fluid. At first, all electric powers, as we have already observed, were supposed to reside in the excited globe or glass tube. The electric spark therefore was imagined to proceed from the electrified body towards any conductor that was presented to it. It was never imagined that there could be any difference in this respect, whether it was amber, glass, sealing wax, or any thing else that was excited. The progress of the electric matter was thought to be quite evident to the senses; and therefore the observation of electric appearances at an insulated rubber occasioned the greatest astonishment.—In this case the current could not be supposed to flow both from the rubber and the conductor, and yet the first appearances were the same. To provide a supply of the electric matter, therefore, philosophers were obliged to suppose, that, notwithstanding appearances were in both cases much the same, the electric fluid was really emitted in one case by the electrified body, and received by it in the other. But now being obliged to give up the evidence from sight for the manner of its progress, they were at a loss, whether, in the usual method of electrifying by excited glass, the fluid proceeded from the rubber to the conductor, or from the conductor to the rubber. It was, however, soon found, that the electricity of the rubber was the reverse of that at the conductor, and in all respects the same with that which had before been produced by the friction of sealing wax, sulphur, rosin, &c. Seeing, therefore, that both the electricities were produced at the same time, by one and the same electric, and by the same friction, all philosophers were naturally led to conclude, that both were modifications of one fluid; though in what manner that fluid was modified throughout the immense variety of electric phenomena, was a matter not easy to be determined.

285 Abbé Nollet's theory.

On this subject the Abbé Nollet adopted the doctrine of *afflux* and *efflux* already mentioned. He supposed, that, in all electrical operations, the fluid is thrown into two opposite motions; that the afflux of this matter drives all light bodies before it by impulse upon the electrified body, and its efflux carries them back again. He was, however, very much embarrassed in accounting for facts where both these currents must be considered; as in the quick alternate attraction and repulsion of light bodies by an excited glass tube, or other excited electric. To obviate this difficulty, he supposes that every excited electric, and likewise every body to which electricity is communicated, has two orders of pores, one for the emission of the effluvia, and another for the reception of them. M. de Tour improved upon Nollet's hypothesis, and supposed that there is a difference between the affluent and effluent current; and that the particles of the fluid are thrown into vibrations of different qualities, which make one of these currents more copious than the other, according as sulphur or glass is used. It is impossible, however, that suppositions so very arbitrary could be at all satisfactory, or received as proper explanations of the electric phenomena.

286 Mr Wilson's theory.

About this time the Leyden phial was discovered; and the extraordinary effects of it rendered the inquiries into the nature of the electric fluid much more general than before. It would be tedious, and indeed impossible, to give an account of all the theories which were now invented. One of the most remarkable was that of Mr Wilson. According to this gentleman, the chief agent in all the operations of electricity, is Sir Isaac Newton's ether; which is more or less dense in all bodies in proportion to the smallness of their pores, except that it is much denser in sulphureous and unctuous bodies. To this ether are ascribed the principal phenomena of attraction and repulsion: the light, the sulphureous or rather phosphoreal smell with which violent electricity is always attended, and other sensible qualities, are ascribed to the grosser particles of bodies driven from them by the forcible action of this ether. He also endeavours to explain many electrical phenomena by means of a subtile medium at the surface of all bodies; which is the cause of the refraction and reflection of the rays of light, and also resists the entrance and exit of this ether. This medium, he says, extends to a small distance from the body, and is of the same nature with what is called the *electric fluid.* On the surface of conductors this medium is rare, and easily admits the passage of the electric fluid; whereas, on the surface of electrics, it is dense and resists it. The same medium is rarefied by heat, which thus changes conductors into non-conductors. By far the greater number of philosophers, however, rejected the opinion of Mr Wilson; and as they neither chose to allow the electric fluid to be *fire* nor *ether*, they were obliged to own that it was a fluid *sui generis*, i. e, one of whose nature they were totally ignorant.

Sect. II. *Of the Theory of Positive and Negative Electricity.*

287
Dr Franklin's theory

According to this theory, all the operations of electricity depend upon one fluid *sui generis*, extremely subtile and elastic. Between the particles of this fluid there subsists a very strong repulsion with regard to each other, and as strong an attraction with regard to other matter. Thus, according to Dr Franklin's hypothesis, one quantity of electric matter will repel another quantity of the same, but will attract and be attracted by any terrestrial matter that happens to be near it. The pores of all bodies are supposed to be full of this subtile fluid; and when its equilibrium is not disturbed, that is, when there is in any body neither more nor less than its natural share, or than that quantity which it is capable of retaining by its own attraction, the fluid does not manifest itself to our senses. The action of the rubber upon an electric disturbs this equilibrium, occasioning a deficiency of the fluid in one place, and a redundancy of it in another. This equilibrium being forcibly disturbed, the mutual repulsion of the particles of the fluid is necessarily exerted to restore it. If two bodies be both of them overcharged, the electric atmospheres repel each other, and both the bodies recede from one another to places where the fluid is less dense. For as there is supposed to be a mutual attraction between all bodies and the electric fluid, such bodies as are electrified must go along with their atmospheres. If both the bodies are exhausted of their natural share of this fluid, they are both attracted by the denser fluid existing either in the atmosphere contiguous to them, or in other neighbouring bodies; which occasions them still to recede from one another as if they were overcharged.

288
Difficulty concerning the reason why bodies negatively electrified repel one another.

This is the Franklinian doctrine concerning the cause of electric attraction and repulsion; but it is evident, that the reason just now given why bodies negatively attracted ought to repel one another, is by no means satisfactory. Dr Franklin himself had framed his hypothesis before he knew that bodies negatively electrified would repel one another; and when he came afterwards to learn it, he was surprised, and acknowledged that he could not satisfactorily account for it *. Other philosophers therefore invented different solutions of this difficulty, of which that above mentioned is one. But by some this was rejected. They said, that as the denser electric fluid, surrounding two bodies negatively electrified, acts equally on all sides of those bodies, it cannot occasion their repulsion. The repulsion, according to them, is owing rather to an accumulation of the electric on the surfaces of the two bodies; which accumulation is produced by the attraction, and the difficulty the fluid finds in entering them. This difficulty is supposed chiefly to be owing to the air on the surface of bodies, which Dr Priestley says is probably a little condensed there. This he deduces from an experiment of Mr Wilson, corrected by Mr Canton. The experiment was made in order to observe the course of the electric light through a Torricellian vacuum. A singular appearance of light was observed upon the surface of the quicksilver, at which the fluid was supposed to enter. Mr Wilson supposed that this was owing to a subtile medium spread over the surface of the quicksilver, and which prevented the easy entrance of the electric fluid. But this was afterwards discovered by Mr Canton to be owing to a small quantity of air which had been left in the tube. It is plain, however, that as the attraction is equal all round, and likewise the difficulty with which the fluid penetrates the air, bodies negatively electrified ought not to repel one another on this supposition more than the former. Nay, they ought to attract each other; because, in the place of contact, the resistance of the air would be taken off, and the electric fluid could come from all other quarters by the attraction of the bodies.

289
Different solutions of this difficulty.

290
Insufficient

This theory is evidently no solution of the difficulty; seeing it is only explaining one fact by another, which requires explanation at least as much as the first. We shall see hereafter how this difficulty may be explained.

291
Dr Franklin's explanation of the phenomena of the Leyden phial.

What gave the greatest reputation to Dr Franklin's theory, was the easy solution which it afforded of the phenomena of the Leyden phial. The fluid is supposed to move with the greatest ease in bodies which are conductors, but with extreme difficulty in *electrics per se*; insomuch that glass is absolutely impermeable to it. It is moreover supposed, that all electrics, and particularly glass, on account of the smallness of their pores, do at all times contain an exceeding great, and always an equal quantity of this fluid; so that no more can be thrown into any one part of any electric substance, except the same quantity go out at another, and the gain be exactly equal to the loss. These things being previously supposed, the phenomena of charging and discharging a plate of glass admit of an easy solution. In the usual manner of electrifying by a smooth glass globe, all the electric matter is supplied by the rubber from all the bodies which communicate with it. If it be made to communicate with nothing but one of the coatings of a plate of glass, while the conductor communicates with the other, that side of the glass which communicates with the rubber must necessarily be exhausted in order to supply the conductor, which must convey the whole of it to the side with which it communicates. By this operation, therefore, the electric fluid becomes almost entirely exhausted on one side of the plate, while it is as much accumulated on the other; and the discharge is made by the electric fluid rushing, as soon as an opportunity is given it by means of proper conductors, from the side which was overloaded to that which is exhausted.

It is not, however, necessary to this theory, that the very same individual particles of electric matter which were thrown upon one side of the plate, should make the whole circuit of the intervening conductors, especially in very great distances, so as actually to arrive at the exhausted side. It may be sufficient to suppose, that the additional quantity of fluid displaces and occupies the space of an equal portion of the natural quantity of fluid belonging to those conductors in the circuit which lay contiguous to the charged side of the glass. This displaced fluid may drive forwards an equal quantity of the same matter in the next conductor; and thus the progress may continue till the exhausted side of the glass is supplied by the fluid naturally

---

* *Franklin's Letters.*

rally existing in the conductors contiguous to it. In this case, the motion of the electric fluid, in an explosion, will rather resemble the vibration of the air in sounds, than a current of it in winds.

It will soon be acknowledged (says Dr Priestley), that while the substance of the glass is supposed to contain as much as it can possibly hold of the electric fluid, no part of it can be forced into one of the sides, without obliging an equal quantity to quit the other side: but it may be thought a difficulty, upon this hypothesis, that one of the sides of a glass plate cannot be exhausted, without the other receiving more than its natural share; particularly, as the particles of this fluid are supposed to be repulsive of one another. But it must be considered, that the attraction of the glass is sufficient to retain even the large quantity of electric fluid which is natural to it, against all attempts to withdraw it, unless that eager attraction can be satisfied by the admission of an equal quantity from some other quarter. When this opportunity of a supply is given, by connecting one of the coatings with the rubber, and the other with the conductor, the two attempts to introduce more of the fluids into one of the sides are made, in a manner, at the same instant. The action of the rubber tends to disturb the equilibrium of the fluid in the glass; and no sooner has a spark quitted one of the sides, to go to the rubber, than it is supplied by the conductor on the other; and the difficulty with which these additional particles move in the substance of the glass, effectually prevents its reaching the opposite exhausted side. It is not said, however, but that either side of the glass may give or receive a small quantity of the electric fluid, without altering the quantity of the opposite side. It is only a very considerable part of the charge that is meant, when one side is said to be filled while the other is exhausted.

It is a little remarkable, adds Dr Priestley, that the electric fluid, in this and in every other hypothesis, should so much resemble the ether of Sir Isaac Newton in some respects, and yet differ from it so essentially in others. The electric fluid is supposed to be, like ether, extremely subtile and elastic, that is, repulsive of itself; but instead of being, like the ether, repelled by all other matter, it is strongly attracted by it: so that, far from being, like the ether, rarer in the small than in the large pores of bodies, rarer within the bodies than at their surfaces, and rarer at their surfaces than at any distance from them; it must be denser in small than in large pores, denser within the substance of bodies than at their surfaces, and denser at their surfaces than at a distance from them.

292 traction d repul- n ough ss ac- nted

To account for the attraction of light bodies, and other electrical appearances, in air of the same density with the common atmosphere, when glass (which is supposed to be impermeable to electricity) is interposed; it is conceived, that the addition or subtraction of the electric fluid, by the action of the excited electric on one side of the glass, occasions, as in the experiment of the Leyden phial, a subtraction or addition of the fluid on the opposite side. The state of the fluid, therefore, on the opposite side being altered, all light bodies within the sphere of its action must be affected in the very same manner as if the effluvia of the excited electric had actually penetrated the glass, according to the opinions of all electricians before Dr Franklin.

293 Improvement of Franklin's theory by Æpinus and Cavendish.

This hypothesis has been greatly improved by M. Æpinus of St Petersburgh, and by the Hon. Henry Cavendish; and we shall now proceed to an illustration of the theory as given by these gentlemen.

Theory of Æpinus.

294 Hypothesis of Æpinus.

Electrical phenomena are produced by a fluid of a peculiar nature, which we call the ELECTRIC FLUID; which has the following properties.

1. Its particles repel each other with a force increasing as the distances decrease.

295 2. Its particles attract the particles of all other matter with a force increasing as the distances decrease, and this attraction is mutual.

296 3. The ELECTRIC FLUID by reason of its extreme subtility is capable of penetrating other bodies, but all bodies are not penetrated by it with equal facility. In those bodies which we call *non-electrics*, such as metals and water, it moves very readily; but in those bodies which have been called *electrics per se*, such as glass, &c. it either does not move at all, or moves with great difficulty.

297 4. Every body has a certain quantity of *electric fluid* which is proper to it, and may therefore be called its *natural quantity*: this quantity is proportional to the mass.

5. We say that a body is electrified *positively* when the quantity of electric fluid which it has in any way received is greater than its *natural quantity*; and when that quantity is less than its natural quantity, we say that the body is electrified *negatively*.

298 6. The phenomena which depend on the action of the *electric fluid* may be reduced to two classes; the first comprehending the cases in which the fluid removes from one body into another which has less of it; the other those in which the bodies containing the fluid are in motion, so as to approach or recede from each other, or so as to attract and repel each other.

Such is the hypothesis of M. Æpinus; let us now inquire what consequences may be drawn from it.

299 Let us suppose a body to contain a certain quantity of the electric fluid, and let us examine the state of a particle of the fluid, as P, near the surface of the body. There is a mutual attraction between the particle P, and the particles of matter in the body; and there is a mutual repulsion between it and the other particles of electric fluid in the body. The whole attracting force may be *equal* or *unequal* to the whole repulsive force. If they be equal, P is in equilibrio, and has no tendency to motion.

300 Now let us suppose the body to have received a quantity of fluid over and above its natural quantity; i. e. let the body be electrified *positively*. As, while the body was in its natural state, the attractive and repulsive forces were in equilibrio, the increase of fluid will augment the repulsive force, which will now exceed the attractive force, and the particle P will be repelled towards that surface to which it is nearest, till it at length quits the body. The repulsive power will continue to act upon other particles, which will be successively pushed nearer the surface, so as to produce a constant *efflux* of the fluid till the equilibrium is re-establish-

ed, or till the body contains no more than its natural quantity.

Let us now conceive that the body has lost a quantity of electric fluid, or that it is electrified *negatively*. The repulsive force of the fluid upon the particle P will then be less than the attractive force of the matter contained in the body or the same particle, this attraction will begin to act, and the particle will move nearer the centre. The attraction continuing to act, particles near the surface, and those of contiguous bodies, will successively move towards the centre of the body; or a continual *influx* of fluid will take place till the equilibrium is restored.

301 Saturation defined.

DEFINITION.—When a body contains its natural quantity of electric fluid, we shall say that it is *saturated*.

302 It will be convenient for us to have general expressions for these several states of a body, in order the better to estimate the forces.

Let Q represent the natural quantity of fluid,
- a, the attractive force of the other matter in the body, which we shall hereafter call simply the *matter*.
- r, the repulsive force of the fluid; and
- f, the redundant or deficient fluid.

Then in the case in which a body is *saturated*, $a-r$ will represent the degree of force with which the particle P is attracted; and $r-a$ the force with which it is repelled. But here $a=r$; consequently $a-r$ and $r-a=o$.

But let the quantity f be added to Q, and uniformly distributed through the body; the fluid will now be $Q+f$. As we must admit the repulsive force to be proportional to the quantity of fluid, we shall have $Q : Q+f = r : \frac{(Q+f)\times r}{Q}$, or $\frac{Qr}{Q}+\frac{fr}{Q}$ or $r+\frac{fr}{Q}$. This quantity will represent the force with which P is repelled by the whole fluid of the body. But it is also attracted by the matter of the body, with the force a; the whole force exerted on P will therefore be $a-r+\frac{fr}{Q}$; but $a-r=o$: the whole action exerted on P is therefore $\frac{fr}{Q}$, or the force with which the particle P is repelled, is $\frac{fr}{Q}$.

303 To conceive this more readily, we are to remember that when the quantity of fluid $=Q$, P is in equilibrio; it will therefore be necessary only to consider the action of the superabundant fluid f. Then to find the repulsive force of this, we say $Q : f = r : \frac{fr}{Q}$ as before; but to this we must affix the sign —, as we must consider repulsive forces as *negative*, and attractive as *positive*. The particle P then being repelled with this force $\frac{fr}{Q}$, it will quit the body unless it be opposed by some obstacle, and the repelling force continuing to act on other particles, an *efflux* of fluid will be produced. The force $\frac{fr}{Q}$ will however be continually diminishing, but will not entirely cease till $f=o$.

Now let the quantity of fluid f be subtracted from Q. Then $\frac{(Q-f)\times r}{Q} = r - \frac{fr}{Q}$ will represent the 304 force with which P is repelled. But it is attracted with the force a; the whole action therefore exerted on P is $a-r+\frac{fr}{Q}$: but $a-r=o$; therefore the whole force $=\frac{fr}{Q}$, which represents the force with which P is attracted.

When there is a deficiency of fluid there is a proportional redundancy of matter, and *vice versa*. Hence we may deduce the following inference.

305 Electrical phenomena depend on a redundancy of fluid or of matter.

The production of electrical phenomena depends entirely on a redundancy of fluid or a redundancy of matter.

306 Causes obstructing these effects.

There are two causes which obstruct or prevent the effects which we have been describing; the one depending on the nature of the body itself, the other on that of the surrounding bodies. The first cause of obstruction takes place when the bodies themselves are those which are called *electrics per se*, in which the fluid moving with considerable difficulty, its *efflux* in the first case, and its *influx* in the second, will be alike retarded. The second cause acts when the surrounding bodies are *electrics per se*, as *very dry air*; as the resistance which these oppose to the motion of the fluid, will produce in the *efflux*, or the *influx*, a retardation similar to that which arises from the electric nature of the electrified body. We may hence conclude that a body will continue to exhibit electrical phenomena for a longer time, *cæteris paribus*, according as the body itself, or the bodies by which it is surrounded, approach nearest to the nature of *electrics per se*, whence we see how electrics are useful in confining the electric fluid, or in *insulating* electrified bodies.

307 Illustration.

The conductors of an electric machine will afford a familiar illustration of the above principles as far as they relate to *non-electrics*. In the ordinary machine, in which a cylinder is employed, the cushion and silk by which the cylinder is rubbed communicate to it a portion of the fluid which they contain, the loss of which they supply from the neighbouring bodies with which they communicate, when the chain connects the rubber with the earth, &c. The fluid is then communicated from the cylinder to the prime conductor by the points placed on the side of it, and the conductor becomes electrified positively. The glass pillar by which the conductor is supported, and which is an *electric per se*, opposes the farther propagation of the fluid, and prevents its escape on one side, while the surrounding air, if it be very dry, opposes its escape on the other; so that the conductor will retain for a moment the excess of fluid which it has received. Now, if we present a fine metallic point to the prime conductor, a small luminous star will appear at the point; indicating, as we have before seen, a positive electricity. This star is produced by the *efflux* of the electric fluid from the conductor, the particles of the fluid being impelled by their mutual repulsion, and by the attraction of the point to approach and penetrate this, as we shall more fully see hereafter.

When the rubber is insulated, as it is perpetually communicating a portion of its fluid to the cylinder, without being able to procure a fresh supply from the surrounding bodies, it is continually acquiring a negative

tive electricity. There will now be a continual *efflux* of fluid from the conductor towards the cushion, and the conductor will, in its turn, be electrified negatively. In this case, if we present a fine metallic point to the conductor, there will issue from the point a luminous pencil, which is produced by the *efflux* of fluid from the point to the conductor, in order to restore the equilibrium.

308 Effect of an unequal distribution of fluid. We have hitherto considered the fluid as uniformly diffused through the body. But it will often happen, that there will be a redundancy of fluid in one part of the body, while there is at the same time a deficiency in another part. In order to simplify our formula, we shall suppose the body BC (fig. 96.) divided into two equal parts, AB, AC, and that the fluid in AB exceeds its natural quantity, while that in AC is less than the same quantity, the proportion of the fluid acquired on one side to that lost on the other being variable at pleasure. Let us examine the situation of two particles P, p, placed towards the two extremities.

Plate CXCVI. fig. 96.

Let Q represent the quantity of fluid necessary for the saturation of AB or AC,
$a =$ the attraction of the whole matter in AB for the particle P or p,
$r =$ the repulsion of the whole fluid uniformly distributed in AB on the same particle,
$r' =$ the repulsion of an *equal quantity* of fluid in AC on the same particle,
$f =$ the quantity of redundant fluid in AB,
and $g =$ the deficient quantity in AC.

309 ction on xternal uid. Now the force by which the particle P or p is attracted by the matter of BC when *saturated*, will be $a-r-r'$, which when the body is in its natural state will be equal to o. But AB contains the redundant fluid f, and AC the deficient fluid g. The whole action exerted must therefore be $a-\frac{(Q+f)\times r}{Q}-\frac{(Q-g)\times r'}{Q}$. But $a-r-r'=o$; therefore the whole action is $\frac{g r'-f r}{Q}$, or rather, since r is greater than r', $\frac{f r-g r'}{Q}$, which will represent the force by which the particle P is repelled. In the same manner, $\frac{g r-f r'}{Q}$ will represent the force by which p is attracted.

310 tion on ternal id. Now, let us suppose a particle p' in the middle of the body BC; while the body is saturated, it will be in equilibrio; but as the one half of the body AB contains the redundant fluid f, and the half AC the deficient fluid g, the particle p' will be repelled in the direction AC by the force $\frac{f r}{Q}$. But it is repelled in the direction AB by the force $\frac{g r}{Q}$; therefore the whole repulsive force by which it is impelled in the direction AC will be $\frac{f r+g r}{Q}$, or, $\frac{\overline{f+g}\times r}{Q}$.

311 uniform usion l be proed if re be no truction. From what we have said above, it appears that so long as there is a redundancy of fluid in AB, and a deficiency in AC, the redundant fluid has a tendency to flow from A to C; and if the body be a perfect conductor, or such as is permeable to the fluid, its state cannot be permanent till the fluid is uniformly distributed between the two halves, unless it is acted on by some external force. But in a non-conductor, or perfect electric, this state may subsist, and it will be continued for a longer or a shorter time, in proportion as the electric may be more or less perfect.

If we had supposed the part AC to be overcharged, instead of AB, P would have been repelled with a stronger force, which would be represented by $\frac{f\times\overline{r+r'}}{Q}$, which is evidently greater than $\frac{f r-g r}{Q}$, the repulsive force in the first case. The particle p is also less attracted than before, when AB is undercharged instead of AC.

The above remarks will equally apply to the case of two conducting bodies AB and CD, fig. 99. separated by an electric, Z. 312 Fig. 99.

It is proper to observe that the quantities f and g, were indefinite in the above reasoning. Their value may be such that the tendency to influx or efflux may cease, or may be reversed; for supposing $g r'-f r=o$, or $g:f=r:r'$; and we shall have $g=\frac{f r}{r'}$. In this case the attraction of the redundant matter balances the repulsion of the redundant fluid, and P is neither attracted nor repelled. Hence we have this important fact, that *a body may be neutral, even where it is redundant or deficient.* 313

When one extremity of the body is thus rendered inactive, the state of the other extremity is changed. To find this state we must put $\frac{f r}{r'}$, in place of its equal g, in the formula $\frac{g r-f r'}{Q}$; and we shall have $f\times\left(\frac{r^2-r'^2}{Q r}\right)$.

Again, the forces may be so balanced, that there shall be no tendency to influx at C, fig. 96. Make $g=\frac{f r}{r'}$, which expresses the action at C. The action at B, the other end, will be obtained by putting $\frac{f r}{r'}$, in place of g in the formula $\frac{f r-g r'}{Q}$ as before, and the result $f\times\left(\frac{r'^2-r^2}{Q r}\right)$, will express the repelling force at B. 314

In order, the better to conceive the relative effects in each of the above cases, we must observe that the repulsion of the part AB on the particle P must increase in proportion as the quantity of additional fluid acquired by AB is greater. On the other hand, the attraction of the part AC for the same particle will increase according as the quantity of fluid subtracted from AC is greater. Now, as we have supposed the quantities of fluid in the two parts variable, we may suppose a case to happen, in which, for instance, the quantity lost by AC may be such that the excess of its attraction on P, thence resulting, may exactly counterbalance the diminished attraction arising from its great distance, compared to the repulsion of the part AB on the same

same particles. In this case, P will remain immoveable.

If, on the contrary, the quantity of fluid lost by AC be not sufficient to compensate for the greater distance, the repulsion of AB will prevail over the attraction of AC, and the particle P will quit the body.

The particle *p* will also undergo certain changes in these different cases. If the particle P remain immoveable, for instance, the particle *p* will have a progressive motion towards the body A, since this is near the part AC of which the attractive force in this case exceeds the repulsive force of AB. If the particle P has already a tendency towards the body A, the particle *p* will for a still stronger reason be attracted towards A.

In general, according to the different degrees of force exerted by the two parts of the body, it will happen that the fluid will be attracted and repelled on both sides by turns, or it will be attracted on one side, while it is repelled on the other, and *v. v.*; or, lastly, it may remain immoveable on one side, while it is attracted or repelled on the other.

315 If we suppose that the redundancy of fluid in AB is exactly equal to the deficiency in AC, then the particle *p* will have a tendency to penetrate the body A, while the particle P will be repelled by it.

To prove this, let us suppose that the parts AB, AC act by turns on the particle *p* placed at a determinate distance; and let us conceive the repulsive force of the part AB to be concentrated in a determinate point, while the attractive force of the part AC must be supposed concentrated in a corresponding point on the other side. For, whatever be the law, in proportion to the distance which the repulsion of the particles of the electric fluid follows, the attraction of the particles of matter in the electrified body ought to follow the same law; since, without this, there could be no counterpoise between the attraction and repulsion of the particles in the natural state of the body. It follows then, that the attraction exerted by AC upon the particle *p* must be equal, in the present case, to the repulsion of AB on the same particle. Since, on one side, the particle is repelled by AB by reason of the excess of fluid in that part, and on the other it is attracted by AC by reason of the quantity of matter in that part, and which is proportional to the quantity of fluid which is supposed to have passed into AB. In the present case, therefore, where the particle *p* is nearer to AC than to AB, the attraction will prevail over the repulsion, and the particle will penetrate to AB, and pass through it to the body A.

In the same manner we might prove that the particle P would be repelled from A.

316 The equilibrium between the forces of the parts AB, AC being disturbed, it is clear that there will be an attempt to restore it, so that a portion of the redundant fluid in AB will pass into AC, till the body be brought back to its natural state. The return to this state will be more or less slow, according as the body is a more or less perfect electric; but if it is a conductor, the fluid will pervade it in an instant, and an equal distribution will immediately take place.

317 Nature of the obstructions considered.

It has been stated that the fluid does not move with equal facility through all bodies, but that in moving through electrics it meets with more or less resistance. It will be proper, before we proceed farther, to consider the nature of this resistance. It may either arise solely from the inertia of the particles of the fluid, which is the case in a perfect fluid; or it may resemble the resistance opposed by a parcel of grain to the descent of small shot through it, or the resistance of a plastic or ductile body, such as clay or lead, to the motion of a body through its pores. In the first case, any inequality of force, however small, is capable of producing a uniform distribution of the fluid, or at least such a distribution as will make the excess of the mutual attractions and repulsions equal to the degree of external force by which an unequal distribution may be kept up. But in the two last cases, before a particle of fluid can change its place, it must overcome the tenacity of the adjoining particles of the body, and, consequently, when an unequal distribution has been produced by an external force, it will not be rendered equable by a removal or alteration of that force, but there will remain such an inequality of distribution, as will cause the want of equilibrium between the attractions and repulsions to be counterbalanced by the tenacity of the body.

From the different states of the particle P, *p*, as described in the above cases, we may conclude, that, during the return of a body to its natural state, the readiness with which the fluid flows from AB into AC must depend much on the nature of the surrounding bodies, and the greater or less facility with which these are pervaded by the electric fluid.

318 If the fluid is not uniformly distributed throughout every part of the body, or if, though there be a uniform distribution, the two parts of the body are unequal, we shall always obtain results analogous to those which have been given. There is an infinity of cases supposable, relative to the different states of AB and AC; but as each of these cases has a determinate relation to the most simple case, which we have been considering, it may always be reduced to this.

Let us suppose, for example, that the part AB is double, triple, &c. the part AC, and that the portion of fluid, which is superabundant in AB, is equal to that which is deficient in AC: If we conceive the particle *p* situated between these two parts, the point in which we must suppose the repulsive force of AB to be concentrated, will not be the same as that given in (315.); but the point in which *p* must be placed that it may be attracted by AC and repelled by AB, will be between the centres of action of AB and AC, though not at an equal distance from these parts. Then, in the case where *p* is nearer to the centre of action of AC than to that of AB, this particle will tend to penetrate into AC, while the particle P will be equally repelled from it.

319 Actions of electrical bodies on each other.

Having thus examined the action between the particles of fluid moving in a body, and the particles of matter in the same body, we shall proceed to consider the action of electrified bodies on each other.

Let there be two bodies, A and B, in their natural state.

Let M represent the common matter in A.
m, the common matter in B.
F, the fluid required to saturate A.
f, the fluid required to saturate B.
z, the mutual action between a particle of fluid and the correspondent matter. This action is represented

Theory of Electricity.

ed by an unknown quantity, because it is indeterminate; varying with every change of distance.

As the actions of these bodies on each other are reciprocal, it will be sufficient here to consider how the body A is affected. There are three circumstances to be taken into consideration.

1. The particles of fluid in A attract the particles of matter in B with the force z; so that the whole attraction of A on B will be the product of F and m multiplied by z or Fmz; or

1st. F tends towards m with the force $+Fmz$.

2. The particles of fluid in A repel the particles of fluid in B with the same force z; so that the whole repulsion of A on B will be Ffz; or

2d. F tends to separate from f with the force $-Ffz$.

3. The particles of matter in A are attracted by the particles of fluid in B with the same force z, so that the whole attraction of B on A will be Mfz; or,

3d. M tends to approach f with the force $+Mfz$.

The whole tendency of A to approach or to separate from B may therefore be represented by the symbol $z \times \overline{Fm+Mf-Ff}$. But as, from the hypothesis, the attraction of the particles of fluid in A for the particles of matter in B is equal to the repulsion between the particles of fluid in A and the particles of fluid in B, which are competent to the matter attracted by the fluid in A, the attraction Fmz is balanced by the repulsion Ffz. We have, therefore, only to consider the remaining attraction, or the attraction of the matter in A for the fluid in B, or Mfz. On the whole, therefore, A will move towards B, and, as all action is equal and contrary, B will move towards A with an equal force.

320 eficiency the hypothesis pplied.

This would be the necessary consequence of the hypothesis, as it stands; but as we see no attraction between bodies in their natural state, there must be some defect in the hypothesis. To remedy this, Æpinus brings another repulsive force into play, and supposes that every particle of matter in A repels every particle of matter in B, as much as it is attracted by so much of the fluid in B as is necessary for its saturation. Now, therefore, the whole action exerted by B on A will be $z \times \overline{Fm-Ff-Mm+Mf}$, so that as Fmz is balanced by Ffz, and Mmz by Mfz, there will remain no excess on either side, and consequently the bodies will have no tendency to motion.

321 pinus deded.

Great objection has been made to this additional part of M. Æpinus's hypothesis, and indeed Æpinus himself acknowledges, that this circumstance appeared to him hardly admissible; it seeming inconceivable that a particle in A shall repel a particle in B, or recede from it electrically, while it tends towards it by planetary gravitation. But more attentive consideration shewed him, that there was nothing in it contrary to the observed analogy of natural operations. We see innumerable instances of inherent forces of attraction and repulsion; and nothing hinders us from referring this lately discovered power to the class of primitive and fundamental powers of nature. Nor is it difficult to reconcile this repulsion with universal gravitation; for while bodies are in their natural state, the electric attractions and repulsions balance each other, and there is nothing to disturb the phenomena of planetary gravitation; and when they are not in their natural electrical state, it is a fact that their gravitation is disturbed. Although we cannot conceive a body to have a tendency to another body, and at the same time a tendency from it, when we derive our notion of these tendencies entirely from our own consciousness of effort, nothing is more certain than that bodies exhibit at once the appearances which we endeavour to express by these words. We bring the north poles of two magnets near each other, and they recede from each other; if this be prevented by some obstacle, they press on this obstacle, and seem to endeavour to separate. If while they are in this state, we electrify one of them, we find that they will now approach each other; and so we have a distinct proof that both tendencies are in actual exertion by varying their distances, so that one or other force may prevail; or by placing a third body, which shall be affected by one but not the other, &c. We do not understand, nor can we conceive, how either force, or how gravity, resides in a body. It must be granted, therefore, that this additional circumstance of Æpinus's hypothesis has nothing in it that is repugnant to the observed phenomena of nature.

In order to simplify the algebraic expressions which we employ in considering the actions of these bodies, we may remark, that, as in the natural state of the bodies they do not affect each other, we need only, in examining the action of bodies not in their natural state, consider the action of the redundant fluid or the redundant matter in them, that is, the fluid or matter which is *unsaturated:* for we may consider an *overcharged* body as one which contains a quantity of *saturated* fluid, and a quantity of *unsaturated* fluid additional; and an *undercharged* body as one containing a quantity of *saturated matter*, and a quantity of *unsaturated matter* in addition. 322

Suppose two bodies A and B overcharged, or containing each a quantity of unsaturated fluid, which we shall call F' and f'. Their mutual action on each other will be $F'+f'+z$, and it is evident from what was said before that this is a repulsion. Hence we have the following general proposition.

1. *Two overcharged bodies repel each other with the force* $F' \times f' + z$. 323

Now let these bodies be *undercharged*, or contain each a quantity of unsaturated matter, M', m'. Their mutual action will now be $M' \times m' + z$. This action is also repulsive, and hence

2. *Two undercharged bodies repel each other with the force* $M' \times m' + z$. 324

Again, let one of the bodies A be *overcharged* or contain the *unsaturated fluid* F', and the other B *undercharged*, or contain the *unsaturated matter* m'. Their mutual action will now be expressed by the symbol $F' \times m' + z$, and will be attractive; or

3. *Two bodies which are,* one overcharged, *and* the other undercharged, *attract each other with the force* $F' \times m' + z$. 325

Lastly, let one of the bodies be overcharged or undercharged, and the other in its natural state. We infer from the above formulæ, that they will neither attract nor repel each other, or that they will be *neutral;* for here either F' or f', or M' or m', one of the factors which made part of the above products, is wanting. This may be inferred also, independently of the formulæ, by considering

sidering that the redundant fluid or redundant matter in one body, is as much repelled or attracted by the fluid or matter in the other, as it is attracted or repelled by the matter or fluid in this other. Hence,

326 4. *If of two bodies, one be in its natural state, they will neither attract nor repel each other.*

327 The truth of the three first propositions will be evident from the experiments related in the last Part, Chap. I. where we found that bodies which were electrified *both positively* or *both negatively*, repelled each other, and that when one body was electrified *positively* and the other *negatively*, they attracted each other. But the last proposition seems contrary to the phenomena; and it certainly contradicts a part of the Franklinian doctrine, which maintains that there is an attraction between an *electrified* and a *non-electrified* body: we shall presently, however, demonstrate the truth of the proposition, but must now proceed in our explanation of Æpinus's theory.

328 Plate CXCVI. fig. 97.

Suppose the body BC, fig. 97. to be overcharged in the half AC, and undercharged in the half AB, and let us now represent the redundant fluid in the part AC by the symbol f', and the redundant matter in AB by m'; let the body D near BC be overcharged with the redundant fluid F'; let z and z' denote the force of action exerted on D at the distances of this body from the overcharged or undercharged parts of BC. Now D is repelled by AC, with the force $F' f' z'$, but it is attracted by AB with the force $F' m' z'$; on the whole, therefore, D will be attracted or repelled by BC, according as $F' m' z$ is greater or less than $F' f' z'$, or (because F is common to both) as $m' z'$ is greater or less than $f' z$. But this will depend on the proportion that f' bears to m', or z to z'. Now, the former of these is regulated by many external circumstances which may tend to produce a greater or less redundancy or deficiency of fluid; and the latter depends on the *law* of electric action. Without inquiring at present into this law, it is sufficient to recollect that the action *decreases* with every *increase* of distance, and that the attraction and repulsion at the same distance are *equal*. Both, therefore, vary according to the same law, and z is always greater than z'.

But the sensible action of BC on D, and (as action and reaction are equal and contrary) of D on BC, may vary with every new position of BC, and even in the same position.

329 1. Let us suppose that BC contains on the whole its natural quantity of fluid, but that part of it is taken from AB, and crowded into AC. This, which is a very common case in electricity, may be expressed in our symbolic manner by making $f'=m'$. Now, in this case, $F' f' z$ is greater than $F' m' z'$, as z is greater than z'. A mutual repulsion will therefore take place between BC and D, and this may be expressed by $F' f' \times (z-z')$.

330 2. If D were placed on the redundant side of BC, it is evident that the action would be reversed, and the above symbols will express the *attraction* between BC and D.

Again, if instead of supposing D to be *overcharged*, we make it undercharged, the actions will again be changed: in its present situation it will be repelled; on the opposite side of BC it will be attracted.

331 3. No action may be exerted between them; for the redundancy and deficiency in BC may he inversely proportional to the forces, or we may have $f' m' : = z' : z$. Now, multiplying extreme and mean terms, we have $f' z = m' z'$, and again $m' = \frac{f' z}{z'}$. In this case the actions counterbalance each other, and when D is at the present distance from the overcharged part AC, it is neither attracted nor repelled. D, and that part of BC that is contiguous to it, may both be overcharged, and yet BC may exert no action on D, or may be *neutral* with respect to it.

Now suppose D on the opposite side of BC; the effects will be different; for as $m' = \frac{f' z}{z'}$, and $m' z'$ is now become $m' z$, and $f' z$ is changed into $f z'$, the action on D will be expressed by $F' \times \left(\frac{f' z}{z'} - f' z'\right) = F' f' \times \frac{z^2 - z'^2}{z'}$; of course D will be attracted. 332

Again, we may have f' and m' so proportioned as that when D, which we suppose overcharged, is placed at the undercharged end of BC, it shall be neither attracted nor repelled, or that at this exact distance BC shall be *neutral*. In this case, $m' = \frac{f z'}{z}$. But if D be on the opposite side of BC, it will be strongly repelled with the force $F' f' \times \left(\frac{z^2 - z'^2}{z}\right)$. 333

334 Bodies neutral at one end have their actio at the other increased.

Hence we see that when the overcharged end of an electrified body becomes *neutral* with respect to another body that is also overcharged, the undercharged end strongly attracts that body; and when the undercharged end becomes *neutral* to the body, this is strongly repelled by the overcharged end, as we may deduce from this reasoning the following general conclusion.

When an electrified body is neutral at one end, it is rendered more active at the other.

One circumstance merits particular attention. In the above paragraphs, the neutrality of BC has been confined to a particular distance of the body D, it being required that m' should $= \frac{f' z}{z'}$; let D be placed nearer to BC, and both z and z' are increased. Their increase may be in the same proportion; or one may increase faster than another: in the former case, the value of $\frac{z}{z'}$ remains the same, and the neutrality continues; in the latter, if z increases faster than z', $f' z$ becomes greater than $m' z'$, and D will be repelled: on the other hand, if z' increases faster than z, D will be attracted. Let D be carried farther from the overcharged end of BC, and the effects will be reversed. 335

336 Effect of unequal distribution in bo bodies. Fig. 98.

We have been supposing that D is overcharged *throughout*, but let us take two bodies AB, and CD, fig. 78. AB being overcharged in u B, and undercharged in u A; and CD being overcharged in v D, and undercharged in v C.

In the first place, let us have the overcharged end of AB opposite the undercharged end of CD as in the figure. Let F and f be the fluid natural to each, F' and f' the redundant fluid in u B and v D, and M' and m' the deficient fluid in u A and v C. Let Z and

Z' denote the intensity of action exerted by a particle in u B on a particle in v D and v C; and let z and z' in like manner express the intensity of action of a particle in u A on a particle in v D and in v C.

It will easily appear from the former examples that the action of CD on AB will be $\frac{F'm'Z - F'f'Z' - M'm'z + M'f'z'}{F'f}$; in which formula the attractions are denoted by $+$, and the repulsions by $-$.

The attractive or repulsive power will prevail according as the sum of the first and last terms in the numerator of the above fraction is greater or less than the sum of the two middle terms. Again the value of each term will vary with the quantity of redundant fluid or of redundant matter, and with the intensity of the electric action. As it would lead us into too long a discussion were we to notice the numerous varieties of effect, we shall only state the most simple case, as being the most frequent and most useful.

337 Let us suppose that the overcharged part of each body is as much redundant in fluid as the undercharged part is deficient; in which case we have $F' = M'$ and $f' = m'$. The action will now be expressed by the formula $\frac{F'f'(Z - Z') - z + z'}{Ff}$. It is evident that the external effect produced on AB must depend on the law of action; if $Z + z'$ be greater than $Z' + z$, AB will be *attracted*, but if $Z + z'$ be less than $Z' + z$, it will be *repelled*.

338 It will be a considerable relief to the imagination to express these abstract values by some sensible quantities, such as lines, and this may be conveniently done in the following manner. From a fixed point in a straight line, measure off portions respectively equal to BC, BD, AC and AD, between those points of the bodies AB, CD, fig. 98. in which we suppose the forces of the redundant fluid and matter to be concentrated, and at the extremities of these portions erect ordinates proportional to these forces. Though the law of action be but imperfectly known, it will readily be seen of what kind the movements of the bodies will be. Thus in fig. 100. from C in the line CZ, make $Cp = BC$: $Cq = BD$: $Cr = AC$, and $Ct = AD$; and erect the ordinates P p, Q q, R r, and T t. If the action of electricity be like other attractive and repulsive forces with which we are acquainted, that is, decreasing with an increase of distance, and more slowly as that distance becomes greater, the ordinates will be bounded by such a curve as PQRTZ, that will have its convexity towards the axis C z.

g. 98.

g. 100.

339 In our construction, the pair of ordinates P p, Q q are evidently equidistant with the pair R r, T t; as are P p, R r, with Q q, T t. It is also clear that the sum of P p and T t is greater than the sum of Q q and R r. Bisect C z and v, and draw V v perpendicular to it, cutting PT and QR in x and y. Then xv is the half of $Pp + Tt$, and yv is the half of $Qq + Rr$. Again, Q m and T n being drawn parallel to C z, it is evident that P m is greater than R r, and in general, if any pair of ordinates be brought nearer to T, their difference increases; and if two pairs be brought nearer to C, the difference of the nearer pair will increase faster than that of the more remote.

340 To apply what has been stated.

1. When the overcharged end of AB is towards the undercharged end of CD, AB is attracted, as $Pp + Tt$ is greater than $Qq + Rr$.

2. The nearer the bodies are brought, the more the attraction will increase, as the difference between P m and R r is thus made greater.

3. The greater the length of AB or CD, the distance BC being the same, the more the attraction will increase: for pr or qt, (which represent the length of AB) being increased, R r is diminished more than T t.

But if the overcharged end of CD be opposite to the overcharged end of AB, their mutual action will be represented by $F'f'\left(\frac{-Pp + Qq + Rr - Tt}{Ff}\right)$ and AB will be repelled; the repulsion becoming greater or less, as the attractions, by every change of distance.

Having thus examined at some length the results of a redundancy or deficiency of fluid, supposing it to be immoveable, we must now proceed to consider the consequences of its mobility.

341 Effect of the mobility of the fluid. Fig. 97.

Let D, fig. 97. contain redundant fluid while BC is supposed in its natural state, and let the fluid in D be fixed, but that in BC moveable. The redundant fluid in D will exert its repulsive power, and will drive the fluid of BC from the proximate end B towards the remote end C, so that the fluid will be rarefied in AB, and constipated in AC. Without examining here the mutual actions of the redundant fluid and matter, it is clear that we have a case similar to that described in N° 309. and so $f' = m'$ and z is greater than z', D will be attracted by BC, with the force $F'f' \times (z - z')$.

We may now solve the difficulty mentioned in N° 317. and perceive that the hypothesis agrees with the fact even in the case in which it appeared so opposite. Had the fluid been immoveable, no attraction would indeed have taken place: but as it is supposed moveable, the redundant matter in the vicinity of D prevails, and a mutual attraction ensues.

342 For the sake of greater simplicity, we have supposed the fluid in D immoveable, but let us suppose it moveable. In that case, as soon as the uniform distribution on BC is disturbed, and it becomes overcharged in AC, and undercharged in AB, certain forces begin to act on D, tending to disturb its uniformity. The redundant matter towards B attracts the fluid in D, more than the redundant fluid towards C, which is more remote, repels it; z' being less than z. By this attraction the fluid of D tends to be constipated in the proximate extremity, and thus again AB is more undercharged, and AC more overcharged than before. Thus the mutual action between the bodies is still more increased. But it is still of the same kind; for however small the redundancy in D may be, it can never be made deficient in its remote extremity by the irregular disposition of the fluid in BC, unless BC contain more or less than its natural quantity. By the change in the disposition of fluid in D, it is clear that the similar change in BC must be increased; the fluid will be still more rarefied at B and condensed at C, and this will go on till all is *in equilibrio*. There are several forces combining to hold *in equilibrio* a particle in BC. The redundant fluid in D impels it towards C; but the redundant fluid here again impels it towards B, while the redundant

redundant matter at B attracts it the same way; and these two forces of BC must be supposed to balance the action of D.

We may here conclude that the density of the fluid in BC increases gradually from B to C; at B it must be less, and at C greater than the natural density, and there will consequently be some point between B and C where it is of the natural density. This point may be called a *neutral* point; though we do not mean to imply by this term that a particle situated at this point is neither attracted nor repelled.

343 We have supposed the fluid in D redundant; but let it be deficient. Then the attraction of the redundant matter in D will change the disposition of the moveable fluid in BC, and will constipate it in B, and rarefy it in C. Again, the redundant fluid at B will act more strongly on the moveable fluid in D, and tend to impel it towards the remote extremity; and D will thus become undercharged in its *proximate* extremity, and less undercharged at its *remote* end than if BC were away. The unequal distribution of fluid in BC will thus be increased; but though both BC and D will be farther from their natural state, the remote end of D can never be overcharged.

It is clear, that when things are in the state which we have described, D and BC will attract each other with the same force as when D was equally undercharged.

344 Induced electricity. Fig. 101.

Let a body, A, (fig. 101.) that is overcharged, be placed near the extremities of two oblong parallel conductors, B and C, that are in their natural state. By the action of A, the fluid in B and C will be repelled towards their remote ends N and *n*, where it will be condensed, while at their proximate ends, S and *s*, it will be rarefied. Both B will attract and be attracted by A. Now the redundant fluid in NB repels the redundant fluid in *n* C, and in like manner the redundant matter in SB repels the redundant matter in *s* C; the bodies B and C therefore repel each other, and will separate; but they ought to approach each other, for SB attracts *n* C, and NB attracts *s* C; but the repelling parts being nearer each other than the attracting parts, the forces of the former will prevail. If the body A were undercharged, it is clear that the same *sensible* appearances would take place, though the internal motions of the bodies would be the reverse of the former.

If another body in the same state with A be placed near the opposite ends of B and C, their internal motions will be diminished or prevented, and of course the sensible appearances should diminish also.

If another conductor, as E, be placed near *s*, opposite to A, it will be affected in the same manner with C, and its proximate extremity *f* will repel *s*; but if it be placed at the remote end, or in the position of F, this remote end will be attracted. As the body A, when redundant or deficient, affects every other body in its vicinity, while these do not by themselves affect each other, A is called the electrified body, and the others are said to be electrified by it. The electricity of these bodies is called *Induced Electricity*.

345 Effect of obstructions.

We have hitherto supposed the fluid moveable, except at first in A; but let us suppose that there is some obstruction to its mobility, and let us examine what will be the consequences. We may state the obstruction as uniform, and as being such that some small force is required to enable a particle of fluid to pass between two particles of matter.

When an overcharged body is placed near an imperfect conductor, it is clear that the fluid cannot be propelled to the remote extremity of the conductor in so great a quantity. We may conceive the distribution of the fluid, by taking a constant quantity from the intensity of the force of the overcharged body at every point of the conductor. This shows that the distribution will not be so unequable between imperfect, as between perfect conductors, and hence that the attraction between the former will not be so strong as between the latter. It will also be much longer before an *equilibrium* can be brought about. This leads us to an important consequence; viz. that the neutral point will not be so far from the other body when the fluid is of its natural density, as it would be, were there no obstructions. The advance of this point along the imperfect conductor will also be very slow; and it is clear, that the final accumulation at the remote extremity of an imperfect conductor will be less than if the conductor were perfect, and the neutral point will be nearer to the other extremity.

The obstruction we are considering will be attended with another remarkable effect. The constipation of the fluid at the commencement of the action will always be greatest at a place much nearer to the disturbing cause than the remote end of the conductor, and beyond that point it will diminish. In the time that elapses during the progress of this change, the condensed fluid tends to repel the fluid beyond it, and thus some of this remote fluid may be displaced, and a part of the imperfect conductor made deficient, while there is a small condensation beyond it. By this again a rarefaction and condensation may be produced in another part, thus causing a very irregular distribution of the fluid. 346

The effect of such a mode of action will be that there may be several neutral points in an imperfect conductor, and several overcharged and undercharged portions, and hence its action on distant bodies may be extremely various. The formula $\frac{fr-gr'+hr''-ir'''}{Q}$, where *f*, *g*, *h*, *i*, express the different portions in opposite states, and *r*, *r'*, *r''* *r'''*, the repulsion at different distances, may be conveniently employed to denote the action in such circumstances. Hence, if another body be placed in the direction of the axis, it will be attracted at one distance, repelled at a greater, again attracted at a still greater distance, and so alternately.

The obstruction may not be considerable, and then the action of the neighbouring overcharged body will produce a deficiency in the proximate part of the conductor, a redundancy farther on, then a deficiency, and so on. Presently these will shift, and successively disappear at the farther end, and the body will remain with only one neutral point. A greater obstruction will leave the body with more than one neutral point, and the number of these will be in proportion to the obstruction.

347 Induced electricit may become per manent i imperfect conducto

The removal of an overcharged body from the vicinity of conductors will have different results according as the conductors are perfect or imperfect, that is, according as there is obstruction or not. In the former case,

case, the electricity induced by the vicinity of the overcharged body will be instantly destroyed on the removal of the body. But where there is an obstruction acting, though, on the removal of the body, the forces that tend to restore the equilibrium in the conductor begin to act, and restore it in part, they can never do this completely; for when the force by which a particle is propelled from an overcharged part to one undercharged, is just sufficient to balance the obstruction, it will remain in that state of distribution at which it had arrived. We may expect, then, that imperfect conductors will retain a part of their induced electricity.

On the removal of the electrifying body, the electric appearances induced by it in the conductor will disappear in a contrary order to that in which they were produced, and they will be left in a state of unequal distribution, or with a degree of electric power proportionate to their imperfection as conductors.

We have now given an account of the principal consequences of the theory of Æpinus, of which a very lame and imperfect account is given by Dr Priestley in his popular work on electricity. More justice has been done to this theory by Mr Cavendish, who before he saw M. Æpinus's work had framed an hypothesis of his own upon very similar principles. Mr Cavendish's paper, in which he has treated this subject in a very able and learned manner, appeared in the 61st vol. of the Phil. Trans.

To this paper we shall in a little be much indebted; in the mean time we shall only extract from it the hypothesis, which is as follows.

348 avendish's ypothesis. There is a substance which we call the electric fluid, the particles of which repel each other, and attract the particles of all other matter, with a force inversely as some less power of the distance than the cube; the particles of all other matter also repel each other, and attract those of the electric fluid, with a force varying according to the same power of the distances. Or, to express it more concisely, if you look upon the electric fluid as a matter of a contrary kind to other matter, the particles of all matter, both those of the electric fluid and of other matter, repel particles of the same kind, and attract those of a contrary kind, with a force inversely as some less power of the distance than the cube.

For the future, he would be understood never to comprehend the electric fluid under the word matter, but only some other sort of matter.

It is indifferent whether we suppose all sorts of matter to be endued in an equal degree with the foregoing attraction and repulsion, or whether you suppose some sorts to be endued with it in a greater degree than others; but it is likely that the electric fluid is endued with this property in a much greater degree than other matter; for in all probability, the weight of the electric fluid in any body bears but a very small proportion to the weight of the matter; but yet the force with which the electric fluid therein attracts any particle of matter must be equal to the force with which the matter therein repels that particle; otherways the body would appear electrical, as will be shown hereafter.

To explain this hypothesis more fully, suppose that one grain of electric fluid attracts a particle of matter at a given distance with as much force as *n* grains of any matter, lead for instance, repel it: then will one grain of electric fluid repel a particle of electric fluid with as much force as *n* grains of lead attract it; and one grain of electric fluid will repel one grain of electric fluid with as much force as *n* grains of lead repel *n* grains of lead.

All bodies, in their natural state with regard to electricity, contain such a quantity of electric fluid interspersed between their particles, that the attraction of the electric fluid in any small part of the body in a given particle of matter, shall be equal to the repulsion of the matter in the same small part, in the same particle.

A body in this state is said to be saturated with electric fluid: if the body contains more than this quantity of electric fluid, he calls it overcharged; if less, he calls it undercharged.

The value, however, of both of these hypotheses, so ingeniously illustrated and ably supported by their respective authors, is greatly diminished, when we consider that the existence of a repulsive power among the particles of the electric fluid is a mere assumption, and that all the known phenomena may be explained more simply by the principles of attraction. On this account, the simple view of the subject given by Mr Singer is much more satisfactory. Bodies in different electrical states exert an attraction for one another. Two bodies in the same electrical state, and both differing in this respect from the ambient air, are attracted by the latter, and therefore recede from one another; because in the direction of their line of separation their own electrical state presents a deduction from that attraction, in consequence of which, the preponderance in the opposite direction is productive of motion when either of the bodies is sufficiently light. The repulsion of the particles of common matter to one another, which, according to these hypotheses, is necessary to explain negative electricity, is, besides, contrary to experience.

SECT. III. *Of the Theory of two Fluids.*

This theory originated, as we have said, in M. du Fay's discovery of the different electricities produced by rubbing glass and sealing wax. 349

Let us suppose that there are two electric fluids, which have a strong affinity for each other, while, at the same time, the particles of each are strongly repulsive of each other. Let us suppose these two fluids in some measure equally attracted by all bodies, and existing in intimate union in their pores; and while they continue in this manner to exhibit no mark of their existence, let us suppose that the friction of an electric produces a separation of these two fluids, causing (in the usual method of electrifying) the vitreous electricity of the rubber to be conveyed to the conductor, and the resinous electricity of the conductor to be conveyed to the rubber. The rubber will then have a double share of the resinous electricity, and the conductor a double share of the vitreous; so that, upon this hypothesis, no substance whatever can have a greater or less quantity of electric fluid at different times; the quality of it only can be changed.

The two electric fluids being thus separated, will begin to show their respective powers, and their eagerness to rush into re-union with each other. With whichever of these fluids a number of bodies are charged, they will repel one another: they will be attracted by all bodies, which have a less share of that particular fluid with which they are loaded; but will be much more strongly attracted by bodies which are wholly destitute of it, and loaded with the other. In this case, they will rush together with great violence.

On this theory, the electric spark consists of both the fluids rushing in contrary directions, and making a double current. When, for instance, the finger is presented to a conductor loaded with vitreous electricity, it discharges it of part of the vitreous, and returns so much of the resinous, which is supplied to the body from the earth. Thus both the bodies are unelectrified, the balance of the two powers being restored.

When the Leyden phial is presented to be charged, and consequently the coating of one of its sides is connected with the rubber and that of the other with the conductor; the vitreous electricity of that side which is connected with the conductor is transmitted to that which is connected with the rubber, which returns an equal quantity of its resinous electricity; so that all the vitreous electricity is conveyed to one of the sides, and all the resinous to the other. These two fluids being thus separated, attract each other very strongly through the thin substance of the intervening glass, and rush together with great violence, whenever an opportunity is presented, by means of proper conductors. Sometimes they will force a passage through the substance of the glass itself; and in the mean time, their mutual attraction is stronger than any force that can be applied to take away either of the fluids separately.

Dr Priestley gives the following view of the comparative merits of this theory and that of Dr Franklin.

" In the first place (says he), the supposition itself of two fluids, is not quite so easy as that of one, though it is far from being disagreeable to the analogy of nature, which abounds with affinities, and in which we see innumerable instances of substances formed, as it were, to unite and counteract one another.

" The two fluids being supposed, the double current from the rubber to the conductor, and from the conductor to the rubber, is an easy and necessary consequence. For if, on the common supposition, the action of the rubber puts a single fluid into motion in one direction, we might expect, that if there were two fluids, which counteracted each other, they would, by the same operation, be made to move in contrary directions. And a person that has been used to conceive that a single fluid may be made to move either way, viz. from the rubber to the conductor, or from the conductor to the rubber at pleasure, according as a rough or a smooth globe is used, can haye much less objection to this part of the hypothesis.

" Admitting then this different action of the rubber and the electric upon the two different fluids, the manner of conveying electric atmospheres, or powers, to bodies is the same on this as on any other theory; and it is apprehended that the phenomena of negative electricity are more easily conceived by the help of a real fluid, than by no fluid at all. Indeed Dr Franklin himself ingenuously acknowledges, that he was a long time puzzled to account for bodies that were negatively electrified, repelling one another; whereas M. du Fay, who observed the same fact, had no difficulty about it, supposing that he had discovered another electricity, similar, with respect to the properties of elasticity and repulsion, to the former.

" By this double action of the rubber, the method of charging a plate of glass is exceeding easy to conceive. Upon this hypothesis, all the vitreous electricity quits its union with the resinous on the side communicating with the conductor, and is brought over to the side communicating with the rubber; which, by the same operation, had been made to part with its resinous electricity in return.

" All the vitreous electricity being thus brought to one side of the plate of glass, and all the resinous to the other, the phenomena of the plate while standing charged, or discharged, are perhaps more free from all difficulty than upon any other hypothesis. When one of the sides of the glass is conceived to be loaded with one kind of electricity, and the other with the other kind; the strong affinity between them, whereby they attract each other with a force proportioned to their nearness, immediately supplies a satisfactory reason, why so little of either of the fluids can be drawn from one of the sides without communicating as much to the other. Upon this supposition, that consequence is perhaps more obvious, than upon the supposition of one half of the glass being crowded with the electric matter, and the other half exhausted. In the former case, every attempt to withdraw the fluid from one of the sides, is opposed by the more powerful attraction of the other fluid on the opposite side. On the other hypothesis, it is only opposed by the attraction of the empty pores of the glass.

" Lastly, The explosion upon the discharge of the glass has as much the appearance of two fluids rushing into union, in two opposite directions, as of one fluid proceeding only in one direction. The same may be said of the appearance of every electric spark, in which, upon this hypothesis, there is always supposed to be two currents, one from the electric, or the electrified body, and the other to it.

" I do not say, continues Dr Priestley, that the bur which is usually seen on both sides of a quire of paper pierced by an electric explosion, and the current of air flowing from the points of all bodies electrified negatively as well as positively, are material objections to the doctrine of a single fluid. But upon the supposition of two fluids and two currents, the difficulty of accounting for these facts would hardly have occurred.

" It is almost needless to observe, that the influence of points is attended with exactly the same difficulty upon this theory, as upon the other. It is equally easy, or equally difficult, to suppose one fluid to enter and go out at the point of an electrified conductor at different times, as to suppose, that, of two fluids, one goes out, and the other goes in, at the same time.

" That bodies immerged in electric atmospheres must acquire the contrary electricity, is quite as easy to suppose upon this, as upon any other hypothesis. For, in this case, suppose the electrified body to be possessed of the vitreous electricity, all the vitreous electricity of the body which is brought near it will be driven backwards to the more distant parts, and all the resinous electricity will be drawn forwards. And, when the attraction between the two electricities in these different bodies is so great as to overcome the opposition to their

Theory of Electricity.

their union occasioned by the attraction of the bodies that contained them, the form of their surfaces, and the resistance of the interposing medium, they will rush together; an electric spark will be visible between them; and the electricity of both will appear to be discharged; the prevailing electricity of each being saturated with an equal quantity of the opposite kind, from the other body.

"This hypothesis will likewise easily account for the difficulty of charging a very thick plate of glass, and the impossibility of charging it beyond a certain thickness; for these fluids, at a greater distance, will attract one another less forcibly, and at a certain still greater distance will not attract at all."

Dr Priestley makes the following answer to the principal objection that may be urged against this theory.

"If it be asked (says he), why the two fluids meeting on the surface of the globe, or in the electric explosion, do not unite by means of their strong affinity, and make no further progress; it may be answered, that the attraction between all other bodies and the particles of both these fluids, may be supposed to be at least as strong as the affinity between the fluids themselves; so that the moment any body is dispossessed of one, it may recruit itself to its usual point of saturation from the other,

"Besides, in whatever manner it be that one of the electric fluids is dislodged from any body (since upon every theory the two electricities are produced at the same time) the opposite electricity will, by the same action, be dislodged from the other substance. And whatever it be that dislodges the fluid from any substance, it will be sufficient to prevent its return; consequently, supposing both the substances necessarily to have a certain proportion of electric matter, each may be immediately supplied from that which was dislodged from the other.

"The rubber, therefore, at the time of excitation, gives its vitreous electricity to that part of the smooth glass against which it has been pressed, and takes an equal quantity of the resinous in return. The glass being a non-conductor, does not allow this additional quantity of electricity to enter its substance. It is therefore diffused upon the surface, and, in the revolution of the globe, is carried to the prime conductor. There it repels the vitreous, and violently attracts the resinous electricity; (and the points of the conductor favouring the mutual transition), the vitreous, which abounds upon the globe, passes to the conductor; and the resinous, which abounds upon the nearest parts of the conductor, rushes upon the globe. There it mixes with, and saturates what remained of the vitreous electricity on the part on which it flows, and thereby reduces it to the same state in which it was before it was excited. Every part of the surface of the globe performs the same office, first exchanging electricities with the rubber and then with the conductor.

"The solution of this difficulty will also solve that of the electric explosion, in which there is a collision, as it were, of the two fluids, while yet they completely pass one another. For still each surface of the glass may be supposed to require its certain portion of electric matter, and therefore cannot part with one sort without receiving an equal quantity of the other. It must be considered also, that the air through which the fluids pass, has already its natural quantity of electricity, so that being fully saturated, it can contain no more, and that the two fluids only rush to the places from which they had been forcibly dislodged, and where the greater body of the opposite fluids waits to embrace them."

351 Defence of the theory of two fluids by M. Tremery.

Although, in our explanation of electrical phenomena, we shall adopt the theory of Æpinus and Cavendish, it is proper to observe that this theory does not universally prevail among the electricians of the present day. The hypothesis of Du Fay, or the theory of two fluids, is still maintained by several, especially on the continent. This theory has lately found two strenuous advocates in France, M. M. Hauy and Tremery.

Their principal objection to the theory of Æpinus seems to be founded on that part of his hypothesis with which Æpinus himself was not perfectly satisfied, but which (in N° 321.) we have attempted to defend, viz. his introduction of a repulsive force among the particles of matter in a body.

"In fact, (say they), the supposition of a single fluid of which the particles mutually repel each other, and are attracted by the particles of matter in all known bodies, gives rise to many distinct forces which cannot be in equilibrio, and which, by their mode of acting, are such, that two bodies which are in their natural state, and which are not attracted by any other force besides that of electricity, must tend towards each other.

"The supposition of a repulsive force among the particles of matter in solid bodies becomes unnecessary if we conceive the electric fluid as composed of two fluids, of which one possesses the property which Æpinus attributes to the particles of matter in the body. It is much better to admit a repulsion at a distance among the particles of two peculiar fluids, which, like all others, repel each other, even in contact, than to conceive such a repulsion to exist among the particles of bodies that are in their nature solid. Those philosophers who endeavour to explain all the phenomena on the principle of a single fluid, believed themselves that its particles repelled each other at a distance, as from one surface of the Leyden phial to the other; and as what we call *action at a distance*, is properly no more than a fact on which we ground a theory, without inquiring what is the cause which furnishes the point of difference, it is sufficient that the manner in which we conceive this fact enables us to adapt it to our theory.

"Æpinus, who does not conceal his reluctance to admit that such a force as that which we have mentioned can take place, would doubtless, (say these gentlemen), have adopted the hypothesis of two fluids, if in his time the nature of the electrical phenomena had been better understood. But at that period, the means of observation not being so perfect, experiments had not been made with that precision which characterize those which we owe to M. Coulomb, and which have formed the foundation of those important discoveries, by means of which this celebrated philosopher, far exceeding the point at which Æpinus rested, has carried the science to a high degree of perfection, in that beautiful series of memoirs, in which we must admire the address with which he has availed himself both of experiment and calculation.

"Almost all the phenomena of electricity, then, seem to depend on the action of two peculiar fluids, which act

act in such a manner, that the particles of each mutually repel *each other at a distance*, with a force which is *inversely as the square of this distance*, and attract the particles of the *other fluid* with the same force.

"It is of consequence not to confound these two fluids with the two currents, the one of *influent* and the other of *affluent* matter, by which Nollet attempted to explain the phenomena. These two *currents* belong to the same matter, and proceed, one *from* the conductor *towards* surrounding bodies, the other *from* these *towards* the conductor.

"We shall now endeavour to apply the hypothesis of two fluids to the explanation of some phenomena which do not appear to agree with it, and which, by the manner in which we are accustomed to view them, seem to indicate that *vitreous* and *resinous* electricity are only modifications of the same fluid.

"The experiments which seem to militate against our theory are very few, and may be reduced to the following.

352 Experiments that seem to militate against this theory.

"*Exper.* 1.—If upon a cake of rosin we trace various designs with the point of a conducting substance, which is at one time electrified *positively*, or by *vitreous* electricity, and at another *negatively*, or by *resinous* electricity; and if on this surface, thus electrified, we let fall a powder (E) properly disposed; the designs thus rendered visible will present characters peculiar to each species of electricity; thus shewing, according to the followers of Franklin and Æpinus, a superabundance of electric fluid on one side and a deficiency on the other.

"*Exper.* 2.—When a conducting body terminating in a point, is electrified *positively* or by *vitreous* electricity, we perceive at the point a *luminous brush*. And if, all other things being equal, we substitute *negative* or *resinous* electricity, the point is illuminated with a *star* or *luminous point*.

"According to the theory of positive and negative electricity, the *brush* indicates the transmission of electric fluid *from* the body which is electrified positively, and the *star* its entrance *into* the body which is negatively electrified.

"*Exper.* 3.—When an electric explosion takes place, all the electric fluid appears constantly to pass *from* the body electrified *positively* to that which is electrified *negatively*."

Here they cite the method of proving this, by piercing a card placed between the conducting balls of the *universal discharger*. (Vid. N° 196. Exp. 2.)

353 Explained by M. Tremery.

These experiments, to which the theory of positive and negative electricity is happily applied, seem at first sight inexplicable, according to the hypothesis of two fluids. In fact, the particles of these two fluids being subject to the same laws, it seems,

1. That the designs traced on a cake of rosin, or other *ideo-electric* substance, with the point of a conductor, electrified at one time positively and at another negatively, should on the whole be similar.

2. That the luminous appearance observed at the summit of a pointed conductor, ought always to be the same, whatever be the *electrical state* of the body.

3. That when an electric discharge has taken place, the vitreous and resinous electricities, which mutually attract each other, ought to form a luminous train on *each* surface of the card, and the card ought to be perforated in a point equally distant from the two extremities of the balls of the discharger.

354 M. Tremery's explanation.

The following is the manner in which M. Tremery undertakes to explain these appearances.

"The matter, (says he), to the action of which we attribute the electrical phenomena, being considered as compounded of two peculiar fluids, we may conclude that all bodies, considered in the relation which they bear to these fluids, do not possess the same properties; it is possible that *vitreous* and *resinous* electricity may be of such a nature, that, on the one hand, certain bodies, whether electrics or conductors, may have with respect to them different conducting powers; and on the other hand, that the *coercive power* (F) of *ideo-electrics* may vary according as they are opposed to the motion of particles proper to *vitreous* electricity, or to the motion of particles proper to *resinous* electricity.

"If, for instance, the air of the atmosphere, in which electrical phenomena usually take place, has an *incomparably* greater coercive power with respect to the resinous electricity than it has to the vitreous, it would be very easy to explain the experiments that we have quoted. In this case, the resinous electricity, because of the almost infinite resistance that the air would oppose to the motion of its particles, might be regarded as inherent in the surface of the bodies; whence it follows, that the same circumstances would take place, as if the body electrified *resinously* had the property of exercising by itself an attraction for the vitreous or *positive* electricity; a property which bodies in the negative state are supposed to have, according to the theory of Franklin.

"If now, the coercive power that we have supposed the air to have with respect to the resinous electricity, could diminish so as to become equal to that which it has with respect to the vitreous, it would happen that the signs which induce us to regard the vitreous electricity as positive, and the resinous as negative, would disappear, so that all the phenomena would seem to depend equally on the action of the two fluids that would be subject to the same law. In this new circumstance, we should observe a luminous pencil at the summit of a pointed conductor electrified *resinously* or negatively, and when an electric discharge took place, the vitreous and resinous electricities would appear to approach each other.

"If, under these circumstances, the coercive power of the air with respect to the vitreous electricity should increase, so as in its turn to become incomparably greater than what it had with respect to the resinous electricity, it

---

(E) This powder should be composed of two substances, which, by their mutual friction against each other, are capable of receiving opposite electricities.

(F) By *coercive power* our author understands that which ideo-electrics or conductors oppose to the motion the particles that are proper to each of the two fluids, that, according to this hypothesis, are supposed to form by their union the *electric* fluid.

it is evident, that the electric matter, acting in the midst of such a substance, would produce phenomena exactly similar to those with which we are acquainted; but, in this case, the vitreous or positive electricity would perform the office of the resinous or negative, and *vice versa*, and they would mutually exchange signs. A luminous pencil would appear at a point electrified negatively or resinously, and a luminous star at a positive or vitreously electrified point; and when two conducting bodies, electrified differently, were placed at a convenient distance, all the electric matter would appear to move *from* the negative body *towards* the positive *."

Chap. II. *A theoretical Explanation of the Phenomena of Electricity.*

Sect. I. *Of the Nature and Distribution of the Electric Fluid.*

355 ature of e electric id.

Before we enter on a theoretical explanation of the phenomena of electricity, it will not be improper to inquire somewhat more at large into the nature of that subtile agent which we have distinguished by the name of the electric fluid, and to notice some of the more plausible opinions that have been hazarded on the subject.

One of the first questions that naturally arises from the very name of *fluid* is, *What proofs have we of the materiality of this power?*

Besides the properties of attraction and repulsion, which are properties of matter, we have many other evidences that are very persuasive, as being more distinctly the objects of our senses.

356 ofs of its eriality.

1. The spark that appears when the electric power passes suddenly through the air or any other resisting medium, and the *snap*, by which it is accompanied, are strong evidences of the materiality of the power by which they are produced. The noise of the spark is occasioned by the sudden impression made on the air, or some other elastic fluid, through which the spark passes. When the air is confined in close vessels, as in a tube above water, no very durable effect is indeed produced on the water in the tube. But this is owing to the rapidity with which the expansion and subsequent condensation take place. Again, it is objected, that it is impossible to communicate motion to a very delicate lever, nicely balanced, by throwing on it any quantity of electricity. Some pretend to have done this; but, however, the impossibility of doing it is no argument against the materiality of the electric fluid; and we might just as well say, that a musket ball is not material, because it may be fired through a paper or thin board delicately suspended, without imparting to them any part of its motion.

2. The light and heat accompanying the spark, are proofs of the materiality of the electric power. These are chemical phenomena; and whether we consider them as effects of the fluid as a simple, or as resulting from its decomposition, we conceive that they prove the materiality of the electric power, as completely as the materiality of caloric and light have been proved.

We are aware that this reasoning will not satisfy those philosophers who deny the materiality of caloric and light; we know that much stress is laid on the experiments of Count Rumford, as completely subversive of the materiality of heat, experiments that could even stagger the opinion of a Robison. Without desiring in the least to detract from the merit of that ingenious and able experimentalist, for whom we entertain a very high esteem, we must confess, that we do not consider his experiments as warranting the conclusions that have been drawn from them, and we are still disposed to think the materiality of caloric and light as fully proved as can be expected, with respect to matter that is not absolutely tangible. The fact, however, is, that the question depends in some degree on the definition which philosophers may choose to give of matter. If ponderability is conjoined to other active powers, we give the substratum in which these concur the name of matter. Where some of the powers and agencies coexist, yet not accompanied by certain others, even when these are the most readily appreciable, we may if we please say that the substratum is not material. But this is a question of words. All our knowledge of physical powers, both in detail and in their permanent relations, remains equally clear and unaffected, whatever modes of expression we may adopt. The attractive power which it possesses is one of the most steady properties of matter; and the powerful mechanical agencies of the electric spark give it the strongest claim to the character of a material substance.

357 Electricity supposed to be the same with caloric.

From the similarity of the chemical effects of the electric fluid with those of elementary fire or caloric, it was long ago (as we have shewn in the beginning of this Part) supposed, that they were the same, and this is still the opinion of some electricians. We cannot here pretend to enter on a full discussion of this question, but we shall briefly state the arguments in favour of the identity of caloric, and the objections that we have to make to them.

Electricity is the same with caloric (say the advocates for their identity) because,

1. Both produce the same chemical effects, expansion, fluidity, inflammation, oxidation, &c.

2. Those bodies that are the best conductors of caloric, as the metals, are also the best conductors of electricity; and glass, which is a very bad conductor of caloric, is one of the most perfect non-conductors of electricity.

358 Arguments against this supposition.

To the first argument for their identity, we shall reply in the words of M. Berthollet, who once considered them as the same, but from experiments was satisfied that their effects were different.

"A wire of platinum was submitted to shocks which were nearly strong enough to effect its combustion; and to be satisfied of this, a shock was excited, by which a great part of the wire was melted and dispersed; afterwards the shocks employed were a little weaker, and immediately after each, the wire was touched to judge of the temperature it had acquired: a heat was felt, which was dissipated in a few minutes, and which, at the utmost, was estimated to resemble that of the boiling point of water. If electricity liquefied metals, and brought them into combustion by the heat it excites, the platinum wire must after a shock, which differed but little from that which would have produced its dispersion and its combustion, have approached the degree of temperature which occasions its liquefaction: Now this degree, which is the most elevated

---

* Journ. de hysique, ol. liv. 357.

elevated that can be obtained, would, according to the valuation, more or less accurate, of Wedgwood, be 32277° of Fahrenheit.

"When the shock is sufficiently strong to destroy the aggregation of the platinum wire, it begins by detaching moleculæ from its surface, which exhale like smoke; if it is strong enough to produce combustion, the remains of the wire appear to be torn into filaments.

"A thermoscope blackened with ink, and placed in the stream of a strong electric spark, only experienced a dilatation which was nearly equal to one degree of Reaumur's thermometer, and this slight effect might depend on the oxidation of the iron of the ink; placed beside the current, it did not show any dilatation, although the air was necessarily affected by the electric action: it was the same when it was placed in contact with a metallic conductor, which received a stream less powerful than in the preceding experiments.

"A cylinder of glass filled with air, with an exciter at each of its extremities, to one of which was fixed a tube communicating with another cylinder filled with water, produced an impulse at each shock, which raised the water more than a diameter above its level, but its effect was instantaneous.

"These experiments seem to me to prove that electricity does not act on substances, and on their combinations, by an elevation of temperature, but by a dilatation which separates the moleculæ of bodies. The slight heat observed in the platinum wire, is only the effect of the compression produced by the moleculæ which first experience the electric action, or which experience it in a greater degree; it must, therefore, be compared to that excited by percussion or compression.

"If the dilatation was the effect of heat, that experienced by a gas, in the experiment related above, would not have been instantaneous; it would only have experienced a progressive diminution by cooling, as when its expansion is owing to heat.

"In the experiment by which ammoniacal gas is decomposed, the gas undoubtedly receives the electric action, and nevertheless it is not heated; and as soon as the decomposition is finished, its volume remains unchanged, because the electric action which is employed in this experiment, is not sufficiently energetic to cause a perceptible dilatation. No sensible dilatation is produced in a gas by a shock which is not very strong, because the impulse not being gradual like the expansion arising from caloric, and being excited instantaneously, the resistance of the liquid becomes too great, and cannot be overcome unless the dilatation has great energy.

"An experiment of Dieman and his learned associates confirms this explanation; they caused a shock to pass through lead placed in a vessel filled with azotic gas, which could not oxidate it; it was reduced into powder retaining all its metallic properties: if it had experienced a liquefaction similar to the action of heat, it would have cooled gradually, and would have congealed into one, or at least into several masses.

"When a metal is submitted to the electric action, the effects produced immediately by the electricity must be distinguished from those which are owing to its oxidation: the first are limited to the diminution or destruction of the effects of the force of cohesion, to removing and dispersing the moleculæ (if by this a little heat is disengaged, it is only owing to the compression sustained by some of the parts); but those which are occasioned by the oxidation, produce a high degree of heat, and then the effects assume all the appearances of an ordinary combustion: hence it arises that the most oxidable metals are those which become red with the greatest facility, and which must shew the properties of a metal liquefied by heat.

"Electricity favours this oxidation in as much as it diminishes the force of cohesion: It is thus that an alkali renders the action of sulphur on oxygen much more powerful, by destroying the force of cohesion opposed to it, and that a metal dissolved in an amalgam, is oxidated much more easily than when it is in a solid state. It is only by destroying the effects of the force of cohesion that heat itself produces the oxidation of metals; but the expansive action of electricity will have a great advantage over that of caloric, because its action is confined to the solid which it encounters in its course, so that the gas itself will not experience a dilatation in opposition to the condensation which accompanies the combination: To this circumstance may be applied what is observed in the action of hydrogen gas, which is capable of completely reducing an oxide of iron placed in the focus of a burning glass, although water, whose two elements receive the heat equally, is decomposed by this metal *."

To the second argument we shall answer, that though in the instance of metals it is correct, in so far as that these bodies are the best conductors, both of caloric and electricity, there are, however, bodies that conduct caloric very well, but either do not *conduct* electricity, or do it very imperfectly.

Even in the case of metallic bodies, so far as can be inferred from the imperfect experiments that have been made on their comparative conducting power, it should appear that the order of their conducting power, with respect to caloric, is not the same as that with respect to electricity.

Farther, caloric takes some time to pass through the best conductors, while the electric fluid pervades the longest with inconceivable velocity.

Again, if electricity were the same with caloric, they should mutually produce the same effects, and should exist simultaneously. But this is by no means the case; a body may be strongly electrified without being sensibly increased in temperature, and so far is heat from producing electricity (except in a few instances), that where the former is present in any considerable degree, the latter is destroyed.

Lastly, the mode in which electricity and caloric pass along conductors is, we think, different. Caloric seems undoubtedly to penetrate their *substance*, while electricity appears not to extend beyond the surface, except it meet with some resistance. The following experiment is usually adduced to prove that electricity pervades the substance of conductors.

359
Whether the electr fluid pervades the substance conducto

Take a wire of any kind of metal, and cover part of it with some electric substance, as rosin, sealing-wax, &c. then discharge a jar through it, and it will be found that it conducts as well as without the electric coating. This, says Mr Cavallo, proves that the electric matter passes through the substance of the metal, and not over its surface. A wire, adds he,

---

* Nicholson's Jour. 8vo.

he, continued through a vacuum, is also a convincing proof of the truth of this assertion. Even here, however, the proof, if impartially considered, will be found very defective. It is a fact agreed upon by all philosophers, that bodies which to us are apparently in contact, do nevertheless require a very considerable degree of force to make them actually touch one another. Dr Priestley found that a weight of six pounds was necessary to press 20 shillings into close contact, when lying upon one another on a table. A much greater weight was necessary to bring the links of a chain into contact with each other. It cannot be at all incredible, therefore, that a wire, though covered with sealing-wax or rosin, should still remain at some little distance from the substance which covers it.

M. Coulomb proves that in an overcharged conducting body, the fluid does not penetrate into its substance, but diffuses itself merely over the surface.

By means of a very delicate electroscope, he examined pits made in a conducting body of various depths, and found that in the shallowest of them there was no sensible electricity; whence he naturally draws the conclusion, that the electricity in such bodies does not extend beyond the surface. The reader may see a description of the electroscope employed, and a detail of the experiments, in the Memoirs of the French Academy for 1786, p. 72, or the *Journal de Physique*, vol. ii. (of the series by Delametherie), p. 236.

Dr Robison repeated Coulomb's experiments with the same results.

360 ectricity ders from ht.

Another opinion that has been maintained with regard to electricity, is that it is the same with *light*. The principal argument for the identity of electricity and light seems to be that bodies are impregnated with the latter by means of the former, and indeed that light commonly appears when the electric fluid passes in any quantity from one body to another.

Another reason given for their identity is, that both move with inconceivable velocity.

A strong argument against the identity of light and electricity, is that the former passes through glass and other transparent electrics, which seem to be impermeable to the electric fluid.

As to the impregnation of opaque bodies with light by means of electricity, this is the effect of chemical decomposition, as will presently appear, and is really produced by light itself.

M. Biot advanced the hypothesis, that the electric spark arises from the compression of air by the rapid motion of the electric fluid, in the same manner as light is elicited by the compression of confined air, by the sudden jerk of a condensing syringe.

61 tric proba- bly com- pod.

What has been now said is, we think, sufficient to prove, that the electric fluid is neither caloric nor light. But the appearance of caloric and light, in many cases, shews that there is an intimate connection between them and the electric fluid. In short, they seem to form part of its composition; and there is some ground to consider it as a compound, containing caloric and light, and probably some peculiar constituent, to which we give the name of electricity. This opinion is not new; it was the hypothesis of Mr James Russel, who filled the natural philosophy chair at Edinburgh, above thirty years ago.

362 Hypothesis of Professor Russel.

Mr Russel considered the electric fluid as a compound of several others, containing particularly elementary fire, from which it derived its great elasticity or power of repulsion. The elasticity of the electric fluid he supposed to differ from that of air, in acting at a distance; whereas the action of the air is only on adjoining particles. Hence bodies that contain more electric fluid than the spaces around them, have a tendency to repel each other.

Mr Russel considered the characteristic ingredient of the compound, i. e. the electricity, as united to the other constituents by chemical affinity, or, as it was then called, *Elective Attraction*. This attraction acts at all distances, but not exactly according to the same law, as the repulsive power of the elastic fluid; and in general, while in this state of composition, counteracts the repulsion of the electric particles. Again, the electricity attracts the particles of other bodies, but with different degrees of affinity. Non-electrics or conductors are attracted by it at all distances, but electrics only at very small and imperceptible distances, and at such distances only its own particles attract each other.

Hence this compound fluid repels its own particles at all considerable distances, but attracts them when very near. It also attracts conductors at all distances, but electrics only when very near. The appearances of light and heat were considered by Mr Russel as proofs of a partial decomposition, and as evincing the presence of elementary fire: the peculiar odour of the electric spark, and the effect produced in certain instances on the organ of taste, were also regarded as proofs of chemical decomposition, and of the compound nature of the electric fluid.

Again, conducting bodies containing electric fluid, if forced very near, attract each other; otherwise they repel each other. Electrics contain the electric fluid in consequence of the electricity existing in the compound; a part of this must be attached to the surface of the electric, but not in its elastic state, since when brought so near as to be attracted, its particles are subjected to their own mutual action, and hence the repulsion occasioned by its combination with the other ingredient of the fluid is overcome by the redoubled attraction; the electric fluid is thus partially decomposed, and the electricity attaches itself to the surface of the electric. Thus the electric fluid may appear in two states; elastic when entire, and unelastic when partially decomposed.

The electricity may be rendered unelastic in several ways, as by friction, by which the electric fluid contained in the air is forced into closer contact, thus producing a decomposition of the fluid, and causing its electricity to unite with the surface of the rubbed body. This operation may be compared to the forcible wetting of a dry sponge, or of some powder, as that of the puff ball, which, when dry, does not easily imbibe moisture; but when wetted by mechanical compression, retains it very forcibly. The electricity unites with bodies in this way during several operations of nature, as in the melting and cooling of some substances, in contact with electrics; and it may be thus forcibly united to the surface of electrics by means of metallic coatings, into which the fluid is forced by the skilful management of its mutual repulsions. This operation, again, was compared by Mr Russel to the condensation of the moisture

moisture of humid air on a cold pane of glass; and the evacuation of fluids from the other side of the coated pane he compared to the evaporation of the moisture from the other side of the cold pane, in consequence of the heat that was extricated from the condensed vapour.

The analogy that exists between electricity and caloric, has induced some to apply to the former the doctrine of capacity, in an acceptation analogous to that of the capacities of bodies for caloric. This doctrine seems to be one of the fundamental principles of Mr Wilkinson's theory of electricity; the substance of which is contained in the following extract.

363 Mr Wilkinson's hypothesis.

"From some experiments, I am induced to suppose, that electricity is universally diffused, but not equally; that those bodies are the best conductors which contain the greatest quantity, and those the best non-conductors which contain the least.—Thus metallic bodies are the best conductors; all fluids, except air and oil, are also conductors. The disposition in the body to retain electricity may be termed its capacity.

"When conducting bodies undergo any change, if by such change their capacities become altered, then signs of electricity are evinced.

"If the change should be of such a nature, that their capacity for electricity becomes increased, the substance will be in a state of abstracting it from surrounding bodies, and therefore will evince negative signs; in the same way as frigorific mixtures produce negative signs of heat.

"If, in the change it undergoes, the capacity of the substance for electricity is diminished, it gives out a portion of its natural quantity, and evinces positive signs, or a state of superabundance.

"When any substance, in the change it undergoes, gives out electricity, it becomes proportionally diminished in its conducting powers; so, on the contrary, when it acquires an increase, it increases also its powers as a conductor.

"Thus a metallic substance, which is a good conductor, when oxidated is a very imperfect one. In the change from its reguline state to a calx, electricity is given out.

"This capacity for electricity is not regulated by any known laws, such as the densities or the specific gravities of the bodies.

"In many substances, the conducting power seems to depend on the addition of other principles; thus wood, when a conductor, is so in consequence of the moisture it contains; when deprived of it by drying, it resists the passage of electricity.

"What this peculiar change may be, is difficult to conceive; but when electric bodies become partial conductors, it seems to be effected by the agency of heat. When the pressing action is very considerable, as in the case of metallic bodies, great quantities of heat are extricated. Thus a nail, when struck violently, soon exhibits signs of considerable warmth; the caloric contained in its interstices is exuded on the surface, in consequence of the approximation of the constituent particles of the iron.

"Whether the caloric diffused in the interstices, or combined with the body, is given out by pressure, is a fact difficult to determine. Those substances which are non-conductors, and consequently capable, from excitation, of giving out signs of electricity, do not all of them lose their power, when freed from the rubbing action. Those bodies which are usually termed resinous, when melted, continue for a certain space of time in their conducting state, until they are equalized with the surrounding air; and, continuing in a disposition to abstract electricity from surrounding bodies, will therefore evince negative signs (G) *."

364 Observations by Mr G. Morgan.

The doctrine of bodies having different capacities for electricity was ingeniously employed by Mr G. Morgan to account for the effects produced on electrics by friction.

"If (says he) we admit the corporeal nature of that which is hence with accuracy called the electric fluid, let us attend to the necessary consequences of what we admit:—1st, That the electric fluid, like all other corporeal substances, is capable of attracting, and of being attracted. 2d, That in consequence of this capacity, it enters into an union with other bodies, and that as the nature of the substances to which it is united may vary, so the degree of force by which it is united may show an equal variety. 3d, That when the electric fluid is separated from any body, this separation must be the effect of lessening the force by which it was united to that body, and thus giving the attractive force of another body the superiority; or it must be the effect of very much increasing the force of the third body, and thus destroying the equilibrium.

"Suppose that any body A, should be capable of uniting to itself, or suppose the law of its constitution were such as to admit of its attaching, fifty particles of the electric fluid to itself, when near or in contact with another body, B, which likewise has an attraction to those particles; now, in case any such change should take place as would add twenty particles to B, and leave thirty only in A, this change, it is evident, must proceed either from a diminution of A's attracting force, or from an adequate increase of force in B. Having deduced, from the corporeal nature of the electric fluid, such consequences as show that when it is separated from a body, it must proceed from a diminution of attractive force in the body that yields, or an increase of the same force in the body that takes; let us now examine how friction is likely to be the cause of such changes.

"By

* *Wilkinson's Elements of Galvanism* vol. ii.

(G) Mr Coulomb endeavours to prove that the electric fluid is not distributed among conducting bodies in contact by chemical affinity, but merely by its repulsive motion.

When two bodies, equal and similar, placed in contact, are tolerably perfect conductors, such as the metals, the electricity communicated from one to the other is in an instant divided equally between them; but when one of the bodies is an imperfect conductor, as a plain of paper, it will take some time before the paper receives the half of the electricity of the metal. In all cases, however, the electricity is equally divided. Vid. *Mem. de l'Acad. Roy. de Paris, pour* 1786, p. 69, "By attending to the nature of friction, we shall find it to be nothing more than a succession of pressure or contacts of the different parts of different substances against each other: and the question in the present case is this;—whether contact is necessarily attended with a change of attractive force in the different substances which are brought together? or whether the close union of a particle of silk, hair, leather, &c. to a particle of glass, may be attended with a change of capacity in those bodies to retain the electric fluid?—If this question be admitted, I think the particular mode in which friction operates is easily discovered.

"My idea of the manner in which friction operates, is briefly this: when two electrics are pressed closely together, while they continue together, they become capable of taking more, or retaining less; and if this be allowed, I think the various appearances of bodies in a state of excitation are easily accounted for.

"However, it may be asked, if the change produced in the surfaces of two bodies be the effect merely of bringing the bodies nearer together; why does not contact alone produce the same effect? I must answer, that the several instances of spontaneous electricity enumerated by Wilcke, Æpinus, and others, appear to me to be so many evidences of the preceding theory. In these instances we see the excitation of surfaces take place in such circumstances as will not rationally admit of any other cause than simple contact.

"It is evident, I think, that contact alone is adequate to the production of electricity. I would add, that in the only case where contact may be applied most completely, electricity is produced in a most remarkable degree.—By Bennet's new electroscope, we find that the slightest evaporation (which is certainly the union of watery with aerial particles) produces immediate signs of electricity. How rationally all the electrical appearances of our atmosphere may be ascribed to the same source, will be shown more fully hereafter.

"Before I quit this subject, I would explain the reasons why, in many cases, agreeably to the preceding hypothesis, friction is necessarily much more powerful in its effects than pressure.

"Suppose A to be a particle of silk, brought into contact with a particle of glass, which I call B; by the increase of attraction consequent upon the union, the combined bodies become capable of attracting a portion of the fluid, which I say, is equal to five. Now A is no sooner separated from B, than another particle of silk comes in contact, and produces a similar effect. The portion accumulated is now ten. A third comes into successive contact with B, and adds to the accumulation; and while the rubbing goes on, a series of successive effects is produced by a series of successive unions and separations; for A is no sooner separated from B, than it is brought into that state in which it was before the union, and consequently disposed to part with what it gained by the union. Now if you suppose A and B, instead of being single particles, to be surfaces, all of whose parts operate at the same time, you may easily perceive how the effect would be increased.

"In the preceding case, I described the capacity of A and B to be enlarged by their union. If it had been lessened, the subsequent effects would have been sufficient; for, in such a case, after the dissolution of their contact, they would be disposed to receive or retake what they had lost by their union. But I will speculate no longer on the consequences of friction, as elucidated from the supposed corporeal nature of the electric fluid, and from the changes supposed to take place on the attractive force of different bodies when brought into very close contact with each other *."

365 Brugnatelli supposes the electric fluid to be an acid.

Sig. Brugnatelli, from the chemical properties of the electric fluid, and from several experiments which he has made upon the subject, concludes that it should be ranked among the acids. This fluid, says he, reddens the tincture of turnsole, which as the fluid dissipates returns again to a blue colour; it penetrates the metals, oxidates them, and produces hydrogen gas. In fine, it possesses all the properties of an acid. He therefore denominates it the *electric* or *oxi-electric acid*, and of course the salts which are formed by its combination with salifiable bases, are called *electrats*. On some of these he makes the following observations.

1. The *electrat* of gold is formed of small, brilliant, and transparent points.

2. The *electrat* of silver consists of small prismatic crystals, terminated by six-sided pyramids, which are limpid and transparent, and strongly reflect the light. They are tasteless and insoluble in water.

3. The *electrat* of copper consists of cubical transparent crystals, which dissolve in the acid with effervescence. The crystals are of a beautiful green colour.

4. The *electrat* of iron is of a reddish yellow colour, and opaque.

5. The *electrat* of zinc is opaque and of a grayish colour.

The *electric acid*, according to this author, is not decomposed, when it oxidates the metals, but the oxygen required for their oxidation, is derived from the water employed in his experiments.

366 Law of action of the electric fluid.

Having thus considered pretty fully the chemical nature of the electric fluid, we shall return to its mechanical properties, and endeavour to ascertain the law by which its particles act on each other, and how it is distributed in bodies of various figures, and in various relations.

It was long a desideratum among electricians to discover the law of action according to which the particles of the electric fluid attract and repel each other. Æpinus, we have seen, states no other law than that the action decreases according as the distance increases. Mr Cavendish suspected, but did not prove either by demonstration or experiment, that the action of electricity was, like that of gravitation, inversely as the square of the distance.

Lord Stanhope attempted to prove that this was the law of electric action, both experimentally and mathematically, and concluded, from the result of both his experiments and reasoning, that the supposition was just. But Dr Robison did not consider the experiment of Lord Stanhope as sufficiently accurate, or sufficiently detailed, to warrant the conclusions that his Lordship had drawn *.

That eminent philosopher, nearly 40 years ago, made a set of experiments for ascertaining this law, and they were attended with results similar to those of Lord Stanhope.

Dr Robison's experiments were made with the assistance

---

* *Morgan's Lectures*, vol

* *Mahon's Principles of Electricity*, Parts iv. v. and vi.

tance of his excellent electrometer, which we have described in N° 206. The mode of using this instrument is as follows.

367 Ascertained experimentally by Dr Robison. Plate CXCI. fig. 72.

The body whose electricity is to be examined is connected with the electrometer by a wire, the end of which is inserted into the hole at F, fig. 72. and made to touch the end of the needle. Now the index is to be turned to the right by the handle I, till it come to 90. In this position LA, and consequently CB, is horizontal; and the moveable ball B rests on A and moves with it. The balls being now electrified, the handle is turned back till the index arrive at 0, from which it set out. If during this motion the balls be noticed, it will be found that in some position of the index they will separate. Bring them again together and again separate them, till the exact point of separation be ascertained. This will give their repulsion when in contact, or at the distance of their centres. Then turn the index still more to the vertical position, and the balls will separate still more. Let an assistant now move the long index till it become parallel to the stalk of the electrometer, which will be known by its hiding the latter from his view. If the stalk be poised, by laying a weight of some grains on the cork ball D, till the stalk become horizontal and nicely balanced, we know exactly the weight that denotes the degree of repulsion that will cause the balls to separate when in the horizontal position, by computing for the proportional lengths of BC and DC. Then, by a very simple computation, we shall find the weight denoting the degree of repulsion with which they separate in any oblique position of the stalk, and again, by the resolution of forces, we find the degree of repulsion with which the balls separate when AL is oblique, and BC makes with it any given angle.

The intention of Dr Robison's experiments was to ascertion the law of repulsion of two *small spheres*, as whatever was the law of distribution of the particles in a sphere, which we shall consider presently, the general action of its particles on those of another sphere will not differ materially from the law of action between two particles, if the spheres are very small in proportion to their distance.

The result of the experiments was, that the mutual repulsion of two small spheres, electrified either positively or negatively, was very nearly inversely as the square of the distance of their centres, or a little greater. Thus, if we express the distance of x, the law of repulsion was as nearly as possible $\frac{1}{x^{2,06}}$. One of the balls being much larger than the other appeared to cause no difference in the results.

Repeating the experiment with balls electrified oppositely, and which of course attracted each other, the results obtained were not quite so regular; but the general result was a deviation from the above law rather less than in the preceding case, this being in defect, while that was in excess.

Sir Isaac Newton has demonstrated, (*Princip.* lib. i. pr. 74.) that if particles of matter act on each other with a force in the inverse duplicate ratio of the distance, spheres composed of such particles, and of equal density at equal distances, will act on each other according to the same law. He has demonstrated that the same holds in the case of hollow spherical shells, and that these act on each other in the same manner as if all their matter were crowded into their centres; and he has farther demonstrated, that if the law of action between the particles be different from what has been stated, the action of spheres or spherical shells will also be different.

M. Coulomb of the French academy made a number of most valuable experiments for the purpose of ascertaining this point, and obtained the same results.

This distinguished academician has published in the memoirs of the Royal Academy at Paris for 1784, 1785, 1786, and 1787, papers which rank him very high among those who have contributed to advance the science of electricity.

In the Memoirs for 1785 appeared the papers that contain the experiments by which he proved the law of electric action. These we cannot here pretend to detail, but the result is highly satisfactory. They were made with the assistance of a very delicate electrometer, the construction of which we shall describe under the article ELECTROMETER.

368 Approximating experiment. Fig. 102.

The reader may satisfy himself very nearly of the truth of this law by the following simple experiment.

A, fig. 102. is the convex extremity of an excited surface. BC is a metallic rod, delicately suspended on the point E. CF is designed to contain any weight which may be applied to the extremity of the rod. The apparatus should be as light as possible, and is best made of reed and cork covered with tinfoil.

While the surface A is in an excited state, B is brought within a certain distance of it, and the weight moved by its influence is carefully observed. A similar observation is then made at a second, a third, and a fourth distance.

Varieties will be discovered in the result of these observations, proceeding from the impossibility of keeping the surface for any considerable time in the same state of excitation. These varieties, however, are trifling; and in a vast number of experiments, the weight will diminish very nearly in the duplicate ratio of the increased distance.

We may now safely conclude that the law of electric action is like that of gravitation, so that electrified bodies attract or repel each other, with a force that is inversely as the square of the distance. The ascertaining of this important law is of infinite consequence. It affords us a full conviction of the truth of the propositions respecting the action of bodies that are overcharged at one end, and undercharged at the other. It renders certain what we could formerly infer only from a reasonable probability. We now see that the curve described in N° 338. must really have its convexity turned towards the axis, and that $Z+z'$ will always be greater than $Z'+z$.

369 Distribution of the electric fluid.

We now proceed to consider the manner in which the electric fluid is distributed, when it is redundant or deficient in bodies; and for this purpose we cannot do better than lay before the reader the following series of propositions, chiefly taken from Mr Cavendish's paper, but accommodated to the true law of action above laid down.

370 Fundamental proposition.

LEMMA I.—Let the whole space comprehended between two parallel planes, infinitely extended each way, be filled with uniform matter, the repulsion of whose particles is inversely as the square of the distance; the plate

plate of matter formed thereby will repel a particle of matter with exactly the same force, at whatever distance from it it be placed.

Fig. 103. For, suppose that there are two such plates, of equal thickness, placed parallel to each other, let A, fig. 103. be any point not placed in or between the two plates; let BCD, represent any part of the nearest plate; draw the lines AB, AC, and AD, cutting the furthest plate, in *b*, *c*, and *d*; for it is plain that if they cut one plate, they must, if produced, cut the other: the triangle BCD, is to the triangle *b c d*, as AB^2 to Ab^2; therefore a particle of matter at A will be repelled with the same force by the matter in the triangle BCD, as by that in *b c d*. Whence it appears that a particle at A will be repelled with as much force by the nearest plate, as by the more distant; and consequently will be impelled with the same force by either plate, at whatever distance from it it be placed.

Cor. 1.—The same will be true of the action of plates of equal thickness and equal density, or of such thickness and density as to contain quantities of matter or fluid proportional to their areas.

Cor. 2.—The action of all such sections made by parallel planes, or by planes equally inclined to their axis, is equal.

Cor. 3.—The tendency of a particle to a plane, or plate of uniform thickness and density, and infinitely extended, is the same, at whatever distance it be placed from the plate, and it is always perpendicular to it.

Cor. 4.—This tendency is proportional to the density and thickness of the plate or plates jointly.

371 sposition parallel ates. g. 104.

Problem 1.—In fig. 104. let the parallel lines A *a*, B *b*, &c. represent parallel planes infinitely extended each way: let the spaces AD and EH be filled with uniform solid matter: let the electric fluid in each of those spaces be moveable and unable to escape: and let all the rest of the matter in the universe be saturated with immoveable fluid. It is required to determine in what manner the fluid will be disposed in the spaces AD and EH, according as one or both of them are over or undercharged.

Let AD be that space which contains the greatest quantity of redundant fluid, if both spaces are overcharged, or which contains the least redundant matter, if both are undercharged; or if one is overcharged, and the other undercharged, let AD be the overcharged one. Then, first, There will be two spaces, AB and GH, which will either be entirely deprived of fluid, or in which the particles will be pressed close together; namely, if the whole quantity of fluid in AD and EH together, is less than sufficient to saturate the matter therein, they will be entirely deprived of fluid; the quantity of redundant matter in each being half the whole redundant matter in AD and EH together: but if the fluid in AD and AH together is more than sufficient to saturate the matter, the fluid in AB and GH will be pressed close together; the quantity of redundant fluid in each being half the whole redundant fluid in both spaces. 2dly, In the space CD the fluid will be pressed close together; the quantity of fluid therein being such as to leave just enough fluid in BC to saturate the matter therein. 3dly, The space EF will be entirely deprived of fluid; the quantity of matter therein being such, that the fluid in FG shall be sufficient to saturate the matter therein: consequently, the redundant fluid in CD will be just sufficient to saturate the redundant matter in EF. And, 4thly, The spaces BC and FG will be saturated in all parts.

Cor. 1.—If the two plates be equally overcharged, all the redundant fluid will be crowded on the remote surfaces, and the adjacent surfaces will be in their natural state.

Cor. 2.—If the redundant fluid in the one be just sufficient to saturate the redundant matter in the other, the two remote surfaces will be in their natural state, all the redundant fluid being crowded in the stratum C *c d* D, and all the redundant matter being in E *e f* F.

372 Disposition in a sphere. Fig. 105.

Lemma II.—Let BDE *b d e*, and β δ ε, (fig. 105.) be concentric spherical surfaces, whose centre is D: if the space B *b* is filled with uniform matter, whose particles repel with a force inversely as the square of the distance, a particle placed anywhere within the space C *b*, as at P, will be repelled with as much force in one direction as another, or it will not be impelled in any direction. This is demonstrated in *Newt. Princip.* lib. i. prop. 70. It follows also from his demonstration, that if the repulsion is inversely as some higher power of the distance than the square, the particle P will be impelled towards the centre; and if the repulsion is inversely as some lower power than the square, it will be impelled from the centre.

Problem 2.—Let the square BDE, be filled with uniform solid matter, overcharged with electric fluid; let the fluid therein be moveable, but not able to escape from it; let the fluid in the rest of infinite space be moveable and sufficient to saturate the matter therein; and let the matter in the whole of infinite space, or at least in the space BB, whose dimensions will be given below, be uniform and solid: it is required to determine in what manner the fluid will be disposed both within and without the globe.

Take the space B *b*, such that the interstices between the particles of matter therein shall be just sufficient to hold a quantity of electric fluid, whose particles are pressed close together so as to touch each other, equal to the whole redundant fluid in the globe, besides the quantity requisite to saturate the matter in B *b*; and take the space BB, such that the matter therein shall be just able to saturate the redundant fluid in the globe: then in all parts of the space B *b*, the fluid will be pressed close together, so that its particles shall touch each other: the space B β will be entirely deprived of fluid; and in the space C *b*, and all the rest of infinite space, the matter will be exactly saturated.

Cor. 1.—If the globe BDE is undercharged, every thing else being the same as before, there will be a space B *b*, in which the matter will be entirely deprived of fluid, and a space B β in which the fluid will be pressed close together; the matter in B *b* being equal to the whole redundant matter in the globe, and the redundant fluid in B β being just sufficient to saturate the matter in B *b*: and in all the rest of space the matter will be exactly saturated, exactly similar to the foregoing.

Cor. 2.—The fluid in the globe BDE will be disposed in exactly the same manner, whether the fluid without is immoveable, and disposed in such a manner that the matter shall be everywhere saturated, or whether it is disposed as above described; and the fluid without the globe will be disposed in just the same manner, whether

Theory of Electricity.

whether the fluid within is disposed uniformly, or whether it is disposed as above described.

373 General representation of the disposition. Plate CXCVII. fig. 106.

Let BC, fig. 106. be a cylindrical conducting body, and A an overcharged body. Draw *b c* parallel to BC, and draw B *b*, C *c*, P *p*, &c. perpendicular to BC, to represent the uniform density of the fluid, when BC is in its natural state; and let B *d*, C *r*, P *s*, &c. represent the unequal densities at different points, while it is opposed to the overcharged body A. Now these ordinates will be bounded by a line *d n r*, cutting the line *b c* in *n*, a point in the line *n* N drawn perpendicular to N, the neutral point of the conductor. The whole quantity of fluid in BC will be represented by the parallelogram *b c*, CB; but this must be equal to the space B C *r n d;* again, the redundant fluid in any portion, as PC or PN, may be represented by the spaces *p t r c*, or *t p n*, and the deficient fluid in any portion BO may be represented by the space *b d v q*. Now, the action of BC on any body placed near it, will entirely depend on the space contained between the curve line and the axis *b c*. With respect to this curve, the only circumstance that we can ascertain, is that variations of curvature at every point are proportional to the forces exerted by the spherical body A; and are, therefore, inversely as the squares of the distances from A, as will be shewn presently. The exact place of the point *n*, and the length of the ordinates, will vary according to the diameter of the conductor. We shall at present consider only the simplest case, or that where the conductor is of no sensible diameter, like a very fine wire.

374 Distribution in a very small canal nearly uniform. Fig. 107.

Let such a slender conducting canal be represented by AE, fig. 107. and let B *b*, C *c*, E *e*, &c. represent the density of the contained fluid, this being kept in a state of unequal density by its repulsion for some overcharged body. Now, a particle at C is impelled in the direction CE by all the fluid that is on the side of A; and it is impelled in the direction CA by all the fluid on the side of E. The moving force will arise from the difference of these repelling forces. When the diameter of the canal continues the same, this will arise from the difference of density only. Therefore, the force of the element at E may be expressed by the excess of D *d* above C *c* + the action at the distance CD.

Draw $\beta c \epsilon$ parallel to AE; then the force of the element E may be expressed by the formula $\frac{d\partial}{c\partial^2}\dot{x}$, and this is the force repelling the particle in the direction CA.

Take CF=CD; the force at F will be expressed by $\frac{f\varphi}{c\varphi^2}\dot{x}$, or $\frac{f\varphi}{c^2}\dot{x}$, and this force also impels the particle in the direction CA. The joint action of the two is $\frac{d\partial+f\varphi}{c\partial^2}\dot{x}$. If *b c e* were a straight line, $d\partial+f\varphi$ would always be proportional to $c\partial$, and might be expressed by $m+c\partial$, m denoting some number that expresses what part of $c\partial$ the sum of $d\partial$ and $f\varphi$ is equal to, suppose $\frac{1}{10}$, $\frac{1}{20}$, $\frac{1}{30}$, &c. But in the present case $d\partial+f\varphi$ is not always proportional to $c\partial$, for $d\partial$ does not increase so fast as $c\partial$, while $f\varphi$ increases faster. We may, however, without any sensible error, express the accelerating force tending towards A, in the neighbourhood of any point C, by $\frac{mc\partial}{c\partial^2}\dot{x}$, that is, by $m\frac{\dot{x}}{x}$, which is the fluxion of the area of a hyperbola HD′G, of which CC′ and CK are assymptotes. The whole action of the fluid between F and D may be expressed by the area C′CDD′H. Hence, the action of the smaller conceivable portion of the canal that adjoins to C on either side, or the difference of the actions of the two adjacent elements, is equal to the action of all beyond it. The state of compression is therefore scarcely affected by any thing at a sensible distance from C, and the density of the fluid in an indefinitely small canal is uniform.

Having thus found that the fluid in very small canals is very nearly of an uniform density, we may now proceed to examine the communication of electricity by means of conducting canals; which forms one of the most important parts of the theory.

375 Communication by straight canals. Fig. 108.

Let us suppose that the body A communicates by the canal EF, with another body D, placed on the contrary side of it from B, as in fig. 108, and let these two bodies be either saturated, or over or undercharged; and let the fluid within them be in equilibrio. Let now the body B be overcharged: it is plain that some fluid will be driven from the nearer part MN to the further part RS; and also some fluid will be driven from RS, through the canal, to the body D; so that the quantity of fluid in D will be increased thereby, and the quantity in A, taking the whole body together, will be diminished; the quantity in the part near MN will also be diminished; but whether the quantity in the part near RS will be diminished or not, does not appear for certain; but probably it will be not much altered.

Cor.—In like manner, if B is made undercharged, some fluid will flow from D to A, and also from that part of A near RS, to the part near MN.

376 By crooked canals. Fig. 109.

Suppose now that the bodies A and D communicate by the bent canal MPN *n p m* (fig. 109.) instead of the straight one EF: let the bodies be either saturated or over or undercharged as before; and let the fluid be at rest; then, if the body B is made overcharged, some fluid will still run out of A into D; provided the repulsion of B on the fluid in the canal is not too great.

The repulsion of B on the fluid in the canal, will at first drive some fluid out of the leg MP *p m* into A, and out of NP *p n* into D, till the quantity of fluid in that part of the canal which is nearest to B is so much diminished, and its repulsion on the rest of the fluid in the canal is so much diminished also, as to compensate the repulsion of B: but as the leg NP *p n* is longer than the other, the repulsion of B on the fluid in it will be greater; consequently some fluid will run out of A into D, on the same principle that water is drawn out of a vessel through a syphon: but if the repulsion of B on the fluid in the canal is so great as to drive all the fluid out of the space GPH *p* G, so that the fluid in the leg MG *p m* does not join to that in NH *p n*; then it is plain that no fluid can run out of A into D; any more than water will run out of a vessel through a syphon, if the height of the bend of the syphon above the water in the vessel, is greater than that to which water will rise *in vacuo*.

This

This is Mr Cavendish's reasoning; but Dr Robison objects to it, that in these cases the fluid does not move on the principle of a syphon, and that there is nothing to prevent the fluid from expanding in GPH. He was therefore of opinion, that it would always move from A to D over the bend.

Cor.—If AB is made undercharged, some fluid will run out of D into A; and that though the attraction of B on the fluid in the canal is ever so great.

377 ction of a ate on a raight nal.

We shall now consider the action of electrified bodies on the canal of communication, in some of the most important cases. But, as we are confined in our limits, and have much important matter yet to treat of, we must content ourselves with enumerating facts without proving them by rigid demonstration.

g. 110.

Let AC*a* (fig. 110.) represent a thin conducting plate, seen edgewise, to the centre of which the slender canal CP is perpendicular. It is required to determine the action exerted by the fluid, or matter, uniformly disposed over the plate, on the fluid moveable in PC?

1. To find the action of a particle at C on the fluid in the whole canal. Join AP, and let CP be denoted by x, AP by y, and AC by r. Also, let f represent the intensity of action at the distance 1 of the scale from which the lines are measured.

The action of A *m* P is $\frac{f}{y^2}$, and it may be demonstrated that the action of A on the whole of CP is $f\left(\frac{1}{r}-\frac{1}{y}\right)=f\left(\frac{y-r}{ry}\right)$.

2. To find the action of the plate whose diameter is A *a* on a particle at P.

Let a denote the area of a circle whose diameter is =1. The action required will be expressed by the fluent $2fa\left(1-\frac{x}{y}\right)$.

Cor.—If PC be very small in comparison of AC, the action will be nearly the same as if the plate was infinite.

3. To find the action of the plate on the whole column. This will be expressed by the fluent $2fa$ $(x+r-y)$.

Our mathematical readers, who are familiar with the method of fluxions, (and to no others will these theorems be intelligible), will readily see the meaning of these expressions.

The following geometrical construction will render the action of the plate for the whole column, or its parts, more familiar, and more easily remembered.

Produce PC till CK is =CA, and with the centre P, describe the arch AI, crossing CK in I. Then the electrical action will be expressed by $2fa\times$IK; and this expression represents a cylinder whose radius is 1 of the scale, and whose height is = 2 IK.

Again, about the centre *p*, with the distance *p* A, describe the arch A *i*, cutting CH in *i*. Then we have $2fa\times i$K, expressing the action of the plate on the column C*p*, and $fa\times$I *i*, expressing its action on P *p*.

By the formula $2fa\times$IK, is meant, that the action exerted by the whole plate on PC is the same as if all the fluid in the cylinder expressed by $a\times 2$ IK were placed at the distance from the acting particle denoted by 1.

378 Cor. 1.—If PC is very great compared with AC, the action is nearly the same as it would be if the column were infinitely extended.

379 Cor. 2.—If, besides, another column *p* C is very small when compared with AC, the action on PC will be to that on *p* C, as *p* C to AC nearly.

The redundant fluid cannot be uniformly diffused over the whole plate, as we have hitherto supposed, since the mutual repulsion of its particles will render it denser at the circumference. As it is difficult to determine the variation of density, we shall only state the result of the extreme case, where the whole redundant fluid is crowded into the circumference of the plate.

380 The action of the fluid in the canal is now $fa\left(r-\frac{r^2}{y}\right)$, and the whole action of the fluid crowded into the circumference will be $far^2\times\left(\frac{y-r}{ry}\right)$ $=far\left(\frac{y-r}{y}\right)$. This may be thus represented geometrically. Describe the quadrant C *b* BE, crossing AP in B, and A*p* in *b*. Draw BD and *b d* parallel to PC. Now, PB is $=y-r$, and DC$=r\left(\frac{y-r}{y}\right)$. The expression $far\left(\frac{y-r}{y}\right)$ will therefore denote a cylinder whose radius is 1, and height DC, multiplied by f. Again *d* C will be the height of the cylinder expressing the action on *p* C, and D *d* that of the cylinder expressing the action on P *p*.

381 Cor. 1.—If CP be very great compared with CA, D is very near to A, and I to C, and CD has to IK very nearly the ratio of equality.

582 Cor. 2.—But if the column *p* C is very short, the action of the fluid uniformly diffused over the plate, is to the action of the fluid crowded into the circumference, nearly as 4 AC to *p* C.

From this corollary we see that the recess of the fluid towards the circumference, has a much less effect on short columns than on *long* ones, i. e. the action in the former case will be much less diminished. Any external force that tends to impel fluid along the canal, and from thence to diffuse it over the plate, will impel a greater quantity to the plate when the fluid of the plate is crowded into the circumference, than if it were uniformly diffused over the plate, and this difference will be greater when the canal is short.

383 Lastly, When KL is equal to AP, or PL to KI, the repulsion exerted by the whole fluid of the plate, collected in K, on the fluid in the canal CL, is equal to the repulsion of the same fluid, when crowded into the circumference, on the column CP.

Cor. 1.—When CP is very long in comparison with AC or KC, the actions of the two fluids in both the above situations is nearly equal.

Cor. 2.—The action exerted by the whole fluid on the column CP, when uniformly diffused, is to its action when collected in K, as 2 IK to CD.

384 Cor. 3.—If CNO be a spherical surface, or a spherical shell, of the same diameter and thickness with the plate A *a*, and containing redundant fluid of uniform density, the action exerted by this fluid on the column CL is equal to twice the action of the fluid on the column

column CP, when the fluid is uniformly diffused over the plate, and to four times its action on the same column, when it is crowded into the circumference.

385 Action of two plates or spheres connected by infinite canals. Fig. 111. Let there be two circular plates, represented edgewise at DE, *de*, fig. 111. or two spherical shells ABO, *a b o*, of the same diameters and thickness with the plates, containing redundant fluid of uniform density, and let them communicate with straight canals OP, *op*, infinitely extended, perpendicular to their surfaces and passing through their centres, and let the fluid in these canals be of uniform density and equally diffused.

It may be demonstrated that the repulsions exerted by the fluid in the plates or spheres on the canals are as the diameters of the plates or spheres.

386 Cor. 1.—When the canals are very long compared to the diameters of the sphere or plates, the repulsions are nearly in the same proportion.

387 Cor. 2.—The more the length of the canals diminishes when compared with the diameters of the plates or spheres, the more the repulsions approach to equality.

388 Cor. 3.—When the density of the fluid in two spherical shells is inversely as their diameters, the repulsions of the contained fluid on a column of fluid infinitely extended, will be equal.

389 Cor. 4.—When the quantities of redundant fluid in two spheres are proportional to their diameters, the repulsions exerted by them on a canal infinitely extended are equal.

390 Fig. 112. Cor. 5.—If there be two overcharged spheres, or spherical shells, as ABO, *o a b*, fig. 112. that communicate by a conducting canal infinitely extended, the quantities of redundant fluid they contain are proportional to their diameters; and they will be nearly so if the canals be very long.

391 Cor. 6.—When the spheres of conducting matter are *in equilibrio*, the pressures exerted by the fluid on their surfaces are nearly proportional to their diameters.

It follows from this corollary that the tendency of fluid to escape from such spheres is, *cæteris paribus*, inversely as the diameters.

392 Important case of four plates. Fig. 113. Let there be four circular plates, as HK, AB, DF, LM, fig. 113. equal and parallel to each other, and let two of them, AB and HK, communicate by an indefinite canal GC perpendicular to their planes and passing through their centres; let DF and LM communicate in like manner by the canal EN, both canals being in the same straight line: let HK be overcharged, and LM just saturated. It is required to determine the disposition of the fluid, and its proportion in the plates, so that the above condition may be possible and permanent, while all is *in equilibrio*?

As HK and AB communicate and are equal, as HK is overcharged, AB will be so also, and in the same degree, and the fluid will be similarly disposed in both. HK and AB being in this situation, if DF and LM be brought near them to within the distance CE, as in the figure, the redundant fluid in AB will act on the moveable fluid in DF, and force some of it along the canal EN into LM, rendering this latter overcharged. Now, if this redundant fluid in LM be taken off, the repulsion which LM was beginning to exert on the canal NE, will be diminished or destroyed. Hence more fluid will move from DF into LM, and this will again be overcharged. The redundant fluid in LM may be again taken off, but in less quantity than before, and so on repeatedly, till no more can be taken off. DF will thus be rendered undercharged, or will contain redundant *matter*. This will act on the fluid in GC, and attract it from G, and consequently the fluid will now move from AK into AB, by which HK will be rendered less overcharged, and AB more so than at first. The thus increased redundancy of fluid in AB will act more strongly on the moveable fluid in DF, and repel a part of it into LM as before. DF will thus be again rendered deficient, and by its redundant matter will again act on the canal GC. Thus, by repeatedly touching LM to take off the fluid driven into it from DF, or by allowing LM to communicate with conducting bodies, an equilibrium will be produced; and when this is the case, HK contains a certain quantity of redundant fluid, AB contains redundant fluid in a greater degree, DF contains redundant matter, and LM is in its natural state. The problem may now be reduced to this: To find what proportion the redundant fluid in HK bears to that in AB, and what proportion this latter bears to the deficient fluid in DF?

To determine these proportions it is necessary that,

1st, The repulsion exerted by the redundant fluid in AB on the fluid in EN be precisely equal to the attraction exerted by the redundant matter of DF on the same canal.

2dly, The repulsion exerted by the redundant fluid in HK on the whole fluid of the canal GC, balances the excess of the repulsion of the redundant fluid in AB on GC above the attraction of the redundant matter of DF on the same canal.

If we call the redundant fluid in AB, f; the redundant matter in DF, m; and the redundant fluid in HK, f': as the fluid in HK and AB is similarly disposed, (they being equal), and as it is probable that the redundant fluid in AB, and the redundant matter in DF, are similarly disposed, it follows, that their actions on the fluid in the canals will be similar, and proportional to their quantities nearly.

Let 1 be to n, as the repulsion exerted by the fluid in AB on the fluid that would occupy CE, to the repulsion exerted by the fluid in AB on the fluid in EN or CG.

AB acts on EN with the force $f \times (n-1)$; and DF acts on EN with the force $m\,n$; but these actions must balance each other, as LM is inactive. Therefore

$$f \times (n-1) = m\,n, \text{ and } m = f \times \frac{(n-1)^2}{n}.$$

If f repels the fluid in CG with the force $f\,n$, m attracts the fluid in CG with the force $m \times (n-1)$; but as $m = f \times \frac{(n-1)^2}{n}$, the attractive force of m for CG will be $f \times \frac{(n-1)^2}{n} \times (n-1)$: Therefore the repulsion of f is to the attraction of m, as $f\,n$ to $f \times \frac{(n-1)^2}{n}$ $= f\,n^2 : f \times (n-1)^2 = n^2 : n-1^2$.

Let r denote the repulsion of f, and a the attraction of m; then $r : a = n^2 : (n-1)^2$; and $r : (r-a) = n^2 : n^2-(n-1)^2 = n^2 : (2n-1)$.

But

But the repulsion of $f' = r - a$; therefore $n^2 : (2n-1) = f : f'$, and $f' = f \times \left(\frac{2n-1}{n^2}\right)$; or $f = f' \times \left(\frac{n^2}{2n-1}\right)$.

If we suppose n^2 much greater than $2n-1$, we shall have the quantity of redundant fluid in AB much greater than that in HK.

393
rodigious ccumula- on and ssipation redun- nt fluid,

When EC is very small in proportion to AC, it will appear, on referring back to N° 382. that 1 is to n nearly as CE : CA; and consequently $n = \frac{AC}{CE}$ nearly. When this is the case, n is a considerable quantity; and there is so little difference between $\frac{n^2}{2n}$ and $\frac{n^2}{2n-1}$, that we may take the former for the latter without any material error. Now we have $f = f' \times \frac{n}{2}$ very nearly. Suppose AC to represent 6 inches, and CE $\frac{1}{10}$th of an inch, we shall have $n = 12a$ and $f = 60f'$, or more exactly $f' = \left(\frac{n^2}{2n-1}, = \frac{14,400}{239} = \right) 60\frac{1}{4}$.

This, it will be remembered, represents the redundant fluid in HK; hence it will appear how great must be the redundancy in HK.

Again, when AB and DF are very near, n is a large number, and the deficiency in DF is nearly equal to the redundancy in AB. In the above example m is $\frac{59}{60}$ths of f', as $m = f \times (n-1)$.

But though there is this great deficiency in DF, and redundancy in AB, DF is not electrical on the side next LM, nor is AB more electrical than HK; in short, this case affords another example of bodies being neutral while redundant or deficient, in addition to what was advanced in N° 313, 314.

394
out sensible rical t.

It will readily occur to the reader, that cases exactly such as we have now stated never happen in the course of experiment: but when the canals are very long in comparison of the diameters of the plate, and when AB is very near DF, the proportion will not greatly vary.

395
e of re- ng the ibrium egrees.

We have been very particular in the examination of this case, because it is of great importance, and will assist us in explaining some of the principal phenomena. To prepare for such an explanation of it, we shall here state some simple consequences of this combination of plates.

If AB be touched by any body, this body will receive from it a part of its redundant fluid, but only a part; for only so much fluid will quit AB as is sufficient to render it neutral, while the touching body communicates with the ground. This will happen till the redundant matter in DF attracts fluid on the remote side of AB as much as the redundant fluid in AB repels it. The repulsion of AB on EN is now diminished, the attraction of DF will therefore prevail, and this will be no longer neutral. If now DF be touched, it may again be made neutral with respect to EN; but AB will again repel the fluid in CG, and being redundant on that side will again become electric. AB being touched again, loses more fluid, and DF becomes electric by deficiency. Thus by alternately touching AB and DF, the redundancy in AB may be exhausted, and the deficiency in DF supplied.

396
At once.

But the equilibrium that is thus *gradually* produced may be effected at once. If we suppose a slender conducting canal *a b d*, brought very near the plates on the outside, so that the end *a* is near to A, and *d* to D; the first effect of the vicinity of *a* to A, will be to cause the fluid in *a b* to recede a little from *a*, by reason of the repulsion of the redundant fluid in AB. Thus, redundant matter will be left at *a*, and this will strongly attract redundant fluid from A, and *a* may receive a spark. Should the fluid approach still nearer the surface at A, the corresponding part of DF will be rendered more attractive, and by the fluid retiring from *a* along *a b*, some of the natural fluid of this canal will be pushed towards *d*; this increases the disposition of A to part with fluid, and of *d* to receive it, while *a* is disposed to give out and D to receive. Thus all contributes to favour the passage of almost the whole of the redundant fluid in AB to rush from AB, by A, along *a b d* into DF.

It is also clear that, without the canal *a b d*, there is a strong tendency of the fluid in AB for the matter in DF, and that, of course, these plates will strongly attract each other.

The theorems we have now given respecting the disposition of the electric fluid are the result of mathematical reasoning, founded on the hypothetical nature of the fluid, and its assumed law of action. We shall conclude this section with relating the result of M. Coulomb's experiments on this subject, given in the Memoirs of the Academy for 1786 and 1787. M. Coulomb gives the following general theorem.

397
Coulomb's experiments on the density of the fluid in contact.
Fig. 213.

In a body of any form, AFB *de*, fig. 114. which is supposed filled with fluid whose particles act on each other with a force that is inversely as the square of the distance, let there be raised a perpendicular *a b* infinitely small, and let a plane, perpendicular to *a b* at the point *b*, divide the body into two parts; one *d a c b*, infinitely small, the other *b* AFB *c b*, of any determinate dimensions. Then the action of the particles composing the thin slice, estimated in the direction *a b*, on the particle *b*, must be equal to the action of the whole fluid in the rest of the body, if *b* be supposed at rest. Now, as whatever be the disposition of the fluid, the law of continuity will be the same, it is evident that if we take *a b* sufficiently small, the difference of the density at *a* and at *c* may be infinitely small; and that the action of *d c b e* will be infinitely near to an equilibrium with that of *d a e b*. Hence the action of the fluid in the rest of the body will be reduced to nothing, or will be infinitely small. But this cannot take place when the action of the mass at a finite distance on a particle of fluid, is infinitely small with respect to that of a particle in contact on the same particle, unless we suppose the quantity of fluid at a finite distance nearly nothing. It follows that the whole redundant fluid must be constipated on the surface, and the interior parts be merely saturated.

M. Coulomb then proceeds to examine the density of the electric fluid in different bodies that are in contact.

He first examines the density of two globes of different diameters in contact.

After a number of experiments, he gives the result in

Theory of Electricity.

in the following table, representing the manner in which the fluid is distributed between the two globes. The first column shews the proportion of the radii of the globes, the second the proportion of their surfaces, and the third the corresponding proportion of their densities. It must be remarked that this table shews only the proportional density of the globes, when after being separated, the fluid is universally diffused over their surfaces.

1	1	1
2	4	1,08
4	16	1,30
8	64	1,65
infinite	infinite	2,00

Thus it appears, that the greater the proportion of the surfaces of the globes, the nearer the proportion of their densities approached to 2, but never attained this.

This is very different from the proportions between two spheres that communicate by a very long slender canal, which, as was shewn in N° 390. contained quantities of fluid proportional to their diameters, and that the densities were inversely as the diameters; and this M. Coulomb found to agree very exactly with experiment.

M. Coulomb next proceeds to examine the density of the fluid in various parts of the surface of the globes in contact, in order to ascertain the distribution.

His method of proceeding was this. He hung a small circle of gilt paper to a thread of lac, fixed to a cylinder of glass or baked wood; the paper was varnished with some electric substance. The body to be examined was first touched with the paper circle, the electricity of which was then examined by means of his electrometer, and an estimation of the density of the spheres made on the supposition that the circle brought off one half of the electricity of the touched point.

The result of numerous experiments made with two globes in contact was as follows. The more unequal the globes were, the more the density of the small globe varied from the point of contact to the distance of 180°, and the nearer it approached to uniformity in the large globe, increasing rapidly from the point of contact, where it was 0, to 7° or 8° from that point. Thus, when he placed a sphere of 8 inches in contact with one of two inches, he found the density of the small globe insensible till about 30° from the point of contact; that at 45° it was nearly the one-fourth of what it was at 90°, and hence it increased in the proportion of 10 to 14 till 180°, where it was uniform. In the larger globe, on the other hand, the density was 0 till about 4° or 5°; hence it increased rapidly, and from 30° to 180° it was nearly uniform.

From these results we may conclude that Mr Cavendish's mathematical demonstration of the uniform distribution of the fluid in a globe that communicates with another by a slender canal, is conformable to the fact.

A small globe between two equal larger globes, was found to possess the same electricity as the other two, when the proportion of their radii was not more than 5 to 1; when it was greater, the small globe shewed no electricity.

Three equal globes being placed in contact, the density in the middle one was $\frac{1}{1,34}$ of that in the other two. When a small globe, after having been in contact with a larger one that was overcharged, was removed to a very small distance, the electricity of the small globe in the fronting point was opposite to that of the large one, at a little greater distance the small globe was neutral, and still farther off, it was redundant.

When the diameters of the globes were 11 and 8 respectively, the small globe at the fronting point was negative, till it was at the distance 1, when it was neutral, and beyond this it was positive. When the diameters were 11 and 4, the neutral distance was 2, and when they were 11 and 2, the distance at which the small globe was neutral was $2\frac{1}{2}$.

It is indifferent whether the globes be solid, or consist merely of a thin shell. This circumstance is an additional proof of the justness of the theoretical investigation, on the supposition of the fluid being diffused over the surface, leaving the interior parts in a neutral state.

Sect. II. *An Application of the Theory of Æpinus and Cavendish to the principal Phenomena of Electricity.*

398 On an attentive consideration of the phenomena that have already passed under our review, and a careful comparison of these with the theory of positive and negative electricity, as improved by Æpinus and Cavendish, it will appear that this theory is at least adequate to the explanation of the facts.

The comparison of the theory with the experiments may readily be made, and we have already hinted at it in several cases. We cannot however, pursue this to any extent, and must restrict ourselves in the remainder of the chapter to the more important and interesting phenomena, leaving the rest to be supplied by the reader, for which purpose we have furnished him with ample materials.

We have already, in our illustration of the theory of Æpinus, so fully considered the phenomena of electric attraction and repulsion in a general view, that little more needs to be done, than to explain a few of the more remarkable cases.

The phenomena of attraction and repulsion may be reduced to the following simple propositions.

399 Electrici by positic illustrate

Prop. I.—If any body be electrified by any means, and if another body be brought near it, this latter becomes electrified by position.

We shall illustrate this proposition by the following simple experiment.

Plate CXCVII. fig. 11

Let there be provided three metallic conductors, each supported on an insulating stand, such as A, B, C, fig. 115. Set these in a row, with their extremities touching each other, and at one end of the row, as at *c*, place a stand, to which is hung a ball electrometer with silk threads. On bringing an excited electric near *a*, the opposite end of the conductor, the pith ball will approach the end *c*. Care, must, however, be taken not to bring the electric so near *a*, as to make the ball strike the opposite extremity; as in that case the experiment would come under our second proposition. When the excited electric is removed, the ball retires to its perpendicular situation. The same effect will be produced if the electrometer be placed at the side

side of the conductor, instead of its extremity, clearly shewing that it is affected by the conductor, and not immediately by the excited electric.

This is an instance of induced electricity, and is easily explained on the principles mentioned in N° 344. The approach of the excited electric to the end *a* of the compound conductor, renders this end deficient, if the electric be overcharged, or redundant if it be undercharged; and the opposite extremity is in the contrary state, and hence attracts the ball of the electrometer.

Although the opposite extremities of the conductor are in opposite states, the fluid is variously disposed in various parts of the conductor; as may be proved in the following manner. While the excited electric remains near *a*, take away the two extreme conductors, A and C, or, if only two have been employed, take away the remote one; remove the excited electric, and examine the parts of the conductor separately. The part A will be found entirely negative; if the electric were overcharged, C will be entirely positive; and if three pieces have been employed, the middle piece B will be faintly positive. If the pieces be again united, they will be found devoid of electricity. The same appearances will be more completely seen by forming a conductor of a series of metallic balls, suspended by silk threads, one of which will be found scarcely electrical.

400 Prop. II.—When an insulated body is brought very near an electrified body, a spark passes between them, and the insulated body becomes electrified permanently by communication, while the electricity of the electrified body is diminished.

In this case the electricity imparted is of the same kind as that of the electrified body, positive if this were positive, and *vice versa*. The proposition may be illustrated by the same apparatus of the conductors and electrometers, and scarcely requires an explanation.

When the electricity is in a small degree, the spark is either very small or scarcely perceptible, but there is no doubt, that it takes place in all cases. The spark is owing to the sudden transference of a portion of the fluid from the electrified body to the unelectrified body.

401 pulsion bodies in same tc.

Prop. III.—When an electrified body has communicated part of its electricity to another body, this latter is repelled, unless it has communicated its acquired store to other bodies.

The flying feather, the cork balls, and many other experiments related in the first chapter of Part III. amply illustrate this proposition, which expresses one of the most general facts in electricity.

Before the electrified body has communicated part of its electricity to the body presented to it, this latter is in its natural state; but after the communication, both are either redundant or deficient, and consequently repel each other, as appears from N° 323, 324.

From these general propositions we may deduce the following corollaries, an application of which will serve still further to illustrate and explain the phenomena of electric attraction and repulsion.

402 Cor. 1.—The vivacity of the appearances produced by a transference of fluid will be proportional to the quantity of fluid transferred.

403 Cor. 2.—The phenomena of communicated electricity will be more remarkable, the greater the conducting power of the bodies to which it is communicated.

It will have appeared from numerous experiments related in Part III. especially that of the *dancing balls* in N° 94. that an imperfect conductor, such as glass, permits the communication of electricity only in the point presented to an electrified body; whereas when electricity is communicated to one point of a tolerably perfect conductor, such as the prime conductor of a machine, the whole conductor is instantly pervaded, and becomes electrical in every part.

Cor. 3.—When an electrified body has a free communication with a perfect conductor, its electricity cannot apparently be communicated to a body touched by it. 404

For the mass of the earth, with which the body communicates, bears so great a proportion to the body itself, that when the electricity of the latter is communicated to the former, it becomes imperceptible in both.

Cor. 4.—When an unelectrified body is presented to an electrified body, the former is first attracted, comes in contact with the electrified body, and is then repelled. 405

This corollary has been illustrated by numerous experiments; we may instance the *dancing figures*, &c. and the appearances are easily explained. The unelectrified body becomes electrical by induction; in consequence of this, it is attracted to the electrified body, from which it receives a spark, becomes electrified by communication, and being now in the same state with the electrified body, is repelled by it.

It will probably have been observed, in making the experiment of presenting a feather, or a pith ball, suspended by a string, to the prime conductor, that they cling to the conductor, and are not repelled for some time. The reason of this is, that these bodies are imperfect conductors, especially when very dry, and hence their influence is not easily pervaded by the fluid; when this becomes equally diffused, they are repelled. The same circumstance explains why the balls of the common electrometer sometimes adhere together, and then separate with a jerk.

Cor. 5.—Electrical attraction and repulsion are not prevented by the interposition of unelectrified non-conducting substances. 406

A thin plate of glass may be interposed between the conductor and the pith-ball in the experiment of N° 399. and still, though the plate be very extensive, the electrometer will be affected.

Nay, an insulated electrified body may be covered with a glass bell, and it will yet attract a ball presented to it.

407 Hypothesis of electric atmospheres.

As this single circumstance affords one of the best arguments against the hypothesis of material electric atmospheres, which has been maintained, and is still maintained, by some of our most eminent electricians; we shall take this opportunity of giving a brief account of this hypothesis, and stating the reasons which induce us to reject it.

It has been supposed, that the electric fluid is collected around the surface of an electrified body, forming a kind of atmosphere; and that on these atmospheres depended the action of these electrified bodies. If the reader will examine the plates of Lord Stanhope's *Principles of Electricity*, he will see the figures of conductors surrounded with a shining margin, like the line of coasts and islands in a map.

This idea of electric atmospheres was first held at a very early period of the science by Otto Guericke, and afterwards by the academicians del Cimento, who contrived to render the electric atmosphere visible, by means of smoke attracted by, and uniting itself to a piece of amber, and gently rising from it, and vanishing as the amber cooled. But Dr Franklin exhibited this electric atmosphere with great advantage, by dropping rosin on hot iron plates held under bodies electrified, from which the smoke rose and encompassed the bodies, giving them a very beautiful appearance. He made other observations on those atmospheres: he took notice that they and the air did not seem to exclude one another; that they were immoveably retained by the bodies from which they issued; and that the same body, in different circumstances of dilatation and contraction, is capable of receiving and retaining more or less of the electric fluid on its surface. However, the theory of electrical atmospheres was not sufficiently explained and understood for a considerable time; and the investigation led to many very curious experiments and observations. Mr Canton took the lead, and was followed by Dr Franklin. Messrs Wilcke and Æpinus prosecuted the inquiry, and completed the discovery. The experiments of the two former gentlemen prepared the way for the conclusion that was afterwards drawn from them by the latter, though they retained the common opinion of electric atmospheres, and endeavoured to explain the phenomena by it. The conclusion was, that the electric fluid, when there is a redundancy of it in any body, repels the electric fluid in any other body, when they are brought within the sphere of each others influence, and drives it into the remote parts of the body, or quite out of it, if there be any outlet for that purpose.

By atmosphere, M. Æpinus says, no more is to be understood than the sphere of action belonging to any body, or the neighbouring air electrified by it. Sig. Beccaria concurs in the same opinion, that the electrified bodies have no other atmosphere than the electricity communicated to the neighbouring air, and not with the electrified bodies. And Mr Canton likewise, having relinquished the opinion that electrical atmospheres were composed of effluvia from excited or electrified bodies, maintained that they only result from an alteration in the state of the electric fluid contained in, or belonging to the air surrounding these bodies to a certain distance; for instance, that excited glass repels the electric fluid from it, and consequently beyond that distance makes it more dense; whereas excited wax attracts the electric fluid existing in the air nearer to it, making it rarer than it was before.

408 Refuted.

It is perhaps a sufficient refutation of this doctrine of material atmospheres, that electric attraction and repulsion may take place, where these atmospheres cannot, according to the general opinion, be formed. Thus, in the instance given above, it is scarcely conceivable, that the excited electric on one side of the glass pane, or bell, should so speedily extend its atmosphere to the other side of the pane, or, in the case of the bell, that it should extend it at all, so as instantaneously to affect an electrometer presented to the other side. Nay, it is well known, that an electrified body will affect a conducting wire, so as to render it positive at one end, and negative at the other, though the wire be completely enveloped in sealing-wax, or some other electric substance. It therefore becomes a question, how, if the interposed body be impermeable to the electric fluid, (and we see no reason to think that glass and other perfect electrics are not so), the electric atmosphere can be produced? The one atmosphere can, in this instance, produce the other only by acting at a distance on the particles of which this latter is to be formed. Even supposing that the one atmosphere could produce the other in this way, we should gain nothing by the supposition. It only supposes innumerable attractions and repulsions in place of one.

Dr Franklin whirled an electrified ball, suspended by a silk thread, many times about his head with great rapidity, and found that its electricity was not sensibly diminished by the motion. Now it is scarcely conceivable, that the electric atmosphere could remain attached to the ball under these circumstances, or that it could be so instantaneously formed, or renewed in every point of its revolution, as to be capable of acting the moment the motions were ended; for the electricity of the ball must in this way have been greatly lessened, or nearly exhausted; whereas Dr Franklin found that, when the air was very dry, the electricity of the revolving ball was, when the ball was stopped, not less than that of a similar ball that had remained for the same time in a state of rest.

409 Permeability of glass supposed by some.

We have said that we see no reason to think, that glass is permeable to the electric fluid. We are aware, that this permeability is supported by some electricians, and that experiments have been related in proof of their opinion. Among the most plausible of these, are the experiments of Mr Lyons of Dover, which may all be reduced to the following. A wire is brought from the outside of a phial charged by the knob, and terminates in a sharp point at a small distance from a thin glass plate; it is commonly introduced into a glass tube, having a ball at the end, and the point of the wire reaches to the centre of the ball; and another wire is connected with the discharging rod, and also comes very near, and frequently close to the other end of the glass, opposite to the pointed wire. With this apparatus he obtains a discharge, and therefore says that the glass is permeable to the electric fluid.

Dr Robison repeated most of Mr Lyons's experiments, and found that, in the above way, he did indeed procure discharges, but that these were very incomplete, and very unlike the full and audible discharge usually obtained; they were always very faint, except when the glass was perforated.

410 Electrics only so superficially

To terminate this long digression, it must be remarked, that the impermeability of electrics supposed in our theory, shews that the redundancy or deficiency induced in an overcharged or undercharged electric, does not extend beyond the surface; for when the surface is rendered electrical by excitation in any way, the impermeability of the body prevents the redundant fluid from penetrating to any depth, or from expanding to supply the deficiency on the surface. Hence we find, that an excited electric, when plunged into water, quickly loses its electricity by communication with this conducting medium.

We must now return to our corollaries, of which we shall deduce one more.

411 Compensated electricity,

Cor. 6.—As non-electrics are conductors, and as some electrics are excited by rubbing them with non-electrics,

electrics, it will follow, that if the non-electrics be insulated and separated from the electric, the former will show signs of electricity as well as the latter, but that, while they remain together, no signs of electricity can be exhibited by either.

This corollary may be illustrated by numerous facts that have been related in the preceding parts of this article.

The sheets of paper in N° 19. showed no signs of electricity while in contact with the table; the sulphur in the experiments of Wilcke and Æpinus, was not electrical while within the metallic cups, &c.

When cases of this kind occur, in which two bodies, that would, when separated after mutual contact, show signs of opposite electricities, are, when united, said to *compensate* each other, the circumstance is easily explained.

In whatever way excitation is produced by friction or other means, which we do not pretend to explain, it must happen that the adjoining surfaces of two bodies rubbed together, must be in opposite states, and the one overcharged in the same degree as the other is undercharged. When the bodies, which we shall suppose to be two plates, are joined, so that the one exactly covers the other, they must be inactive; because a particle of moveable fluid in any part of one surface of the overcharged plate, will be as much attracted by the undercharged surface of the farther plate, as it is repelled by the overcharged surface of the nearer plate. As the surfaces are supposed equal, coincident, and equally electrical, their actions must balance each other. The action of the united bodies will be expressed by $F'm' \times (z-z')$ or $F'm'$; $z-z'$ being here $=0$.

But now again, if the plates be separated, a considerable part of the redundant fluid will fly back from the one surface to the other, being impelled thither by the repulsion of its own particles, and drawn by the attraction of the redundant matter in the other surface. But, as the electric is a non-conductor, it will retain a portion of fluid, or will remain deprived of a portion, in a stratum a little way within the surface, the two plates must, after separation, be in opposite states, and the non-electric plate, if it has been insulated before separation, will, after separation, appear electrified.

We shall close our consideration of electrical attraction and repulsion, by explaining two very beautiful experiments of Dr Franklin; one of which, the electrical well, has been described in N° 79.; the other shall be described presently.

412 ectrical ll ex- ined.

It appears from Mr Cavendish's account of the disposition of fluid in a sphere, given in N° 372. that when the sphere is overcharged, all the redundant fluid is crowded into the surface, leaving the internal parts in a neutral state. Now the vessel that represents the electrical well is exactly in this condition; the electrometer, therefore, when let down within the cavity of the vessel, cannot be affected, because all that space is neutral; but when the balls are raised above the brim of the vessel, they are affected, because they come within the sphere of action of the redundant surface.

The other experiment to which we allude, is that of the electrified can and chain, which is thus made.

413 trified and n.

Insulate a metallic can, or any other concave piece of metal, and place within it a pretty long metallic chain, having a silk thread tied to one of its ends. At the handle of the can, or to a wire proceeding from it, suspend a cork-ball electrometer; then electrify the can, by giving it a spark with the knob of a charged phial, and the balls of the electrometer will immediately diverge. If, in this situation, one end of the chain be gradually raised up above the top of the can, by the silk thread, while the lower end of the chain remains in it, the balls of the electrometer will converge a little, and more or less in proportion to the greater or less elevation of the chain above the top of the vessel. A similar experiment was made by Mr Ronayne, which is as follows:—He excited a long slip of white flannel, or a silk ribband, by rubbing it with his fingers; then, by applying his hand to it, took off as many sparks as the excited electric would give; but when the flannel, &c. had lost the power of giving any more sparks in this manner, he doubled, or rolled it up; by which operation the contracted flannel, &c. appeared so strongly electrical, that it not only afforded sparks to the hand, brought near, but it threw out spontaneous brushes of light, which appeared very beautiful in the dark.

To explain this experiment, we must have recourse to an inference, that is easily deducible from the same theorem of Mr Cavendish: namely, that in overcharged bodies of all shapes, the redundant fluid will be much more dense near the surface than in the more internal parts; and that it will be also denser in all elevated or protuberant parts of these bodies, as also near the extremity of oblong bodies; and in general, that the redundant fluid, or redundant matter, will bear a much nearer proportion to the surfaces of bodies, than to their quantities of matter. Hence we may perceive, that when the chain, in the above experiment, is lifted up, it will attract to itself a part of the denser fluid, leaving that of the surface of the vessel, to which the electrometer is attached, more rare; and consequently, the divergence of the balls will decrease, in proportion as the chain is more elevated above the rim of the cup. Mr Ronayne's experiment admits of a similar explanation.

414 Action of points explained.

The well known effects of points, in causing a quick discharge of electricity, seem to agree very well with this theory.

It appears from 391. that, if two similar bodies of different sizes are placed at a very great distance from each other, and connected by a slender canal, and overcharged, the force with which a particle of fluid placed close to corresponding parts of their surface is repelled from them, is inversely as the corresponding diameters of the bodies. If the distance of the bodies is small, there is not so much difference in the force with which the particle is repelled by the two bodies; but still, if the diameters of the two bodies are very different, the particle will be repelled with much more force from the smaller body than from the larger. It is indeed true, that a particle placed at a certain distance from the smaller body, will be repelled with less force than if it be placed at the same distance from the greater body; but this distance is in most cases pretty considerable. If the bodies are spherical, and the repulsion inversely as the square of the distance, a particle placed at any distance from the surface of the smaller body, less than a mean proportion between the radii of the two bodies, will be repelled from it with more force than if it be be placed at the same distance from the larger body.

We may probably, therefore, be well assured, that if two similar bodies are connected together by a slender canal, and are overcharged, the fluid must escape faster from the smaller body than from an equal surface of the larger; but as the surface of the larger body is greatest, it is not certain which body ought to lose most electricity in the same time; and indeed it seems impossible to determine positively from this theory which should, as it depends in a great measure on the manner in which the air opposes the entrance of the electric fluid into it. Perhaps, in some degrees of electrification, the smaller body may lose most, and in others the larger.

Fig. 116. Let now ACB (fig. 116.) be a conical point, standing on any body DAB, C being the vertex of the cone; and let DAB be overcharged: Mr Cavendish supposes, that a particle of fluid placed close to the surface of the cone anywhere between *b* and C, must be repelled with at least as much, if not more, force, than it would, if the part A *a b* B of the cone was taken away, and the part *a* C *b* connected to DAB by a slender canal; and consequently, from what has been said before, it seems reasonable to suppose that the waste of electricity from the end of the cone must be very great in proportion to its surface; though it does not appear from this reasoning, whether the waste of electricity from the whole cone should be greater or less than from a cylinder of the same base and altitude.

All that has been here said relating to the flowing out of electricity from overcharged bodies, holds equally true with regard to the flowing in of electricity into undercharged bodies.

The action of pointed or angular bodies seems to consist in promoting the recession of the particles of electrified air, by protruding a part of the electrical atmosphere of the conductor into a situation more exposed to the action of the ambient unelectrified medium, and thereby producing a current of air from the electrified point to the nearest uninsulating body. This has been taken notice of in N° 80. *et seq.* and is produced in the following manner.

If a globular body ABD is overcharged, the air close to it, all round its surface, is rendered overcharged by the electric fluid, which flows into it from the body; it will therefore be repelled by the body; but as the air all round the body is repelled with the same force, it is in equilibrio, and has no tendency to fly off from it. If now the conical point ACB be made to stand out from the globe, as the fluid will escape much faster in proportion to the surface from the end of the point than from the rest of the body, the air close to it will be much more overcharged than that close to the rest of the body: it will therefore be repelled with much more force; and consequently a current of air will flow along the sides of the cone from B towards C; by which means there is a continual supply of fresh air not much overcharged, that the electricity would have but little disposition to flow from the point into it.

The same current of air is produced in a less degree, without the help of the point, if the body, instead of being globular, is oblong or flat, or has knobs on it, or is otherwise formed in such a manner as to make the electricity escape faster from some parts of it than the rest.

In like manner, if the body ABD be undercharged, the air adjoining to it will also be undercharged, and will therefore be repelled by it; but as the air close to the end of the point will be more undercharged than that close to the rest of the body, it will be repelled with much more force; which will cause exactly the same current of air, flowing the same way, as if the body was overcharged; and consequently the velocity with which the electric fluid flows into the body, will be very much increased. We believe, indeed, that it may be laid down as a constant rule, that the faster the electric fluid escapes from any body when overcharged, the faster will it run into that body when undercharged.

Points are not the only bodies which cause a quick discharge of electricity; in particular, it escapes very fast from the ends of long slender cylinders; and a swift current of air is caused to flow from the middle of the cylinder towards the end: this will easily appear by considering, that the redundant fluid is collected in much greater quantity near the ends of the cylinders than near the middle. The same thing may be said, but we believe in a less degree, of the edges of thin plates.

What has been just said concerning the current of air, serves to explain the reason of the revolving motion of Dr Hamilton's and Mr Kinnersley's bent pointed wires, (N° 81.) for the same repulsion which impels the air from the thick part of the wire towards the point, tends to impel the wire in the contrary direction.

It is well known, that if a body B is positively electrified, and another body A, communicating with the ground, be then brought near it, the electric fluid will escape faster from B, at that part of it which is turned toward A, than before. This is plainly conformable to theory; for as A is thereby rendered undercharged, B will in its turn be made more overcharged, in that part of it which is turned towards A, than it was before. But it is also well known, that the fluid will escape faster from B, if A be pointed, than if it be blunt, though B will be less overcharged in this case than in the other; for the broader the surface of A, which is turned towards B, the more effect will it have in increasing the overcharge of B. The cause of this phenomenon is as follows.

If A is pointed, and the pointed end turned towards B, the air close to the point will be very much undercharged, and therefore will be strongly repelled by A, and attracted by B, which will cause a swift current of air to flow from it towards B; by which means a constant supply of undercharged air will be brought in contact with B, which will accelerate the discharge of electricity from it in a very great degree; and moreover, the more pointed A is, the swifter will be this current. If, on the other hand, that end of A which is turned towards B is so blunt, that the electricity is not disposed to run into A faster than it is to run out of B, the air adjoining to B may be as much overcharged as that adjoining to A is undercharged; and therefore may, by the joint repulsion of B and attraction of A, be impelled from B to A, with as much or more force, than

than the adjoining air to A is impelled in the contrary direction; so that what little current of air there is, may flow in the contrary direction.

We might here give an account of Coulomb's experiments on the dissipation of electricity into the air, and along imperfect conductors. But we must defer this to the article ELECTROMETER, under which we shall describe the instrument with which they were made. We must now proceed to the theory of the Leyden phial.

415 Phenomena of charged glass illustrated. In the 4th, 6th, and 7th chapters of the third part, we have related a considerable number of experiments, illustrating the phenomena of charged electrics. Before we examine the theory of the Leyden phial, it will, therefore, be necessary to consider the phenomena only in a simple case, and for this purpose we shall give an experiment, by which the late Dr Robison used to illustrate the theory of charged glass.

Plate CXCVIII. fig. 117. Fig. 117. represents the professor's apparatus. G is the extremity of a prime conductor, on which is fixed a quadrant electrometer H. AB represents a round plate of tin-foil, pasted on a plate of glass, the edges of which extend beyond the tin-foil about two inches. The plate of glass is fixed to a wooden stand, so that it may be placed upright, and at any required distance from the conductor. DF is another plate of equal dimensions with AB, having a wire EN fixed in its centre, with its extremity N, terminating in a small ball, from which is hung a common ball electrometer. The wire also passes through a wooden ball O, which is fastened to the insulating stand P. It is necessary that the glass plates be very clean and dry, and a little warm.

The conductor G is to be connected with the plate AB, by a wire reaching to the centre C. Now move the electrical machine slowly, till the index of the quadrant rise to 30° or 40°, and mark the number of turns required to produce this effect. Take off the electricity, and having removed the connecting wire GC, turn the machine again slowly, till the index be in the same situation. The difference in the number of turns in this latter case, from the former, will shew pretty nearly the expenditure of fluid necessary to electrify only the plate of tin-foil. This difference will be found very trifling, when a low degree of electricity is employed; and to this it is necessary to confine the electrification, to prevent too great a dissipation from the edges of the plate. Now replace the wire, and cause the index of the electrometer to point again at 30°; bring forward the plate DF, taking care to keep it just opposite and parallel to AB without touching it. No sensible change will be produced on the index, till the plate DF come within four or five inches of AB, and it may even be brought much nearer, without making the index sink more than two or three degrees, unless a spark pass between AB and DF. Remove DF again to the distance of two or three feet, and fasten to the ball N a piece of chain, or metallic thread, so that it may lie on the table. Now raise the electrometer again to 30°, and advance DF gradually towards AB. The index will gradually fall as DF advances, but will rise again to its former height, if DF be carried back to its original situation.

These appearances are easily explained on the principles laid down in N° 392, 393. For as DF advances towards AB, the redundant fluid in the latter repels a part of the fluid in DF towards the remote end of the wire EN, as is shewn by the separation of the balls at N; hence an accumulation commences in AB, and the index of the electrometer HG falls just as if part of the fluid in the prime conductor were communicated to AB. When DF is made to communicate with the floor, much more electricity is repelled from DF, according as it approaches nearer to AB; but, by reason of the communication, the electrometer at N gives no signs of electricity.

If, instead of connecting AB with the prime conductor, we adapt to the wire GC, at the extremity G, a metallic plate of the same dimensions as AB, with an electrometer attached to it next AB, and if this apparatus be any how electrified, and the separation of the balls at H be noted, before DF, which communicates with the floor, be approached, on attending to the charges, it will be seen, that the divergency of the balls corresponds very nearly to the distance of DF, as is required by the theory.

Now, while the plates are near each other, especially if DF communicates with the floor, if we suspend a pith ball by a silk thread between AB and DF, the ball will be strongly attracted by either of these plates that is nearest to it, suppose DF; and, having touched this, it will be immediately repelled, and drawn towards AB, by which it will be again repelled to DF, and it will thus be driven backwards and forwards like the electrified spider described in N° 126. as long as any electricity remains in either of the plates. In the mean time, the index of the electrometer at H will gradually descend, till the motion of the pith ball ceases.

All these appearances are more remarkable, according as the plates are nearer to each other; and when they come in contact, the phenomena are the most complete.

If, when the plates are charged, we approach one end of a bended wire, (having a downy feather at each end), to the plate DF, and bring the other to AB, we shall observe the feathers spread out their fibres to the plates, and then the equilibrium will be restored, or the plates will be discharged.

In the simpler theory, by which repulsion is excluded as an original property of the electric fluid, it is maintained, that when a charged coated electric is brought near to an uninsulated conductor, its electricity disappears, because the attraction of the fluid for the surrounding air is now compensated by the greater attraction between it and the exhaustless store of unexcited conducting matter constituting the earth. As the whole of it receives that direction, it does not make its appearance as existing in the air, which has more of an insulating quality; and as electrical attraction is inversely as the square of the distance, the action of this principle of compensation is greater as the distance of the opposite surfaces is less.

Having, by means of this experiment, brought again into view the phenomena of charging and discharging a coated electric, we are prepared to explain the theory of the Leyden phial, which can easily be done by recurring to the important theorem of the disposition and actions of four parallel plates, so fully detailed in N° 392.

The following observations will also afford some idea of the manner in which the fluid is disposed in the substance of the glass.

416 Theory of the Leyden phial.

It fully appears from what has been said in N° 409, that the electric fluid is not able to penetrate a plate of glass without breaking it; and yet it seems able to penetrate to a very small depth within the surface of the glass.

Fig. 118.

Let ACGM, fig. 118. represent a flat plate of glass, or any other substance which will not suffer the electric fluid to pass through it, seen edgeways; and let B *b d* D, and E *e f* F, or B *d* and E *f*, as we shall call them for shortness, be two plates of conducting matter of the same size, placed in contact with the glass, opposite to each other; and let B *d* be positively electrified; and let E *f* communicate with the ground; and let the fluid be supposed either able to enter a little way into the glass, but not to pass through it, or unable to enter it at all; and if it is able to enter a little way into it, let *b* B ∂ *d*, or *b* ∂ as we shall call it, represent that part of the glass, into which the fluid can enter from the plate B *b*, and *e* φ that which the fluid from E *f* can enter. By the above-mentioned proposition, N° 134. it appears that if *b e*, the thickness of the glass, is very small in respect of *b d*, the diameter of the plates, the quantity of redundant fluid forced into the space B *d* or B ∂, (that is, into the plate B *d*, if the fluid is unable to penetrate at all into the glass, or into the plate B *d*, and the space *b* ∂, together, if the fluid is able to penetrate into the glass) will be many times greater than what would be forced into it by the same degree of electrification, if it had been placed by itself; and the quantity of fluid driven out of E φ will be nearly equal to the redundant fluid in B ∂.

If a communication be now made between B ∂ and E φ by the canal NRS, the redundant fluid will run from B ∂ to E φ; and if in its way it passes through the body of any animal, it will, by the rapidity of its motion, produce in it that sensation, called a *shock*.

It appears from N° 392. that, if a body of any size was electrified in the same degree as the plate B *d*, and a communication was made between that body and the ground, by a canal of the same length, breadth, and thickness as NRS; that then the fluid in that canal would be impelled with the same force as that in NRS, supposing the fluid in both canals to be incompressible; and consequently, as the quantity of fluid to be moved, and the resistance to its motion, are the same in both canals, the fluid should move with the same rapidity in both: and there seems no reason to think that the case will be different, if the communication is made by canals of real fluid.

Therefore, in the opinion of Mr Cavendish, as great a shock would be produced by making a communication between the conductor and the ground, as between the two sides of the Leyden phial, by canals of the same length, and same kind. This seems a necessary consequence of this theory; as the quantity of fluid which passes through the canal is, by the supposition, the same in both; and there is the greatest reason to think, that the rapidity with which it passes, will be nearly, if not quite, the same in both.

It may be worth observing, that the longer the canal NRS is, by which the communication is made, the less will be the rapidity with which the fluid moves along it; for the longer the canal is, the greater is the resistance to the motion of the fluid in it; whereas the force with which the whole quantity of fluid in it is impelled, is the same whatever be the length of the canal. Accordingly it is found in melting small wires, by directing a shock through them, that the longer the wire, the greater charge it requires to melt it.

As the fluid in B ∂, is attracted with great force by the redundant matter in E φ, it is plain that if the fluid is able to penetrate at all into the glass, great part of the redundant fluid will be lodged in *b d*, and in like manner there will be a great deficiency of fluid in *e* φ. But in order to form some estimate of the proportion of the redundant fluid, which will be lodged in *b* ∂: let the communication between E *f* and the ground be taken away, as well as that by which B *d* is electrified; and let so much fluid be taken from B ∂, as to make the redundant fluid therein equal to the deficient fluid in E φ. If we suppose that all the redundant fluid is collected in *b* ∂, and all the deficient in E φ, so as to leave B *d* and E *f* saturated; then as the electric repulsion is inversely as the square of the distance, a particle of fluid placed anywhere in the plane *b d*, except near the extremities *b* and *d*, will be attracted with very near as much force by the redundant matter in *e* φ, as it is repelled by the redundant fluid in *b* ∂. Hence it follows, that if the depth to which the fluid can penetrate is very small in respect of the thickness of the glass, but yet is such that the quantity of fluid naturally contained in *b* ∂ or *e* φ, is considerably more than the redundant fluid in B ∂; then, as the repulsion is inversely as the square of the distance, almost all the redundant fluid will be collected in *b* ∂, leaving the plate B *d* not very much overcharged; and in like manner E *f* will be not very much undercharged: if the repulsion were inversely as some higher power than the square, B *d* will be very much overcharged, and E *f* very much undercharged: and if the repulsion were inversely as some lower power than the square, B *d* will be very much undercharged, and E *f* very much overcharged.

417

It is a part of Dr Franklin's theory, that no electric fluid can be thrown into one side of a coated plate, unless an equal quantity be at the same time abstracted from the other side; and that consequently the charged plate contains no more fluid than before it was charged. We find, indeed, that one side of the plate will not receive a charge, unless the other side at the same time communicate with the ground. He infers the same consequence from the circumstance, that if a jar be discharged through a person when insulated, the person is not found electrified; the necessary consequence of which is, according to Dr Franklin, that any number of jars may be charged by the same turns of a machine, provided that the outside of one jar communicates with the inside of the next successively, while the outside of the last has a communication with the ground. He found, however, by experiment, that a greater number of turns was necessary, than his theory required; but he attributed this circumstance to the dissipation of the fluid into the air. But we learn from our theory that the redundant matter in the plate that communicates with the ground is less than the redundant fluid in the other plate, in the proportion of $n—1$ to n: and that the proportion of redundant fluid in the next plate

plate or jar is no greater. If we have any number of jars, the charge of the *m*th jar in the series, will be $\left.\overline{\frac{n-1}{m}}\right|^{m}$. If the charge of the first jar or $n=60$, that of the 10th will $=51$ nearly.

Though a coated plate will not receive a charge, unless one side communicate with the ground, it may however be rendered electrical, as appears when we attempt to charge it while insulated. For when we attempt to electrify one side, the other gives a spark which proves this to be electrified also. Again, when a charged phial is discharged by means of an insulated discharger, it always remains electrical, positively or negatively, according as the body from which it was charged was positive or negative.

418
istake of
ilcke.

It was supposed by Wilcke, that when a jar is charged by connecting one side of it with the prime conductor, and the other with the rubber, it is neutral on both sides. But if this were the case, it could not be discharged; and in fact, it will be found by experiment to be equally active on both sides.

419
ethod of
ifying
theory.

It is scarcely necessary to remark, that the theory of the Leyden phial, and that of a coated plate, are the same; and hence we have an easy method of comparing the theory with experiment, by taking two plates of the same kind of glass, and of an equal thickness, but different in the extent of coated surface. If we charge both plates, by means of very long conducting wires attached to both sides, we are to measure how often the charge of the lesser plate is contained in the greater, which is easily done by the following method of Mr Cavendish.

420
endish's
hod of
suring
arge.

When a jar is charged, observe the electrometer that is connected with it, and immediately communicate the charge to another equal jar, the perfect equality of which has been previously ascertained by the methods which will presently appear. Again, note the electrometer. This will give the elevation, that indicates one half, independent of all theory. Now electrify a jar, or a series of equal jars, to the same degree as the first, and communicate the charge to a coated plate of mirror glass, discharging the plate after each communication, till the electrometer reaches the degree that indicates one half. This shows how often the charge of the plate is contained in that of the jar or row of jars.

Let the charge of the plate be to that of the jars as x to 1. Then by each communication, the electricity is diminished in the proportion of $\overline{1+x}$ to 1. If m communications have been made, it will be reduced in the proportion of $\overline{1+x}^{m}$ to 1. Therefore $\overline{1+x}^{m}=2$, and $\overline{1+x}=\sqrt[m]{2}$, and $x=\sqrt[m]{2-1}$.

When x is small in proportion to 1, we shall come very near the truth, by multiplying the number of communications by 1,444, subtracting 0,5 from the product. The remainder shows how often the charge of the plate is contained in that of the jars or $\frac{1}{x}$.

421 The important discovery of Franklin, that the charge of coated glass resided in the glass and not in the coating, led Beccaria to a no less important discovery; namely, that in a charged plate of glass, and probably of any other electric, there are several strata, inconceivably thin, that are alternately in a positive and negative state, and that the number of these strata increases as the electrification is continued.

This disposition of the surfaces of electric plates explains many phenomena; particularly the experiments with charged plates described in N° 151. and some curious appearances observed by Beccaria, and ranked by him under the head of *vindicating electricity.*

They are thus described by Mr Cavallo.

422
Beccaria's
vindicating
electricity.
Fig. 119.

1. AB, *a b*, fig. 119. represents a plate of glass, coated on both sides with the two metallic coatings, CD, *c a*, which are not stuck to the plate, but only laid upon it.

Fig 120.

From the upper coating CD, three silk threads proceed, which are united at their top H, by which the said coating may be removed from the plate in an insulated manner, and may be presented to an electrified electrometer as represented in fig. 120. in order to examine its electricity. FG is a glass stand, which insulates and supports the plate, &c.

2. Let the plate AB, *a b*, be charged in the common manner, by means of an electrical machine, so that its surface AB may acquire one kind of electricity, (which may be called K) and the opposite surface *a b* may acquire the contrary electricity, (which we shall call L). Then, if the coating CD be removed from the plate, and be presented to an electrified electrometer, as represented in fig. 120, it will be found possessed of the electricity K, viz. of the same kind with that which was communicated to the surface AB of the glass plate; from whence it is deduced, that the surface AB has imparted some of its electricity to the coating. Now, this disposition of the charged plate to give part of its electricity to the coating, is what the learned F. Beccaria nominates the *negative vindicating electricity.*

3. If the coating be again and again alternately laid upon the plate and removed, its electricity K will be found to decrease gradually, till after a number of times (which is greater or less, according as the edges of the plate insulate more or less exactly), the coating will not appear at all electrified. This state is called the *limit* of the two contrary electricities; for if now the above-mentioned operation of coating and uncoating the plate be continued, the coating will be found possessed of the contrary electricity, viz. the electricity L. This electricity, L, of the coating is weak on its first appearance; but it gradually grows stronger and stronger till a certain degree; then insensibly decreases, and continues decreasing until the glass plate has entirely lost every sign of electricity.

By this change of electricity in the coating, it is deduced, that the surface AB of the glass plate changes its property; and whereas at first it was disposed to part with its electricity, now, (viz. beyond the limit of the two contrary electricities) it seems to vindicate its own property, that is, to take from the coating some electricity of the same kind with that of which it was charged: hence this disposition was by F. Beccaria called the *positive vindicating electricity.*

4. This positive vindicating eleetricity never changes, though the coating be touched every time it is removed. It appears stronger, and lasts a very considerable

able time after the plate has been discharged; which is a very surprising property of glass, and probably of all good and solid electrics.

5. If, soon after the discharge of the plate, the coating be alternately taken from the plate, and replaced, but with the following law, viz. that when the coating is upon the plate, both coatings be touched at the same time, and when the coating is cut off, this be either touched or not: then the surface AB of the plate, on being uncoated every time, takes a quantity of electricity, which it alternately loses every time it is coated.

6. On removing the coating in a dark room, a flash of light appears between it and the glass, which is still more conspicuous if the coating be removed by the fingers being applied immediately to it, viz. not in an insulated manner, because when the coating is not insulated, the glass plate can give to, or receive from it, more of the electric fluid, and that more freely, than otherwise.

7. It is observable, that in the negative vindicating electricity, the glass loses a greater or less portion of electricity in an inverse proportion of the charge given to the plate, viz. the part lost is greater when the charge has been the weaker; for in the positive vindicating electricity, the force of receiving electricity is the stronger, when the charge has been stronger, and contrarywise.

8. If, after every time that the coating CD is removed, the atmospheres E, *e*, that is, the air contiguous to the surface of the glass plate, be examined, they will be found electrified as in the following table, viz. the threads of an electrometer, brought within one or two inches, or more, of the surfaces AB, *a b*, will diverge with electricities contrary to those expressed in the table.

During the time of the negative vindicating Electricity.	the air E. if the plate has been charged	moderately	moderately L.
		high - - -	o
		very high -	moderately K.
	the air *e* is electrified L.		
During the time of the positive vindicating Electricity	the air E the air *c*	are electrified L.	

In the simpler theory of compensation, as above stated, the effect of the glass is to retain the electric excitement on its surface, and by acting as a resisting medium to prevent the transmission of the electric fluid from the one surface to the other, while it offers no resistance to the production of the phenomena arising from the simple attraction of the fluid for other matter. The fluid on the positive side is retained by the attraction of the matter of the negative side, while the glass prevents the efficiency of this attraction in the form of an explosion, or the establishment of an equilibrium.

423 Theory of the electrophorus.

The theory of coated glass naturally leads us to that of the electrophorus; for though this apparatus is not exactly similar to a charged plate, as has been supposed by some, there is yet a considerable resemblance in the phenomena.

We have given a description of the electrophorus, and of its effects, in Chap. X. of Part III. where we also stated, that, for illustrating the theory, it was proper to make the several parts of the apparatus of considerable thickness, as the more instructive but minute changes are thus greatly increased, though the showy and brilliant phenomena are not so remarkable. Fig. 121. represents a section of the three parts of the apparatus in contact, where ABCD is the electric *cake*, CDEF the *sole*, and ABHG the *cover*. They are here represented lying horizontally on each other; but for experiment, it will be most convenient to have them fixed vertically to glass supporters, furnished with leaden feet to keep them steady.

Fig. 121.

We might here give a mathematical explanation of the phenomena of the electrophorus; and the actions of every part of the apparatus might easily be stated by means of the propositions in N° 308 to 314, and the corresponding ones in N° 228—335, taking into consideration the true law of action. But as this would be going over again much of the ground that we have already trodden, where our readers might not be pleased with being obliged to follow us, we shall treat the subject in a manner somewhat more popular, the result, however, of strict mathematical reasoning.

424 Disposition of fluid in the electrophorus.

Having related the general phenomena in N° 207, we have now to consider only the disposition of fluid in the various parts of the apparatus in various situations, and the mutual forces that operate between them.

We shall consider the instrument under various states.

425 1. Its primitive state.

1. When the cake is left to cool after being made, it becomes negative by cooling; and if it were by itself, the surface on both sides would be negative to a considerable thickness near the edges; and the fluid would probably grow denser by degrees towards the middle, where it would have its natural density. This disposition may be inferred from N° 371, 372. But as it cools in conjunction with the sole, the attraction of the redundant matter in the cake for the moveable fluid in the sole, must disturb its uniform diffusion in the sole, and cause it to approach the cake. And as this probably happens while the cake is still in a conducting state, the disposition of its fluid will be different from what is described above, and the final disposition of the fluid in the cake and sole will resemble that given in N° 371. where the plates may represent the cake and sole. It will be sufficient at present to consider the cake and sole as divided into only two strata; one containing redundant fluid, and the other deficient, neglecting the neutral stratum interposed between them in each. The cake then consists of a stratum AB*ba*A, containing redundant matter, and a stratum *ab* CD containing redundant fluid; and the sole of a stratum DC *n m* containing redundant fluid; that is, all that belongs naturally to the space DC FE, and of a stratum *m n* FE, containing redundant matter. We may call this the *primitive state* of the cake and sole; and if this is once changed by communication with unelectrified bodies, it can never be recovered without new excitation.

426 2. Common state.

2. If the sole is touched by a body that communicates with the ground, fluid will enter it, till the repulsion of the redundant *fluid* in the sole for a superficial particle is equal to the attraction of the redundant *matter* in the cake for the same particle. What we have said concerning infinitely extended plates rendered neutral on one side, may suffice to give a notion of the present

present disposition of the fluid in the sole. The inferior surface will be neutral; and the density of the fluid will increase towards the surface DC. The sole contains more than its natural quantity of fluid, but is neutral by the balance of opposite forces. Let it now be insulated. This may be called the *common state* of the electrophorus.

427 3. Place the cover GHBA on the cake. A particle Z, at the upper surface of the cover, must be more attracted by the redundant matter in the stratum AB *b a* than it will be repelled by the redundant fluid in the remoter strata; for the fluid in the cake is less than when it is in its natural state, and therefore Z is attracted by the cake. The redundant fluid which has entered the remote side of the sole is less than what would be sufficient to saturate the redundant matter of the cake, because it only balances the excess of the remote action of this matter above the nearer action of the compressed fluid in the sole, and this smaller quantity of redundant fluid acts on Z at a greater distance than that of the redundant matter in the cake. Therefore the particle Z, lying immediately within the surface GH, is on the whole attracted; some fluid will move towards the cake, and its natural state of uniform diffusion in the cover will be changed into a violent state, in which the fluid will be compressed on the surface AB, and abstracted from the surface GH. There will now be a stratum G *gp* H, containing redundant matter, and another *gp* B A containing redundant fluid. But this disposition will disturb the arrangement that had taken place in the sole, and had rendered it neutral on the inferior surface. The particle Z situated in that surface, will be more repelled by the compressed fluid in the stratum *gp* CA than it will be attracted by the equivalent more remote redundant matter in GH *pg*. Fluid is now therefore disposed to quit the surface EF, and the sole will appear positively electric, but in a small degree only, if the cover be thin. All this may be observed by attaching a small ball electrometer to the lower surface of the sole, or touching the sole with it, and then trying its electricity by excited glass, or sealing-wax.

428 4. A particle of fluid Z, placed immediately without the surface GH, is more attracted by the deficient stratum GH *g q* and by AB *b a*, than it is repelled by the redundant strata beyond them, and hence the cover must be sensibly negative. This is the common state of the whole apparatus after setting on the cover. The lower surface of the sole is slightly positive, and the upper surface of the cover more sensibly negative. A smart spark will be seen between the apparatus and the finger, and fluid will enter till the attraction of the redundant matter in AB *b a* balances the repulsion of the redundant fluid in DCFE.

429 s neutral ate.

5. A spark may now be obtained from the sole; for it was faintly positive before, and there is now the additional action of the fluid that has entered into the cover. Part of the fluid in the sole is therefore disposed to fly to any body that is presented to it. But when this transference has taken place, the equilibrium at the surface GH is destroyed, and this surface again becomes negative, and will attract fluid, although the cover contains already more than its natural quantity. A small spark will therefore be seen between the cover and any conducting body presented to it. By touching it, the neutrality or equilibrium may be restored at GH; but it will be destroyed again at EF, from which a positive spark may be obtained, leaving GH negative in its turn. This would go on for ever in a series of communications continually diminishing, so as at last to become insensible, if the three parts of the electrophorus be thin. This shows the necessity of making them otherwise, if the instrument be intended for illustrating the theory.

The equilibrium is at length completed at the surfaces GH and EF, both of which are neutral with respect to surrounding bodies, although both the cover and sole contain more than their natural share of electric fluid. This state of the apparatus may be called its *neutral state*; and it may be produced at once, instead of doing it by these alternate touches of GH and EF. If we touch at once both these surfaces, we shall have a bright, pungent spark, and a small shock. If this be the object of the experiment, the state N° 428. which gives occasion to it may be called the *charged state* of the electrophorus.

430 Its charged state.

When the apparatus has been thus rendered neutral with respect to surrounding bodies, it may continue in this state for any length of time, without its capability of producing the other phenomena being diminished, provided that no fluid pass from the cover to the cake.

431 Its charging state.

6. Now, if the cover be removed to a distance, both parts of the apparatus will exhibit strong marks of electricity. For the cover contains much redundant fluid, and must therefore appear strongly positive; it will give a brisk spark, which may be employed for any purpose, particularly for charging a jar positively by the knob, if we just touch the cover with the knob. Again, the sole will attract fluid, or it will be negative, though it contains more than its natural quantity of fluid; it will therefore take a spark. The sole, therefore, in the absence of the cover, may be employed to charge a jar negatively by the knob. By being touched with the finger, or with the knob of a jar held in the hand, it will be reduced to the common state described in N° 426.; and now all the former experiment may be repeated. We may call this the *active* or the *charging state* of the electrophorus.

432 7. If the electrophorus be not insulated, a shock may however be obtained, by touching first the sole, and then the cover, without taking off the finger; but will not be so smart as when the negative cover is touched at the same time with the sole. The difference will, however, be scarcely perceptible when the pieces are thin.

433 8. If the apparatus has not been insulated, the cover when put on will afford a spark, in the manner already mentioned, and this will be rather stronger than when it is insulated; for the fluid being allowed to escape from the sole, does not obstruct the entry of fluid into the cover. If then, without removing the finger from the cover, we touch the sole, we feel nothing; but if we first touch the sole, and then, without removing the finger from it, touch the cover, we shall obtain a shock. By this series of alternate touches, the period of the electrophorus is completed. For it is first charged or rendered neutral, by touching the plates in contact; then, by touching both when separate, the whole is reduced to the common state. When after having been in

in the *neutral state* they are separated, they have opposite electricities, the *sole* having that of the cake. When brought together, each in the *common state*, they have opposite electricities, the *cover* having that of the cake.

434 Method of renewing its activity. 9. By being long exposed to the air without the cover, the electrophorus gradually loses its activity. This may however be again restored in several ways. One of the most obvious methods is, to produce a fresh excitation of the resinous cake; and this is best done by rubbing it with a piece of new flannel, of cat or hare's skin, or, what answers still better, a piece of mole skin. This friction renders the cake negative. It may also be electrified negatively, by placing it on a jar charged negatively in the inside, and then touching the knob of the jar with any conducting body that communicates with the ground. By this means it may be very strongly excited, if the jar be large, and if the cake be covered with a piece of tin-foil that comes closely in contact with its whole surface. But one of the most expeditious and effectual methods of restoring the energy of the cake, will be to electrify it by means of an electrical machine, while the surface of the cake is connected with the rubber.

The only important part of the theory of electricity which we have yet to consider, is that of the condenser, but as this will be greatly elucidated by an application of Coulomb's experiments on *insulators*, we shall delay it till we give an account of these in the article ELECTROMETER.

PART V.

ATMOSPHERICAL ELECTRICITY.

THE phenomena of electricity, that we have hitherto described, are sufficiently curious, and many of them extremely interesting; but they are trifling, when compared with those that are now to come under our consideration. In the present part of our article, we are to view the electric fluid as one of the principal agents, employed to produce some of the most remarkable and astonishing phenomena of nature. We are about to prove, by a series of the most satisfactory experiments, that thunder and lightning are merely the effects of a vast explosion of accumulated electricity in the atmosphere.

CHAP. I. *Of Thunder.*

SECT. I. *Of the Identity of Electricity and Lightning.*

435 Identity of electricity and lightning. IT is not surprising that the experiments in which the electric spark is made to produce the effects which we have recounted in the third part of this article, should have led philosophers to conceive a similarity between these effects, and those produced by lightning.

436 Conjectured by Wall and Grey. Dr Wall and Mr Grey seem to have fancied a resemblance between thunder and the snapping noise produced by applying the fingers to an excited electric: but how such a resemblance should strike them, is not easy to conceive; and indeed it seems to have been merely a bold conjecture.

437 By the abbé Nollet. The abbé Nollet appears to have formed the first rational idea of their similitude, and expresses himself on the subject in the following remarkable manner.

"If any one should take upon him to prove from a well connected comparison of phenomena, that thunder is in the hands of nature what electricity is in ours; that the wonders which we now exhibit at our pleasure, are little imitations of those great effects that frighten us, and that the whole depends upon the same mechanism: if it can be demonstrated that a cloud prepared by the action of the winds, by heat, by a mixture of exhalations, &c. is opposite to a terrestrial object; that this is the electrified body, and at a certain proximity to that which is not: I avow that this idea, if it was well supported, would give me a great deal of pleasure; and in support of it, how many specious reasons present themselves to a man who is well acquainted with electricity! The universality of the electric matter, the readiness of its action, its inflammability, and its activity in giving fire to other bodies, its property of striking externally and internally even to their smallest parts, the remarkable example we have of this effect in the Leyden experiment, the idea which we might truly adopt in supposing a greater degree of electric power, &c. all these points of analogy which I have been some time meditating, begin to make me believe, that by taking electricity for the model, one might form to one's self, in respect to thunder and lightning, more perfect and more probable ideas than have hitherto been offered."

438 Supposed by Dr Franklin. But the first electrician who formed a plan for ascertaining the truth of this hypothesis, was Dr Franklin, who truly realized the fable of Prometheus in bringing down fire from heaven.

Before we relate Dr Franklin's experiments, we shall state the points of resemblance which led him to think of making them.

He begins his account of the similarity of the electric fluid and lightning, by cautioning his readers not to be staggered at the great difference of effects in point of degree; since that was no argument of any disparity in their nature. It is no wonder, says he, if the effects of the one should be so much greater than those of the other. For if two gun-barrels electrified will strike at two inches distance, and make a loud report; at how great a distance will 10,000 acres of electrified cloud strike and give its fire, and how loud must be the crack!

439 Similar effects of lightning and electricity. 1. Flashes of lightning are generally seen crooked and waving in the air. The same is the electric spark always, when it is drawn from an irregular body at some distance. He might have added, when it is drawn by an irregular body, and through a space in which the best conductors are disposed in an irregular manner,

manner, which is always the case in the heterogeneous atmosphere of our globe.

2. Lightning strikes the highest and most pointed object in its way, preferably to others; as high hills and trees, towers, spires, masts of ships, point of spears, &c. In like manner, all pointed conductors receive or throw off the electric fluid more readily than those which are terminated by flat surfaces.

3. Lightning is observed to take the readiest and best conductor; so does electricity in the discharge of the Leyden phial.

4. Lightning sets fire to inflammable bodies; so does electricity.

5. Lightning, as well as electricity, fuses metals.

6. Lightning rends some bodies. The same does electricity; and both show various other expansive effects.

7. Lightning has often been known to strike people blind. And a pigeon, after a violent shock of electricity, by which the Doctor intended to have killed it, was observed to have been struck blind likewise.

8. Lightning destroys animal life. Animals have likewise been killed by the shock of electricity. Turkeys of 10 pounds weight were killed by an electrical shock in the experiments of Dr Franklin.

9. Magnets have been observed to lose their virtue, or to have their poles reversed, by lightning. The same effect has been produced by electricity.

440 Franklin's proposal for verifying these conjectures.

Reasoning on the similarity of these effects, which differ only in degree, he formed the bold attempt to draw down lightning from the clouds, and examine by experiment whether he could produce effects similar to those of nature. Having observed the effects of pointed conductors in attracting the electric fluid more easily than those of any other form, he conceived that pointed rods of iron, fixed in the air, when the atmosphere was loaded with lightning, might draw from it the matter of thunderbolts, without noise or danger, into the body of the earth. His account of this supposition is given by himself in the following words: "The electric fluid is attracted by points. We do not know whether this property be in lightning; but since they agree in all the particulars in which we can already compare them, it is not improbable that they agree likewise in this. Let the experiment be made."

441 His experiments to bring down lightning from the clouds.

In the year 1752, while waiting for the erection of a spire in the city of Philadelphia, not imagining that a pointed rod of a moderate height could answer the purpose; at last it occurred to him, that, by means of a common kite, he could have readier access to the higher regions of the atmosphere than any other way whatever. Preparing, therefore, a large silk handkerchief, and two cross sticks of a proper length on which to extend it, he took the opportunity of the first approaching thunder-storm to take a walk into a field where there was a shed proper for his purpose. But dreading the ridicule which too often attends unsuccessful attempts in science, he communicated his intention to nobody but his son, who assisted him in raising the kite. A considerable time elapsed before there was any appearance of success. One very promising cloud had passed over the kite without any effect; when, just as he was beginning to despair, he observed some loose threads of the hempen string to stand erect, and avoid one another, just as if they had been suspended by the conductor of a common electrical machine. On this he presented his knuckle to a key which was fastened to the string, and thus obtained a very evident electric spark. Others succeeded, even before the string was wet; but when the rain had begun to descend, he collected electric fire pretty copiously. With these sparks spirits were fired, phials charged, and the usual electrical experiments performed. We are told, that when he saw the fibres of the string erect themselves, he uttered a deep sigh, and wished that moment to be his last, feeling that by this discovery his name would be immortalized. He had afterwards an insulated iron rod to draw the lightning into his house; and performed almost every experiment with real lightning, that had before been done with the artificial representations of it by electrical machines. That he might lose no opportunity of making his experiments, he connected two bells with his insulated rod; and these by their ringing, gave him notice whenever his apparatus was electrified by the lightning.

Although we have recounted Dr Franklin's experiments first, he was not, however, the first who verified his own hypothesis. This was done in France, about a month before Dr Franklin's experiments with the kite.

442 The identity of lightning and electricity first discovered in France.

The most active persons were two French gentlemen, Messrs Dalibard and Delor. The former prepared his apparatus at Marly la ville, situated above five or six leagues from Paris; the latter at his own house, which was on some of the highest ground in that capital. Mr Dalibard's apparatus consisted of an iron rod, 40 feet long, the lower extremity of which was brought into a sentry box where the rain could not enter; while, on the outside, it was fastened to three wooden posts, by silken strings defended from the rain. This machine was the first that happened to be favoured with a visit from the ethereal fire. Mr Dalibard himself was not at home; but, in his absence, he had intrusted the care of his apparatus to one Coisier a joiner, who had served 14 years among the dragoons, and on whose courage and understanding he could depend. This artisan had all the necessary instructions given him; and was desired to call some of his neighbours, particularly the curate of the parish, whenever there should be any appearance of a thunder-storm. At length the long-expected event arrived. On Wednesday the 10th of May 1752, between two and three in the afternoon, Coisier heard a pretty loud clap of thunder. Immediately he ran to the machine, taking with him a phial furnished with a brass wire; and presenting the wire to the end of the rod, a small spark issued from it with a snap like that of a spark from an electrified conductor. Stronger sparks were afterwards drawn, in the presence of the curate and a number of other people. The curate's account of them was, that they were of a blue colour, an inch and a half in length, and smelled strongly of sulpher. In taking them, he received a stroke on his arm, a little below the elbow; but he could not tell whether it came from the brass wire inserted into the phial, or from the bar. He did not attend to it at the time; but the pain continuing, he uncovered his arm when he went home, in the presence

of

of Coisier. A mark was perceived round it, such as might have been made with a blow of the wire on his naked skin.

Eight days after, Mr Delor witnessed the same appearances at his own house, though only a cloud passed over, without either thunder or lightning. His apparatus differed little from that of Mr Dalibard, except that his rod was 99 feet high, and answered rather better than that of the other gentleman. As it was found that only a small quantity of electric fluid could be collected by a single pointed rod, these experimentalists added to this apparatus a number of insulated iron bars, communicating with the pointed iron conductor, constituting what they called a magazine of electricity.

443 Dr Franklin having proved the identity of lightning and electricity, was desirous of ascertaining whether the electricity produced from the clouds was positive or negative. The first time he succeeded in making an experiment for this purpose, was on the 12th of April 1753, when the lightning appeared to be negative. Having found that the clouds electrified negatively for eight successive thunder-gusts, he concluded that their electricity was always negative, and set about forming a theory to account for this. But he afterwards found he had concluded too soon. For on the sixth of June following, he met with one cloud which was electrified positively; upon which he corrected his former theory, but did not seem able perfectly to satisfy himself with any other. The Doctor sometimes found the clouds would change from positive to negative electricity several times in the course of one thunder-gust, and he once observed the air to be strongly electrified during a fall of snow, when there was no thunder at all.

The experiments of Dr Franklin and M. Dalibard, were soon known over all Europe, and the electricians of every country were eager to participate in the glory and satisfaction to be derived from such grand undertakings. M. M. Mazeas, Monnier, and de Romas in France, Canton and Wilson in England, and above all, Beccaria in Italy, made a number of interesting experiments on the electricity to be drawn from the clouds. De Romas constructed a kite seven feet high, which was raised to a height of 550 feet by a string containing a metallic wire, by which electric sparks, or rather balls, were darted to the earth, an inch in diameter and ten feet long, accompanied with other phenomena equally terrific. These different experimenters soon discovered that signs of electricity might be obtained, not only during thunder-storms, but almost at all times, and in every kind of weather. But before we relate these observations, we must conclude our present subject. We shall only here describe Dr Priestley's method of constructing a thunder-rod for making such observations.

444 Method of constructing thunder rods.

"On the top of any building, which will be the more convenient if it stand upon an eminence, erect a pole as tall as a man can well manage, having on the top of it a solid piece of glass or baked wood a foot in length. Let this be covered with a tin or copper vessel in the form of a funnel, to prevent its ever being wetted. Above this let there rise a long slender rod, terminating in a pointed wire, and having a small wire twisted round its whole length, to conduct the electricity the better to the funnel. From the funnel make a wire descend along the building, about a foot distance from it, and be conducted through an open sash, into any room which shall be most convenient for making the experiments. In this room let a proper conductor be insulated, and connected with the wire coming in at the window. This wire and conductor, being completely insulated, will be electrified whenever there is a considerable quantity of electricity in the air: and notice will be given when it is properly charged, either by Mr Canton's balls hung to it, or by a set of bells *."

SECT. II. *Of the Phenomena and Effects of Lightning.*

445 Progress of a thunder-storm.

A thunder-storm commonly commences in the following manner. At first a low dense cloud begins to form in a part of the atmosphere which was previously clear; this cloud increases fast, but only from its upper part, and spreads into an arched form, appearing like a large heap of cotton wool. Its lower surface is generally level, as if it rested on a smooth plane. The wind is all this time very gentle, and frequently it is imperceptible.

Numberless small ragged clouds, like teazled flakes of cotton, soon begin to make their appearance, moving about in various directions, and perpetually changing their irregular surface, appearing to increase by gradual accumulation. As they move about, they approach each other, and appear to stretch out their ragged arms towards each other; they do not often come in contact, but after approaching very near each other, they evidently recede, either in whole, or by bending away their ragged arms.

While this irregular motion continues, the whole mass of small clouds gradually approaches towards the large cloud which first appeared, and with which they nally coalesce; frequently, however, uniting with each other into larger masses, before the general coalescence takes place. The upper cloud often increases by accession of fresh vapour, without any assistance from the smaller masses. When this happens, its lower surface, which was before level and regular, becomes ragged, and stretches out its irregular tatters towards each other, and towards the earth. The clouds now thicken fast, moving about swiftly in all directions, and flashes of lightning are seen to dart from one cloud to another; the wind now rises or increases, generally blowing in squalls. The lightning becomes more frequent, striking between the clouds and the earth, often in two places at once; flashes of various shapes and various brilliancy are produced, and frequently a vast expanse of horizon appears in one blaze of light. The thunder is now heard to roar at a distance, gradually approaching nearer, and soon succeeded by heavy rain *.

The circumstances to be noticed as attending a thunder-storm, chiefly respect the form and colour of the lightning, the sound of the thunder, and the devastations produced when an explosion takes place between a cloud and some imperfectly conducting body on the surface of the earth.

446 Form of the flash.

The form of the flash is various, but in ordinary lightning it is generally angular, or *zig-zag;* this zigzag is sometimes larger than at others, and in some instances the flash is divided into several distinct currents.

---

* Priestley's Hist. part v. sect. 1.

* *Beccaria Lett. del Elettricismo.*

These diversities might be expected from the heterogeneous nature, and various conducting power, of the several substances which float in our atmosphere. As these substances are placed in no certain order, the electric spark, in passing through the air, and striking successively from one of these bodies to another, as so many stepping stones irregularly placed, can seldom observe the same track, and hence its zig-zag appearance.

Sometimes the flash appears as one dense ball of fire, especially when it strikes from a cloud to any part of a building, when it is generally described as a globe of fire falling on the building.

447 Colours of the flash.

The colours of the flash are also various; pale straw colour, vivid yellow, and various shades of blue, are the most prevailing tints. These various colours probably depend on the different density of the air through which the light has passed, or perhaps, on its different nature. In the experiments of Mr Morgan, already related, on the appearance of the electric light in rarefied air, its colour varied with the degree of rarity produced in the exhausted receiver; and from the experiments on passing the electric spark through various gases, we found that the colour of the light varied considerably with the nature of the gas through which it passed.

448 Clap of
nunder al-
vays pre-
eded by a
ash of
ghtning.

Lightning very often appears without being succeeded by thunder, but there is scarcely an instance where the latter is not preceded by the former. We have indeed on record in the 77th volume of the Philosophical Transactions, an account of a thunder-storm that happened on the banks of the Tweed in 1785, in which an explosion took place that killed a man and two horses, though not preceded by any flash. The respectable recorder of this account, Mr Brydone, was not himself a witness of this accident, but could not learn from the persons whom he interrogated, (two Scotch peasants), who had seen the accident, that there was any preceding flash of lightning. In such singular circumstances, and such doubtful authority, we should suspend our belief, and, until some similar instance better authenticated shall occur, take it for granted, that a clap of thunder is always preceded by a flash of lightning.

449 und of
e explo-
n.

The sound which attends the explosion of the lightning, varies according to the distance from which it is heard, and the nature of the country where the storm takes place. At a little distance, it is generally a hoarse grumbling noise, which appears to extend through a considerable part of the atmosphere, and gradually dies away. If it be heard very near, the crash is instantaneous, and exactly similar to the explosion of a cannon, when we are very near it at the time of its being fired.

When the explosion begins very near, the snap begins with great smartness, and for some time resembles the violent tearing of a piece of strong silk; but it becomes more mellow as it proceeds to a greater distance.

If the country where the storm happens be high and irregular, where there are numerous objects capable of reverberating the sound, the explosion consists of a long and broken succession of claps, the loudness of which varies more according to the nature and circumstances of the reverberating objects, than according to the length of time which intervenes between the claps. In a level and low country, where there is no diversity of reverberating objects, and particularly at sea, the series of explosions is regular, and their loudness decreases as the length of time increases.

The explosion of thunder differs from the snap produced by the electric spark, or even the explosion of a jar or a battery, not only in its degree of loudness, but in its nature; it is a long-continued, rumbling, unequable noise. The long-continued roar of thunder, is certainly owing to the commencement and termination of the explosion reaching our ears at different periods of time; and the unequally loud rumbling noise is owing to the different parts of the explosion striking the ear in a different manner.

450 Method of measuring the distance of the explosion.

It will not be improper here to mention the method by which the distance of a thunder-stroke may be ascertained. By observing the flash, and counting, by means of a watch with a *second hand*, the number of seconds which elapse between the appearance of the flash and the commencement of the roar, this may be easily effected; for we know that sound travels at the rate of 186,768 feet in a minute: by reducing the time observed between the flash and the report, into seconds, and allowing for each its proper number of feet, we obtain, with sufficient accuracy, the distance of the stroke from the place of observation.

451 Manner in which the explosion takes place.

To understand the manner in which the explosion of thunder is produced, we must observe, that the air of the atmosphere is often arranged in strata, and these strata are bounded by clouds. That the clouds are stratified, is very evident. From various causes, to be explained hereafter, these strata, or the opposite surfaces of a particular stratum, are possessed of opposite states of electricity, or the stratum becomes charged as the plate of air between the two coated boards, described in N° 235. Numberless experiments have proved, that during a thunder-storm, there is a contemporaneous accumulation and deficiency of the electric fluid, or that there are two parts in the atmosphere, that are in the opposite states of positive and negative electricity. Hence we may easily conceive the nature of the explosion; for when the accumulation and deficiency on the opposite surfaces of the stratum of air have attained a certain height, a discharge must take place, similar to the spontaneous discharge of a Leyden phial.

452 Generally confined to the heavens.

The explosion commonly takes place in the heavens, and is merely the restoration of the equilibrium between opposite clouds. These are accompanied with no danger; but, in some instances, the explosion happens between the clouds and the earth. In this latter case, it is believed by some electricians, that the earth is in the negative state; but Mr G. Morgan is of opinion, that the deficiency is never in the earth, but in some other cloud to which an easier passage is found through so good a conductor as the wet earth, than through the air, which is an imperfect conductor. Mr Morgan brings a great many arguments in support of his opinion, but for these we must refer to his lectures. It is of little consequence to our present purpose, whether the deficiency is in the earth or in some adjacent cloud; it is sufficient to know, that lightning sometimes strikes from the cloud to the earth, or from the earth to the clouds. When this happens, and when the accumulated fluid comes in contact with any body that is an imperfect

imperfect conductor, such as trees, buildings, &c. it produces those devastations which are sometimes the attendants of severe thunder-storms; these, therefore, we are now to consider.

453
Effects produced by lightning on a building.

Lightning, when it strikes a building, for the most part attacks the highest part of it, as the chimneys, or spires, especially if these are surmounted by any metallic work, which is always the case with spires of churches, and not unfrequently on chimney-tops, where iron machines have been placed to prevent smoking. In most of the cases which have been recorded of houses being damaged by lightning, it has entered by the chimney, down which it seems to be conducted by the smoke and soot. Having entered the house, it commonly proceeds to the best and nearest conductors in its passage, particularly bell-wires, gilt cornices, frames of pictures, and other gilded furniture; these it commonly destroys, fusing, and very often oxidating, the metal as it passes along. Some very remarkable instances are related of the power of lightning in fusing metals; we have heard of the fusion of bells, of large chains, and of iron conducting rods near an inch in diameter; but the authority on which these facts are related does not seem worthy of our implicit confidence. There are instances, however, sufficiently credible, where the pointed end of a conductor has been rounded, parts of leaden spouts melted, and the edge and point of a knife completely fused. But in general the bell wires of a house suffer the most: these are always shortened, and very commonly melted in some parts; while in others, they are entirely dissipated in oxide, marks of which are very commonly visible on the walls.

454
Fusion of metals by lightning not a cold fusion.

It has been disputed, whether the fusion of metals by lightning be such a chemical fusion as is occasioned by fire, or what is called a *cold fusion*. Dr Franklin was of the latter opinion; the principal arguments for which are, that money has been melted in a person's pocket, and a sword within its scabbard, without the pocket or the scabbard being destroyed. It is not easy to conceive what is meant by a *cold fusion*, as we have no idea of a metallic body being fused at all, i. e. reduced into those globular forms which metals that have been subjected to the action of lightning and electricity usually assume, but by the power of a degree of heat, which would, when applied to bodies sufficiently inflammable, set them on fire.

455
Lightning sets fire to inflammable bodies.

That the explosion of lightning frequently does this, is sufficiently certain. In the ordinary cases, indeed, of a building's being struck by lightning, inflammation does not ensue, because the parts of the building through which the fluid passes, either have in their nature very little inflammability, or are so hard and dense in their texture, that they are not easily inflamed. But when the building attacked contains matter of a very combustible nature, such as hay, straw, and more especially gun-powder, a fire is very commonly the consequence; and accordingly, we every now and then hear of instances of stables being burned, and powder magazines blown up by lightning.

456
Tears such bodies as resist its passage.

When the lightning in its course meets with any obstruction, as in passing through a body which is an imperfect conductor, it overcomes this obstruction by forcing a passage through the resisting body: hence we very commonly find large beams shattered, and stones and bricks either driven from their places, or split and perforated in an unequal manner. Frequently, the lightning will forsake one conducting body, as the handle of a bell-wire, and strike through the wall of the room, attracted by some conductor, either of greater power or larger dimensions, such as a kitchen grate, on the other side. This effect of lightning is exactly similar to the perforation and rending of bodies by electricity, as we related when treating of the mechanical effects of that power; it is undoubtedly owing to the sudden expansion of the air or moisture contained within the pores of the resisting body.

457
Destroys animal life.

We have seen that animals are destroyed by lightning; but the effects of this power on the animal body come to be explained with more propriety in a future part this work, where we shall treat of the effects of electricity on vegetable and animal life.

458
Death of Professor Richman by lightning.

We shall here only relate the unfortunate death of the celebrated Professor Richman of St Petersburgh. This happened on the 6th of August 1753, as he was making experiments on lightning drawn into his own room. He had provided himself with an instrument for measuring the quantity of electricity communicated to his apparatus; and as he stood with his head inclined to it, Mr Solokow an engraver, who was near him, observed a globe of blue fire, as big as his fist, jump from the instrument, which was about a foot distant, to Mr Richman's head. The professor was instantly dead, and Mr Solokow was also much hurt. The latter, however, could give no particular account of the way in which he was affected; for, at the time the professor was struck, there arose a sort of steam or vapour, which entirely benumbed him, and made him sink down to the ground, so that he could not even remember to have heard the clap of thunder, which was a very loud one. The globe of fire was attended with an explosion like that of a pistol; the instrument for measuring the electricity (called by the professor an *electrical gnomon*) was broken to pieces, and the fragments thrown about the room. Upon examining the effects of the lightning in the professor's chamber, they found the door-case half split through, and the door torn off and thrown into the room. They opened a vein in the body twice, but no blood flowed; after which, they endeavoured to recover life by violent friction; but in vain: upon turning the corpse with the face downwards during the rubbing, an inconsiderable quantity of blood ran out of the mouth. There appeared a red spot on the forehead, from which spirted some drops of blood through the pores without wounding the skin. The shoe belonging to the left foot was burst open, and uncovering the foot at that part, they found a blue mark; from whence it was concluded, that the electric matter having entered at the head, made its way out again at the foot. Upon the body, particularly on the left side, were several red or blue spots, resembling leather shrunk by being burnt. Many more also became visible over the whole body, and particularly over the back. That upon the forehead changed to a brownish red, but the hair of the head was not singed. In the place where the shoe was unripped, the stocking was entire: as was the coat everywhere, the waistcoat only being singed on the fore flap where it joined the part behind: but there appeared on the back of Mr Solokow's lokow's coat long narrow *streaks*, as if red-hot wires had burned off the nap, and which could not well be accounted for.

When the professor's body was opened next day, the cranium was very entire, having neither fissure nor contra-fissure: the brain was sound; but the transparent pellicles of the windpipe were excessively tender, and easily rent. There was some extravasated blood in it, as also in the cavities below the lungs. Those of the breast were quite sound; but those towards the back, of a brownish black colour, and filled with more of the blood above mentioned. The throat, the glands, and the small intestines, were all inflamed. The singed leather-coloured spots penetrated the skin only. In 48 hours the body was so much corrupted, that they could scarcely get it into a coffin.

459 istance at hich the xplosion ust be angerous.

From the dangers to which persons and buildings are exposed from lightning, it becomes an object of importance to ascertain the distance at which they may be considered as secure from its influence. The following observations of Mr G. Morgan on this subject are replete with ingenuity and good sense.

460 organ's servations.

"The greatest danger of a thunder-storm lies between the two nearest extremities of the correspondent parts of the charged atmosphere, or in that interval of unelectrified air which is always found to separate the positive from the negative portion of the loaded cloud: but on either side of this interval, the further you get into the positive or the negative, the more does the power of injuring diminish.

"The idea which I now wish to impress, will be illustrated by the following circumstances of fact.

"Take a Leyden phial, five inches in diameter, and thirteen or fourteen inches in height. On the inside, let the coating rise till its upper edge be two inches and a half from the rim of the vessel. On the outside, let the coating rise no higher than one inch from the bottom. When the phial is thus coated, let it be charged, and a spark will pass from the tin-foil on the outside to that on the inside; but its form will resemble that of a tree, whose trunk will increase in magnitude and brilliancy, and consequently in power, as it approaches the edge, owing to ramifications which it collects from all parts of the glass. Within two inches of the edge it becomes one body or stream, and along that interval its greatest force acts.

"When two clouds, or the two correspondent parts of a cloud, have their equilibrium restored by a discharge, the appearances are exactly similar to those of the preceding experiment. Each extremity of the flash is formed by a multitude of little streams, which gather into one body, whose power is undivided in that interval only which separates the positive from the negative.

"In this country these appearances are frequently seen; but they are most commonly hidden by intervening clouds. While I was passing over Mount Jura, one night during a thunder storm, the flashes succeeded each other so rapidly, that about thirty struck within each minute, but owing to the height of my situation at that time, not one of them appeared otherwise than partially or generally, according to the description I have just given. Sometimes a lower cloud would hide one of the two charged parts, and in this case the lightning assumed the form of a tree, whose trunk and branches only appeared. Sometimes the trunk was hidden, and then the ramifications on each side were alone visible. Frequently intervening clouds would hide all but the trunk, and the lightning then appeared as it commonly does to a spectator in a low situation.

"It must be obvious from the preceding statement of circumstances, that the greatest devastation of lightning must take place in that interval through which the whole body of the fluid passes, and that as you penetrate further and further into the cloud, the stream that is formed becomes less and less, like a river which diminishes by entwisting itself as you approach its fountain. Hence to us placed on the ground, no danger can ever occur, till the clouds are so low, that the striking distance through air, or the aerial interval between the charged parts, resists the passage more powerfully than the body of earth, and any additional portion of atmosphere which may lie in the direction of the earth from the striking interval.

"If the charged cloud lies in contact with the ground, its passage to the earth will be that of several streams, and the danger will be great, in proportion to the magnitude of that separate stream which passes through any given part of the earth; and several distinct situations may be thus unequally endangered at the same time. Hence it happens that the same stroke will frequently injure several distinct buildings, which are very near to each other, and that different degrees of injury are always observed in the different tracks.

"The striking distance, or the length of the interval of greatest danger, will vary with the height of the charge, and not with the dimensions of the charged body. This is clear from a multitude of facts already illustrated and applied. We may hence safely conclude that the longer any charged cloud is in the vicinity of the wet ground, the more will the length, and consequently the danger, of its striking distance be diminished, provided the points and prominences, which are active on the ground, discharge the fluid more abundantly that it is accumulated by the producing cause.

"From what I have already said, it is clear that all the parts of the circuit, through which a thunder cloud may discharge its contents, are not equally dangerous, and that the maximum of danger is confined within much narrower limits than those of the interval within which it may be felt in one inferior degree or another. You must however perceive, that as the cloud enlarges, the number of additions increases, by which the great body of the flash is formed, and that the length of the most dangerous interval will always increase with, and bear a certain proportion to, the diameter of the cloud. In our attempts to estimate this diameter, we may follow two methods, which have been recommended; but I cannot say that either of these methods has any great pretensions to accuracy.

"1st, If you measure the space on which the thunder-shower falls, it is said that you measure what is commensurable with the dimensions of the thunder-cloud. In a mountainous country this measurement is very possible; for the body of the shower may be seen at a small distance, well described upon the elevated grounds whose parts it separates from the eye. Its diameter, therefore, may be correctly estimated from the distance

stance of those well-known objects by which it is bounded. Those thunder-showers, which I have observed, have varied in their diameter, from five hundred yards to two miles. It is, however, to be observed, that the partial vacuum, produced by the collapse attending the removal of the electric fluid, may extend its influence to a greater distance, and cause the fall of rain, by rarefying the atmosphere, far beyond the bounds of the charged cloud.

"2dly, The velocity of a cloud may be known by measuring its height, and the time which any fixed appearance in it takes to describe a certain angle. This may be done in a very small portion of time, and when it is done, you are next to watch the moment at which it begins to affect your elevated conductor, and with equal accuracy you are to mark the evanescence of its signs. The knowledge of these circumstances, united with that of the cloud's velocity, will correctly determine its dimensions.

"From a diary in my possession, made by Mr Brook, it does not appear that the same electricity ever lasted more than fifteen minutes. When the symptoms of approaching thunder were decisive, the opposite electricity generally lasted as long, and the interval of time between the two electrics seldom exceeded one-tenth of the whole.

"If we allow, that the cloud in this case moved at the rate of eight or ten miles in an hour, its diameter must have been four miles. However, in many instances, all the above-mentioned changes of electricity took place in two minutes. This happened several times successively, and each series of changes terminated by a flash of lightning. In all instances of this kind, to make the diameter of the cloud half a mile, we must suppose that it moves at the rate of thirty miles an hour; and in such a case, one-tenth of the whole, or the interval of greatest danger, would not exceed a hundred and eighty yards. But on the supposition that the size of the cloud were such as to strike over the distance of two miles, many are the circumstances which, on its descent towards the ground, will encroach upon its offensive powers, change its direction, or decrease and perhaps altogether annihilate its violence.

"1. Innumerable points and prominences rise from the whole surface of the earth over which it hangs. These act as so many channels, through which its contents will find a rapid evacuation. In the power of carrying off the fluid gradually, I have been able to discover but little difference between partial and metallic conductors. It should be added, that the torrent through an elevated wire is such, when the cloud approaches it, as would discharge a battery, whose surface equalled four or five acres, in twenty or thirty seconds. When, therefore, millions of other conductors are acting with equal effect at the same moment, that must be an immense cloud indeed, whose striking distance in such circumstances is not much lessened, or whose striking powers are not altogether exhausted.

"2. Metals alone conduct the fluid better than charged surfaces. If a plate of glass, coated on one side with tin-foil, be charged and placed in a circuit, so that the contents of a jar may pass over the other side uncoated, the luminous striking distance will be quadruple what it is in air. Such a combination of changes as that which I have now described must frequently occur in the upper regions of the atmosphere; for the charged clouds must lie in strata above each other; and in the varieties of their motions, produced by their mutual attractions, and by the innumerable causes which affect their different currents, they must be perpetually serving as discharging-rods to one another. We consequently find that nine hundred and ninety-nine flashes out of a thousand, strike from cloud to cloud through the intervening air †."

461
Danger from distant thunder.

Severe shocks have been sometimes experienced from a flash of lightning, when the person or building struck has been at a very considerable distance from the cloud in which the discharge appeared to take place. A person at Vienna received a terrible shock from a thunder-rod, on which his hand rested during an explosion that happened at the distance of three miles from the place where the conductor was erected; and it is supposed that a shock might be felt, or even a person killed, at a distance, "prodigiously greater." It is certain that during a thunder-storm, the insulated conductor is affected at every explosion, however great, so as to emit sparks.

It is supposed by most electricians that no *direct* stroke is adequate to the production of these effects, and they have therefore had recourse to what Lord Stanhope calls the *returning stroke*. The following is an abridgement of this theory.

462
Lord Stanhope's theory of the returning stroke.
Fig. 122.

Let DC, fig. 122. represent a conductor charged positively; and AB a conductor in its natural state, placed so that one of its extremities, A, may just enter the atmosphere of DC. In this case Lord Stanhope says, that the superabundance of DC will cause some of the natural share of AB to pass from A to B, where it is stopped and accumulated. By this change A is left in a different or negative state, and B by the addition it has received becomes positive. But when the superabundance at B is taken off, the positive fluid at B rushes back to its natural place at A, and this restoration is called the *returning stroke*.

Again, let us suppose DC to be *negative*; and A placed as before just within its atmosphere. Now part of the fluid in AB will rush from B to A, and there being stopped will produce an accumulation; but when BC is discharged, this accumulation will disappear, and the returning stroke will be from A to B *.

To apply this to the present case. Let us suppose two clouds horizontally distant, A and B (in the annexed diagram), the one A electrified positively and the other B negatively, to be incumbent over the surface of the earth at *a* and *b*; they will here tend to produce the opposite states, or the part of the surface *a* will be *negative* and *b positive*. If now a discharge take place between the clouds A and B, the fluid will rush back from *b* to *a*; and if conductors are fixed at these places, the fluid will rush down the conductors at *b*, and up that at *a*. The same effects, though in a less degree, will be produced, if we suppose the negative cloud B placed *above* the positive cloud A. By this theory, Lord Stanhope undertook to explain how the man and two horses were killed in the thunder-storm described by Mr Brydone, and his Lordship presented a very able paper on this subject to the Royal Society †.

$$\begin{array}{cc} A+ & -B \\ \hline a- & +b \end{array}$$

This theory of Lord Stanhope has been well received,

---

† Morgan's Lectures.

* Mahon's Principles of Electricity, p. vii.

† Phil. Trans. vol. lxxvii.

ed, and it is no small testimony in its favour that it has obtained the support of so able a philosopher as Professor Robison. Mr G. Morgan, however, strenuously objects to this theory, on the very serious grounds that its *principle* is *erroneous*, its *effects overrated*, and its *application unnecessary* [*]. Our limits will not permit us to detail all Mr Morgan's objections, but we must confess they do not convince us of the *fallacy* of the theory, although they certainly tend to invalidate the *effects* attributed to the returning stroke.

463 Effects of the returning stroke overrated.

"Let us allow (says Mr Morgan), that the force required by the theory is rendered active in the manner which I have just described, what reason have we for believing that it would be active to the *degree supposed*? Lord Stanhope has estimated, that what is separated from our natural share *without injuring us*, and what may be *absent for hours without being felt*, is so great in quantity as to destroy us by its motion in returning. But what are the grounds of this estimate? As yet it has been justified by no appeal, either to fact or experiment; and the person who could say, that the greatest possible loss from our natural share is little or nothing, would certainly stand upon equal, I think rather better, grounds, than those who would make it adequate to the fusion of metals and the destruction of life. I would add, that when the power of the returning stroke is magnified as it is in this theory, the *rationale* of this bold estimate is not only neglected, but it is neglected where it might have been made without much trouble.

"If the returning stroke of a thunder-cloud will destroy large edifices, surely artificial electricity could produce a similar stroke which would destroy a bird or a mouse, or act on some scale analogous to that which it is said to resemble. If I say, the returning stroke in nature will melt the irons of a waggon wheel, surely, with the grand machines which we are now able to construct, such a returning stroke might be caused as would melt a capillary thread of metal. But nothing of this kind has ever been done or attempted by those who support the theory, and I am bold enough to prophesy, from the details of my own experience, that nothing of the kind ever will be done [†]."

SECT. III. *Of the means of preventing Accidents from Lightning.*

464 Invention of conductors against ightning by Dr Franklin.

No man ever exemplified better than Dr Franklin, the maxim, that knowledge is valuable chiefly in proportion as it is useful. No sooner was the real nature of lightning ascertained by experiment, than it was naturally suggested that this grand discovery might be rendered beneficial to mankind, by affording means of security from the dangers accompanying a thunderstorm, particularly to buildings and ships. Here too, the genius of Franklin led the way; and as he certainly deserves the greatest share of the merit due to the discovery of the identity of lightning and electricity, we are also chiefly indebted to him for the means of applying this knowledge to advantage. He was led to propose the use of pointed metallic conductors attached to the building, as a security against the effects of lightning; and this proposal, like most of Dr Franklin's ingenious contrivances in electricity, was the result at once of acute reasoning and accurate observation.

465 His directions for their construction.

Dr Franklin considered the earth as performing the office of a conductor, in restoring to the atmosphere the electrical equilibrium, that had been disturbed by the causes which tend to produce atmospherical electricity. In its course, he observes, that the lightning will commonly strike the best conductors; and accordingly, as a metallic rod is a much more perfect conductor than the stones, bricks, &c. of which buildings are chiefly composed, the lightning will strike the rod in preference to the materials of the building. He therefore advised, that a metallic rod should be fixed to some part of the building, continued to the ground, and even penetrating for some distance into the moist earth; and, as lightning does not in every case strike the highest parts of a building, that the rod should extend for some feet above these, in order, as it were, to solicit the lightning. As lightning has been found to destroy metallic rods of a considerable diameter, he advises, that these conductors should be at least half an inch thick, that they may the better resist the destructive power of the lightning.

466 Requisites to be observed.

From a comparison of numerous experiments and observations, the following rules have been laid down for the construction of conductors.

467 Should be of the best conductors.

1. *That the rods be made of such substances as are in their nature the best conductors of electricity.*

It is found that all metals do not conduct equally well, and that *lead* and *copper* are the best fitted to serve as conductors against lightning; but as lead is exceedingly destructible by electricity, and therefore would require to be of a very considerable diameter, *copper* is to be preferred, as well on account of its greater conducting power, as from its being less liable to contract rust than *iron*, which is commonly employed.

468 Should be of sufficient diameters, and

2. *That the rods be of a sufficient diameter.*

469 perfectly continuous.

3. *That they be perfectly uninterrupted, or, if formed of several pieces, that their junctions be as close as possible.*

The effect of interruptions in conductors, as well as the effects of lightning in general on buildings, may be illustrated by the following experiments.

470 Thunder-house. Fig. 123.

Exper. 1.—Fig. 123. shews an instrument representing the side of a house, either furnished with a metallic conductor, or not; by which both the bad effects of lightning striking upon a house not properly secured, and the usefulness of metallic conductors, may be clearly represented. A is a board about three-quarters of an inch thick, and shaped like the gable end of a house. This board is fixed perpendicularly upon the bottom board B, upon which the perpendicular glass pillar CD is also fixed, in a hole about eight inches distant from the basis of the board A. A square hole, ILMK, about a quarter of an inch deep, and nearly one inch wide, is made in the board A, and is filled with a square piece of wood, nearly of the same dimensions. We say nearly of the same dimensions, because it must go so easily into the hole, that it may drop off by the least shaking of the instrument. A wire, LK, is fastened diagonally to this square piece of wood. Another wire, IH, of the same thickness, having a brass ball, H, screwed on its pointed extremity, is fastened upon the board A; so also

---

[*] Morgan's Lectures, vol. ii. p. 171.

[†] Morgan ubi supra, p. 279.

also is the wire MN, which is shaped in a ring at O. From the upper extremity of the glass pillar CD, a crooked wire proceeds, having a spring socket F, through which a double-knobbed wire slips perpendicularly, the lower knob G of which falls just above the knob H. The glass pillar DC must not be made very fast into the bottom board; but it must be fixed so as to be pretty easily moved round its own axis, by which means the brass ball G may be brought nearer or farther from the ball H, without touching the part of EFG. Now when the square piece of wood LMIK (which may represent the shutter of a window or the like) is fixed into the hole so, that the wire LK stands in the dotted representation IM, then the metallic communication from H to O is complete, and the instrument represents a house furnished with a proper metallic conductor; but if the square piece of wood LMIK is fixed so, that the wire LK stands in the direction LK, as represented in the figure, then the metallic conductor HG, from the top of the house to its bottom, is interrupted at IM, in which case the house is not properly secured.

Fix the piece of wood LMIK, so that its wire may be as represented in the figure, in which case the metallic conductor HO is discontinued. Let the ball G be fixed at about half an inch perpendicular distance from the ball H, then, by turning the glass pillar DC, remove the former ball from the latter: by a wire or chain connect the wire EF with the wire Q of the jar P, and let another wire or chain fastened to the hook O, touch the outside coating of the jar. Connect the wire Q with the prime conductor, and charge the jar; then, by turning the glass pillar DC, let the ball G come gradually near the ball H, and when they are arrived sufficiently near one another, you will observe that the jar explodes, and the piece of wood, LMIK is pushed out of the hole to a considerable distance from the thunder-house. Now the ball G, in this experiment, represents an electrified cloud; which, when it is arrived sufficiently near the top of the house A, the electricity strikes it, and, as this house is not secured with a proper conductor, the explosion breaks part of it, i. e. knocks off the piece of wood IM.

Repeat the experiment with only this variation, viz. that this piece of wood IM is situated so, that the wire LK may stand in the situation IM; in which case the conductor HO is not discontinued; and you will observe, that the explosion will have no effect upon the piece of wood LM; this remaining in the hole unmoved; which shews the usefulness of the metallic conductor.

Further: Unscrew the brass ball H from the wire HI, so that this may remain pointed, and, with this difference only in the apparatus, repeat both the above experiments; and you will find that the piece of wood IM is in neither case moved from its place, nor any explosion will be heard; which demonstrates the preference of conductors with pointed terminations to those with blunted ones.

471
Powder-house.
Fig. 124.

Exper. 2.—This apparatus is sometimes made in the shape of a house, as represented fig. 124. where, for the sake of distinctness, the side and part of the roof next the eye are not represented. The gable end AC represents that of the thunder-house, and may be used in the same manner with that above described, or more readily by the following method. Let one ball of the discharging rod touch the ball of the charged jar, and the other the knob A of the conductor AC of the thunder-house; the jar will then of course explode, and the fluid will act upon the conductor just mentioned. The conducting wire at the windows *h h* must be placed in a line. The sides and gable AC of the house are connected with the bottom by hinges; and the building is kept together by a ridge on the roof. To use this model, fill the small tube *a* with gunpowder, and ram the wire *c* a little way into the tube; then connect the tube *e* with the bottom of a large jar or battery. When the jar is charged, form a communication from the hook at C, on the outside, to the top of the jar, by discharging the rod; the discharge will fire the powder, and the explosion of the latter will throw off the roof, with the sides, back and front, so that they will all fall down together. The figures *f* and *g* in the side of the house represent a small ramrod for the tube *a*, and a pricker for the touch-hole at C.

472
Effects of breaks in conductors, illustrated by a pyramid.
Plate CXCIX. fig. 125.

Exper. 3.—Fig. 125. represents a wooden pyramid, made in several pieces, with a wire through each, so that their ends may touch, as at *s s s*. Let one corner of the pedestal *d* be loose, and have the safety wire pass almost but not quite through it. Let the wire passing through the rest of the pedestal join by a chain the outside coating of a Leyden phial. If the cloud *x* be supported by a wire from the prime conductor, and hang half an inch from the knob *q* of the pyramid; when the phial is discharged, a flash will take place between *x* and *g*; the spark will pass along the wires *s s s*, till it comes to the break at *d*; there an explosion will take place that will drive out the corner-stone *d*, and overthrow the fabric.

Abundant observation has proved the danger of having discontinuous conductors either attached to a building, or forming part of the materials. About the middle of the last century, the steeple of St Bride's church in London was struck by lightning, and greatly injured. In the construction of this steeple a great deal of iron work had been employed; the stones having been fastened together in many places by iron cramps, the ends of which were covered with small stones. The lightning seems first to have struck the vane of the spire, from which it was safely conducted down the shaft by which the vane was supported; from the extremity of this shaft, it leaped to two cross iron bars which were at the base of the obelisk, shattering the obelisk in its way. Hence it passed to one of the above-mentioned cramps, and thus from cramp to cramp, throwing out or demolishing the stones as it passed along.

473
Effect of an interruption explained.

The principles of electricity afford us an easy explanation of the manner in which the interruption of conductors acts. We know that at the extremity of all long rods there is a considerable accumulation of electricity, and this has here a tendency to fly off with great force, especially if there is another conductor at hand. This other conductor also assists the accumulation in the former, by acquiring at its adjacent extremity the opposite electricity. Supposing a positive cloud to be over the upper conductor, this conductor will be electrified positively at its lower extremity, and this accumulation being increased by the negative electricity of the upper end of the lower conductor, will tend to fly

fly off with great violence into the air, or if any obstruction oppose its passage, this will be removed by the bursting or displacing the resisting body.

474 Should be properly connected with the earth.

4. *It is necessary that the connection between the conductor and the common stock, or the earth, be as complete as possible.*

It has been said, that the lower extremity of the conductor should be inserted some feet below the surface of the ground: it is also proper that it should be turned in a direction away from the foundation; and as moisture is one of the best conductors, it would be adviseable, where this can conveniently be done, to connect the extremity of the metallic rod with some neighbouring piece of paper.

475 Should be as straight as possible.

5. *That the rod be carried from the top of the building to the common stock in the shortest convenient direction.*

It is also of some importance that they should not be connected with other masses of metal in the building, which might chance, by occasional contiguity to other conducting matter, to change the direction of the fluid. The rods may be connected to the wall by iron or copper staples, larger than the rod themselves; and in this case, that part of the rod which passes through the staple ought to be covered with some folds of woollen cloth dipped in melted pitch.

476 Should be pointed.

6. *That the upper extremity be finely tapered, and terminate in a sharp smooth point.*

There is no question in electricity, that has been argued with more keenness, than whether thunder-rods should terminate in a sharp point, or in a round ball. Dr Franklin, we have seen, decidedly gave the preference to a pointed conductor, and he has been followed by most of the electricians of Europe; Dr Wilson standing almost alone in support of the round ball. This controversy was renewed with great warmth on the occasion of a house at Purfleet, belonging to the board of ordnance, having been struck by lightning, although guarded by a pointed conductor. A set of very ingenious experiments were made, both by Mr Nairne and Dr Wilson, to estimate the comparative merits of pointed and obtuse conductors; but by these the question was not decided; Mr Nairne's experiments always concluded in favour of pointed conductors, while those of Dr Wilson as constantly favoured the obtuse termination. Most electricians, however, still prefer the pointed conductor, as it is difficult to make the charge pass this with an explosion. It is in general either transmitted silently, or with greatly diminished force.

Fig. 126.

Let B (fig. 126.) represent the position of a charged cloud; A, the part that is oppositely charged, or that is connected with it; FG a pointed wire. In this case, the electric fluid must pass either through the series of partial conductors, *a*, *b*, *c*, &c. or through the body of earth, AF.

Now when, on the one hand, we consider the dryness of that soil which is generally selected for the foundation of buildings, the probability there is that nothing but the soil, thus dry, may separate A from the wire FG, and the certainty that if water should connect A and FG, its resistance is very considerable; when, on the other hand, we take into consideration, the nails, bolts, iron bars, strips of lead, bell wires, and metallic utensils that are scattered through all buildings, we shall, I think, perceive the much greater probability there is of the lightning's passing through *a*, *b*, *c*, *d*, &c. to the cloud, than of its passage through the ground.

2. Let us erect another wire, HI, and still the danger is almost as great; for now the possible circuits of the lightning are four, and of these, that leading through the house appears to be the easiest: If HI convey it harmless, then it must pass through the body of the air IG, or over the roof of the house. We well know from past experiments, that the insulating power of the air makes the resistance in the direction IG very considerable; and even on the supposition that *j* were wet, the resistance over the roof of the house is not much considerable. If the house were covered or coped with lead, the probability of a stroke would then be diminished, but not taken away; for, suppose the easiest circuit should lie in the direction KM, then, rather than pass through the body of earth HK, or FK, it might find an easier passage through the house than either of the conductors. This would not be the case, if a strip of lead, or metallic substance of any kind, extended from K to H, and from K to F. "I hence thought, (says Mr Morgan), at one time, that a house would be perfectly safe, if a strip of lead were carried around the top, and all the bottom of the building, and then connected by two or three metallic strips extending from the one to the other.

"Let us suppose that a house were erected over a stratum of moisture, or any other conducting substance, which dipped considerably, at a little distance from the house, and then suddenly rose just below it; in that case, if the stratum became the circuit of a charge, the stroke would rise immediately in the centre or body of the house, and in all directions would force its way with devastation, towards the conductors on the outside."

477 Mr Morgan's proposal for preventing all possible danger.

To prevent all possible danger, Mr G. Morgan proposes, that, while the house is building, the foundation of each partition wall be laid on a strip of lead, or that such a strip be fastened to the sides of these partition walls. The strips should be two inches wide, and at least a quarter of an inch thick, and they should be closely connected with each other. A perpendicular strip on each side of the house, should rise from this bed of conductors, to the surface of the ground; whence a strip should be continued round all the house, and carefully connected with water-pipes, &c. The strips on the sides of the house, should then be continued to the roof, which should be guarded in the same manner as the foundation. The top should be surrounded by a strip, whose connection should spread over every edge and prominence, and should continue to the summit of each separate chimney. It is particularly necessary to guard the chimneys; for Mr Morgan was witness to a case, in which a house that had been guarded, in most respects, according to the foregoing directions, except that the chimneys were unprotected, was struck with lightning, which entered by one of the chimneys: here it spent its fury; but the chimney falling on the roof, did considerable damage.

The conductors for powder magazines are placed at a short distance from the building. In this case the rods should rise eight or ten feet above the highest part of the magazine, and penetrate as much below its foundation.

The principal objection to this method, is the expence attending it; but this may be, in a great measure avoided, by making proper use of the leaden pipes, gutters, and copings, which belong to most houses.

478 Means of protecting ships, and carriages.

Ships, from the height and construction of their masts, and from their being such insulated conducting objects as must necessarily attract the lightning from a cloud that is very near, are peculiarly exposed to danger. It is, therefore, still more necessary to guard vessels by proper conductors. Chains are very commonly employed for this purpose, from their being more conveniently disposed among the rigging; but it is found, that from the want of continuity in the links, chains are very imperfect conductors, and have not unfrequently been broken by a severe shock. They are also apt to be occasionally laid aside. Strips of lead are, therefore, to be preferred, both as they are cheaper, and less liable to be injured by the weather and salt water, than iron chains. One strip should surround the deck, and another the bottom or side of the keel, and these should be connected with other strips, embracing the ship in various parts. If the ship be copper-bottomed, it will only be necessary to connect the copper with the deck; but in every case a strip should pass on each side from the rest of the strips to each mast. The mast may be protected by extending a metallic body along the stays to as great a height as possible, and connecting this with the top of the mast, and with the rest of the conductors surrounding the ship. Those parts of the ship which are intended to be moveable should be connected by spiral wire, which is a better conductor than a chain, and admits of equal accommodation.

Carriages may also be rendered secure, by having their metallic fillets all connected together, and connected with the iron hoops of the wheels.

479 Means of preventing personal danger.

The principles of electricity, applied to the explanation of the phenomena of lightning, also afford us some useful hints for our personal security during a thunder-storm. These naturally divide themselves into two heads; first, the consideration of the signs of approaching danger, and, secondly, the rules to be observed, when we find ourselves within the striking distance of the cloud.

480 Signs of approaching danger.

1. Approaching danger may be dreaded from the following circumstances.

a. *A rapid approach of the charged clouds.* The longer time any given portion of charged air remains over a certain space, the more it is affected by points and prominences; but when a cloud seems to be over our heads almost as soon as it is formed, we are exposed to the utmost of its fury. When a cloud grows darker and darker while it is near us, it is also a mark of great danger, for we may be certain the accumulation is not materially lessened by an exhaustion, and that the charge must soon attain its striking height.

b. *The perpendicular direction of the flashes.* This is a certain evidence that the charged clouds are at that height from which they can strike into the ground. The appearance of two flashes at the same time, has been considered as an evidence, that the earth is acting as a discharging rod; but this may often happen, as the two extremities of the flash, when passing behind a cloud which partly hides it, may often give out the same appearance; the sign, therefore, is not sufficiently accurate, and cannot be considered as denoting more than a certain degree of probable danger.

c. *In making experiments with the kite, if very strong sparks are emitted from the string, or if a sensation like a cobweb passing over the face be felt, it is time to desist.* This will be fully illustrated in the experiments which we are about to relate on atmospherical electricity.

d. *In making experiments with an insulated conductor, if a torrent of sparks should flow from its interruptions, or if such a torrent, after having continued for some time, should suddenly stop, and soon after recommence with an opposite electricity, there is considerable danger in being near the conductor.*

2. Having ascertained, that we are within the limits of danger, our next object is to seek protection; it is therefore necessary to know how the threatened danger may be avoided.

481 Rules for protection in various situations.

In a house, it is necessary to place one's self at a distance from all good conductors, such as chimney places, gilt mirrors or pictures, lustres, or burning candles. It is therefore proper, to withdraw into the middle of a room, where no metallic body is suspended from the ceiling, and here, according to Dr Franklin, almost all possible danger may be avoided, by bringing a bed or mattress, and placing on it the chair on which we sit.

If we are in the open air, and overtaken by a thunder-storm, it is proper to avoid taking shelter under high and pointed objects, as houses and trees. The most eligible situations are at a distance of 20 or 30 feet from tall trees or houses, as these bodies are the most likely to receive any discharge that is made in their neighbourhood. It is particularly necessary to avoid rivers and brooks, as these are excellent conductors, and are likely to determine the course of an electrical discharge.

If overtaken in a storm, it is safer to be completely wet than dry. In the interior of a house the most secure situation is the middle of a room, and the security is increased by standing on an insulating substance, such as a hair mattress, or even a thick woollen hearth-rug. The fire-place should be carefully avoided, as the charry matter forming the soot readily conducts the lightning downward. Gilt furniture, bell wires, and other metallic bodies of moderately extensive surfaces, should for the same reason be avoided. In a carriage, the precaution of keeping at a distance of some inches from the sides and back should be observed.

CHAP. II. *Experiments and Observations on the Spontaneous Electricity of the Atmosphere.*

482 Experiments on atmospherical electricity, by Monnier.

THE first person who observed the spontaneous electricity of the atmosphere, was M. Monnier, who found that even when there was no appearance of lightning, some degree of electricity might generally be observed in the atmosphere. His experiments were made at St Germaine en Laye, and published in a memoir read at the Royal Academy of Sciences at Paris in 1752.

483 Abbe Mazeas.

But more accurate experiments were made upon the electricity of the air by the abbé Mazeas, at Chateau de Maintenon, during the months June, July, and October, of 1753, and communicated to the Royal Society in a letter to Dr Hales.

The

Atmospherical Electricity.

The abbé's apparatus consisted of an iron rod, 370 feet long, raised 90 feet above the horizon. It came down from a very high room in the castle, where it was fastened to a silken cord six feet long; and was carried from thence to the steeple of the town, where it was likewise fastened to another silk cord of eight feet long, and sheltered from rain. From the extremity of this rod, a large key was suspended to receive the electric fluid.

When he began his experiments, viz. on the 17th of June, the electricity of the air was sensibly felt every day, from sunrise till seven or eight in the evening, except in moist weather, when he could perceive no signs of electricity. In dry weather, the rod attracted minute bodies at no greater distance than three or four lines. He repeated the experiment carefully every day, and constantly observed, that in weather void of storms, the electricity of a piece of sealing-wax of two inches long, was above twice as strong as that of the air. This observation inclined him to conclude, that in weather of equal dryness, the electricity of the air was always equal.

It did not appear to him that hurricanes and tempests increased the electricity of the air, when they were not accompanied with thunder; for that during three days of a very violent continual wind in July, he was obliged to put some dust within four or five lines of the conductor, before any sensible attraction could be perceived.

No sensible alteration in the electricity of the air was observed under different directions of the winds, except when these were moist.

He could observe no electricity in the air during the driest nights of summer, but it returned in the morning with the sun, disappearing again soon after sunset.

The strongest common electricity of the atmosphere during that summer, was observed in July, on a very dry, clear, warm day.

On the 27th of June, about noon, he perceived some stormy clouds rising above the horizon, and observed that the electricity of the atmosphere occasioned by them, was increased as the clouds reached the zenith. He at this time drew considerable sparks from his apparatus, though there was neither thunder nor lightning.

The electricity observed during the appearance of these stormy clouds, was not diminished by a very heavy rain, till the clouds began to dissipate [*].

484 r Kinnersley. Mr Kinnersley observed, that when the air was in its driest state, there was always a quantity of electricity in it, and which might be easily drawn from it. This, he says, may be proved by a person in the negative state of electricity extending his arm into the air in the dark while holding a pointed needle in his hand: this, however, can only be observed when the air is very dry.

Whether the electricity in the air, in clear dry weather, be of the same density at the height of two or three hundred yards, as on the surface of the earth, Mr Kinnersley thought might be easily ascertained by Dr Franklin's old experiment with the kite. The twine, he says, should have throughout a very small wire in it, and the ends of the wire, where the several lengths are united, ought to be tied down with a waxed thread, to prevent their acting in the manner of points [†].

485 Mr Canton. Mr Canton made several ingenious experiments on atmospherical electricity, by means of his pith-ball electrometer, described in N° 66. According to this philosopher, desiccated atmospheric air, when heated, becomes negatively electric, and when cooled, the electricity is of the positive kind, even when the air is not permitted to expand or contract; and the expansion or contraction of atmospheric air occasions changes in its electrical state [‡].

486 Beccaria. But no electrician, in the earlier stage of the science, conducted his observations in this way with greater accuracy, or pursued them farther, than Sig. Beccaria. He observed, that during very high winds, his apparatus gave no signs of being electrified. Indeed he found, that in three different states of the atmosphere, he could find no electricity in the air: viz. in windy and clear weather; in weather when the sky was covered with distinct and black clouds, that had a slow motion; in moist weather, not actually raining. In a clear sky, when the weather was calm, he always perceived signs of a moderate electricity, but interrupted. In rainy weather without lightning, his apparatus was always electrified a short time before the rain fell, and during the time of the rain, but it ceased to be affected a little before the rain was over.

The higher his rods reached or his kites flew, the stronger signs they gave of electricity. Also longer strings and cords, extended and insulated in the open air, acquired electricity sooner than those which were shorter. A cord 1500 Paris feet long, stretched across the river Po, was as strongly electrified during a shower without thunder, as a metallic rod, employed to bring lightning into the house, had been in any thunderstorm.

Having two rods for bringing the lightning into his house, 140 feet asunder, he observed, that if he took a spark from the higher of these, the spark from the other, which was 30 feet lower, was at that instant lessened; but its power again revived, though he kept his hand upon the former.

He imagined that the electricity communicated to the air might sometimes furnish small sparks to his apparatus; since the air parts with the electricity it has received very slowly, and therefore the equilibrium of the electric fluid in the air, will not be restored so soon as in the earth and clouds.

487 Rain, hail, and snow, supposed effects of electricity. Among the effects of a moderate electricity in the atmosphere, Signior Beccaria considers rain, hail, and snow.

Clouds that bring rain, he thought, were produced in the same manner as thunder-clouds, only by a more moderate electricity.

He notes several circumstances attending rain without lightning, which make it very probable, that it is produced by the same cause as when it is accompanied with lightning. Light has been seen among the clouds by night in rainy weather; and even by day, rainy clouds are sometimes seen to have a brightness evidently independent of the sun. The uniformity with which the clouds are spread, and with which the rain falls, he thought were evidences of a uniform cause, like that of electricity.

Phil. Trans. ol. xlviii.

[†] Phil. Tr. vol. liii.

[‡] Ibid. vols. xlviii. and xlix.

electricity. The intensity of electricity in his apparatus, generally corresponded very nearly to the quantity of rain that fell in the same time.

Sometimes all the phenomena of thunder, lightning, hail, rain, snow and wind, have been observed at one time; which shows the connection they all have with some common cause.

Signior Beccaria supposes, therefore, that previous to rain, a small quantity of electric fluid escapes out of the earth, in some place where there was a redundancy of it; and in its ascent to the higher regions of the air, collects and conducts into its path a great quantity of vapours. The same cause that collects will condense them more and more, till in the places of the nearest intervals they come almost into contact, so as to form small drops, which uniting with others as they fall, come down in rain. The rain will be heavier in proportion as the electricity is more vigorous, and the cloud approaches more nearly to a thunder cloud.

He imitated the appearance of clouds that bring rain, by insulating himself between the rubber and conductor of his electrical machine, and with one hand dropping *colophonium* into a spoon fastened to the conductor, and holding a burning coal, while his other hand communicated with the rubber. In these circumstances, the smoke spread along his arm, and by degrees all over his body, till it came to the other hand that communicated with the rubber. The lower surface of this smoke was everywhere parallel to his clothes, and the upper surface was swelled and arched like clouds replete with thunder and rain. In this manner, he supposed, the clouds that bring rain diffuse themselves from over those parts of the earth which abound with the electric fluid, to those parts that are exhausted of it; and by letting fall their rain, restore the equilibrium between them.

488 Beccaria's idea of the production of hail.

This ingenious philosopher supposes hail to be formed in the higher regions of the air, where the cold is intense, and where the electric fluid is very copious. In these circumstances a great number of particles of water are brought near together, where they are frozen, and in their descent collect other particles, so that the density of the substance of the hailstone grows less and less from the centre; this being formed first in the higher region, and the surface being collected on the lower. Agreeable to this it is observed, that in mountains, hailstones, as well as drops of rain, are very small; there being but small space through which to fall and thereby increase their bulk. Drops of rain and hail also agree in this circumstance, that the more intense is the electricity that forms them, the larger they are.

Clouds of snow differ in nothing from clouds of rain, but in the circumstance of cold which freezes them. Both the regular diffusion of snow, and the regularity in the structure of its particles, shew the clouds of snow to be actuated by some uniform cause like electricity. All these conjectures about the cause of hail and snow were confirmed by observing, that his apparatus never failed to be electrified by snow, as well as by rain.

A more intense electricity unites the particles of hail more closely, than the more moderate electricity does those of snow. In like manner, we see thunder clouds more dense than those that merely bring rain, and the drops of rain are larger in proportion, though they often fall not from so great a height*.

489 Observations by Mr Ronayne.

Mr Ronayne observed, that the air in Ireland was generally electrified in a fog, and even in a mist, and that both day and night, but principally in winter; seldom in summer, except from positive clouds or cool fogs. The electricity of the air in a frost or fog is always positive. He says, that he has often observed, during what seemed the passing of one cloud, successive changes from negative to positive, and from positive to negative. It may be remarked that most fogs have a smell like an excited glass tube †.

490 By Mr Henley.

Mr Henley has shewn, that fogs are more strongly electrified in or immediately after a frost than at other times; and that the electricity of fogs is often the strongest soon after their appearance. Whenever there appears a thick fog, and at the same time the air is sharp and frosty, that fog is strongly electrified positively.

Though rain is not an immediate cause, yet Mr Henley is inclined to consider it as a remote consequence of atmospherical electricity; and he generally found that in two or three days after he had discovered the air to be strongly electrified, there was either rain or snow. If in clear weather, a low cloud, which moves slowly and is considerably distant from any other, passes over the apparatus, the positive electricity generally grows very weak, but does not become negative; and when the cloud is gone, it returns to its former state. When many whitish clouds keep over the wire, sometimes uniting with and then separating from each other, thus forming a body of considerable extent, the positive electricity commonly increases. In all the above circumstances the positive electricity never changes to negative.

The clouds which lessen the electricity of the exploring wire, are those which move; though those that are low, seem also to have the same effect.

491 By Mr Cavallo.

Mr Cavallo has considerably improved our knowledge with respect to atmospherical electricity, and, by his apparatus, has greatly facilitated the means of making experiments. His first experiments were made by means of a kite; and after bestowing much pains in constructing kites of various dimensions, &c. he found that a common school-boy's kite, about four feet high, and two wide, answered as well as any other. The string of his kite was formed by twisting together two threads of common twine, and one of copper thread, such as is used for trimmings. When a kite constructed in this manner was raised, he always found the string give signs of electricity, except once, when the weather was warm, and the wind so very weak, that the kite could scarcely be raised, and could be kept up only for a few minutes. Afterwards, however, when the wind increased so that he could easily raise the kite, he obtained, as usual, pretty strong signs of electricity.

492 Construction of his kite.

493 Means of avoiding danger.

As making experiments on atmospherical electricity is often attended with more or less danger, it is necessary to observe the following directions given by Mr Cavallo.

Fig. 127.

"In raising the kite when the weather is very cloudy and rainy, in which time there is fear of meeting with a great quantity of electricity, I generally use to hang upon the string AB, fig. 127. the hook of a chain C, the other extremity of which falls upon the ground. Sometimes I use another caution besides, which is, to stand upon an insulating stool; in which situation

---

* Lett. dell Elettricismo.

† Phil. Trans. vol. lxii.

Atmospherical Electricity.

I think, that if any great quantity of electricity, suddenly discharged by the clouds, strikes the kite, it cannot much affect my person. As to insulated reels, and such-like instruments, that some gentlemen have used to raise the kite, without danger of receiving any shock; fit for the purpose as they may appear to be in theory, they are yet very inconvenient to be managed. Except the kite be raised in time of a thunder storm, there is no great danger for the operator to receive any shock. Although I have raised my electrical kite hundreds of times without any caution whatever, I have very seldom received a few exceedingly slight shocks in my arms. In time of a thunderstorm, if the kite has not been raised before, I would not advise a person to raise it while the stormy clouds are just overhead; the danger at such time being very great, even with the precautions above mentioned: at that time, without raising the kite, the electricity of the clouds may be observed by a cork-ball electrometer held in the hand in an open place; or, if it rains, by my electrometer for the rain; which will be described hereafter.

"When the kite has been raised, I generally introduce the string through a window in a room of the house, and fasten it to a strong silk lace, the extremity of which is generally tied to a heavy chair in the room. Fig. 128. In fig. 128. AB represents part of the string of the kite which comes within the room; C represents the silk lace; DE, a small prime conductor, which, by means of a small wire, is connected with the string of the kite; and F represents the quadrant electrometer, fixed upon a stand of glass covered with sealing-wax, which I used to put near the prime conductor, rather than to fix it in a hole upon the conductor, because the string AB sometimes shakes so as to pull the prime conductor down; in which case the quadrant electrometer remains safe upon the table: otherwise it would be broken, as I have often experienced before I thought of this method. G represents a glass tube, about eighteen inches long, with a knobbed wire cemented to its extremity; with which instrument I use to observe the quality of the electricity, when the electricity of the kite is so strong that I think it not safe to come very near the string. The method is as follows:—I hold the instrument by that extremity of the glass tube which is the farthest from the wire, and touch the string of the kite with the knob of its wire, which, being insulated, acquires a small quantity of electricity from it; which is sufficient to ascertain its quality when the knob of the instrument is brought near an electrified electrometer.

"Sometimes, when I raise the kite in the night-time, out of the house, and where I have not the convenience of observing the quality of its electricity by the attraction and repulsion, or even by the appearance of the electric light, I make use of a coated phial which I can charge at the string, and, when charged, put it into my pocket; wherein it will keep charged even for several hours. By making use of this instrument, I am obliged to keep the kite up no longer than is necessary to charge the phial, in order to observe the quality of the electricity in the atmosphere; for after the kite has been drawn in and brought home, I can then examine the electricity of the inside of the phial, which is the same as that of the kite.

"When the electricity of the kite is very strong, I fix a chain, communicating with the ground, at about six inches distance from the string; which may carry off its electricity, in case that this should increase so much as to put the by-standers in danger.

"Besides the above-described apparatus, I have occasionally used some other instruments, which I have often varied, according as some particular experiments required; but, as they are of no great consequence, I shall omit to describe them. It is only necessary, to give an idea of the standard of my quadrant electrometer; which may, very probably, shew the same intensity of electricity under a number of degrees different from the other instruments of the same kind. When the kite is flying, and the apparatus is disposed as in fig. 128. I bring, under the extremity E of the prime conductor, a little bran, held upon a tin plate, and observe, that when the index of the electrometer is at ten degrees, the prime conductor begins to attract the bran at the distance of about three-fifths of an inch: when the index is at twenty degrees, the prime conductor attracts the bran at the distance of about one inch and a quarter; when the index is at thirty degrees, the bran begins to be attracted at the distance of two inches and one-fifth. These distances vary, as the weather changes its degree of dryness; but in frosty weather I observe them constantly as above."

494 Instance of great danger.

Mr Cavallo has given copious extracts from a journal which he kept of his experiments with the kite; from these we shall give his account of one experiment, which is peculiarly interesting, from the danger to which the experimenters appear to have been exposed.

"October the 18th. After having rained a great deal in the morning, and night before, the weather became a little clear in the afternoon, the clouds appearing separated, and pretty well defined. The wind was west, and rather strong, and the atmosphere in a temperate degree of heat. In these circumstances, at three P. M. I raised my electrical kite with three hundred and sixty feet of string. After that the end of the string had been insulated, and a leather-ball, covered with tin-foil, had been hung to it, I tried the power and quality of the electricity, which appeared to be positive, and pretty strong. In a short time a small cloud passing over, the electricity increased a little; but the cloud being gone, it decreased again to its former degree. The string of the kite was now fastened by the silk lace to a post in the yard of the house wherein I lived, which was situated near Islington, and I was repeatedly charging two coated phials, and giving shocks with them:—while I was so doing, the electricity, which was still positive, began to decrease, and in two or three minutes time it became so weak, that it could be hardly perceived with a very sensible cork-ball electrometer. Observing at the same time that a large and black cloud was approaching the zenith (which, no doubt, caused the decrease of the electricity) indicating imminent rain, I introduced the end of the string through a window, in a first-floor room, wherein I fastened it by the silk lace to an old chair. The quadrant electrometer was set upon the same window, and was, by means of a wire, connected with the string of the kite. Being now three quarters of an hour after three o'clock, the electricity was absolutely unperceivable; however, in about three minutes time, it became

became again perceivable, but now upon trial was found to be negative; it is therefore plain, that its stopping was nothing more than a change from positive to negative, which was evidently occasioned by the approach of the cloud, part of which by this time had reached the zenith of the kite, and the rain also had begun to fall in large drops.—The cloud came farther on;—the rain increased, and the electricity keeping pace with it, the electrometer soon arrived to 15°. Seeing now, that the electricity was pretty strong, I began again to charge the two coated phials, and to give shocks with them; but the phials had not been charged above three or four times, before I perceived that the index of the electrometer was arrived at 35°, and was keeping still increasing. The shocks now being very smart, I desisted from charging the phials any longer; and, considering the rapid advance of the electricity, thought to take off the insulation of the string, in case that if it should increase farther, it might be silently conducted to the earth, without causing any bad accident, by being accumulated in the insulated string. To effect this, as I had no proper apparatus near me, I thought to remove the silk lace, and fasten the string itself to the chair; accordingly I disengaged the wire that connected the electrometer with the string; laid hold of the string; untied it from the silk lace, and fastened it to the chair; but while I effected this, which took up less than half a minute of time, I received about a dozen, or fifteen, very strong shocks, which I felt all along my arms, in my breast, and legs; shaking me in such a manner, that I had hardly power enough to effect my purpose, and to warn the people in the room to keep their distance. As soon as I took my hands off the string, the electricity (in consequence of the chair being a bad conductor) began to snap between the string and the shutter of the window, which was the nearest body to it. The snappings, which were audible at a good distance out of the room, seemed first isochronous with the shocks which I had received, but in about a minute's time, oftener; so that the people of the house compared their sound to the rattling noise of a jack going when the fly is off. The cloud now was just over the kite; it was black, and well defined, of almost a circular form, its diameter appearing to be about 40°; the rain was copious, but not remarkably heavy. As the cloud was going off, the electrical snapping began to weaken, and in a short time became inaudible. I went then near the string, and finding the electricity weak, but still negative, I insulated it again, thinking to keep the kite up some time longer; but observing that another larger and denser cloud was approaching apace towards the zenith, as I had then no proper apparatus at hand, to prevent every possible bad accident, I resolved to pull the kite in; accordingly a gentleman, who was by me, began pulling it in, while I was winding up the string. The cloud was now very nearly over the kite, and the gentleman, who was pulling in the string, told me, that he had received one or two slight shocks in his arms, and, that if he were to feel one more, he would certainly let the string go; upon which I laid hold of the string, and pulled the kite in as fast as I could, without any farther observation; being then ten minutes after four o'clock.

"N. B.—There was neither thunder or lightning perceived that day, nor indeed for some days before or afterwards*."

495
Cavallo's conclusions.

From his experiments with the kite, Mr Cavallo deduces the following conclusions.

1. The air appears to be electrified at all times; its electricity is constantly positive, and much stronger in frosty, than in warm weather; but it is by no means less in the night than in the day-time (H).

2. The presence of the clouds generally lessens the electricity of the kite; sometimes it has no effect upon it; and it is very seldom that it increases it a little.

3. When it rains, the electricity of the kite is generally negative, and very seldom positive.

4. The aurora borealis seems not to affect the electricity of the kite.

5. The electrical spark taken from the string of the kite, or from any insulated conductor connected with it, especially when it does not rain, is very seldom longer than a quarter of an inch; but it is exceedingly pungent. When the index of the electrometer is not higher than 20°, the person that takes the spark will feel the effect of it in his legs; it appearing more like the discharge of an electric jar, than the spark taken from the prime conductor of an electrical machine.

6. The electricity of the kite is in general stronger or weaker, according as the string is longer or shorter; but it does not keep any exact proportion to it: the electricity, for, instance, brought down by a string of a hundred yards, may raise the index of the electrometer to 20°; when, with double that length of string, the index of the electrometer will not go higher than 25°.

7. When the weather is damp, and the electricity is pretty strong, the index of the electrometer, after taking a spark from the string, or presenting the knob of a coated phial to it, rises surprisingly quick to its usual place; but in dry and warm weather, it rises exceedingly slow.

496
Application of Bennet's electrometer to the kite.

Mr Bennet observed with his electrometer, that in very clear weather, when no clouds were visible, on applying the instrument to the insulated string of kites without metal, their positive electricity caused the slips of gold-leaf to strike the sides of the glass; but when a kite was raised in cloudy weather, with a wire in the string, and when it gave sparks about a quarter of an inch long, the electricity was sensible by the electrometer, at the distance of about ten yards from the string; but when placed at the distance of six feet, the gold-leaf continued to strike the sides of the electrometer for more

* *Cavallo's Electricity*, vol. ii.

(H) In all his experiments, it happened only once that the string of the kite gave no signs of electricity; it was one afternoon, when the weather was warm, and the wind so weak, that the kite was raised with difficulty, and could hardly be kept up for a few minutes; in the evening, however, the wind, which in the day-time had been north-west, shifted to the north-east, blowing a little stronger: he then raised the kite again, being half past ten o'clock, and obtained, as usual, a pretty strong positive electricity.

more than an hour together, with a velocity increasing and decreasing with the density or distance of the unequal clouds that passed over.

Sometimes the electricity of an approaching cloud has been sensible without a kite, though in a very unfavourable situation for it, being in a town surrounded with hills, and where buildings encompassed the wall on which the electrometer was placed. A thunder cloud passing, caused the gold leaf to strike the sides of the glass very quick at each flash of lightning.

Mr Bennet relates the following instance of the danger sometimes incurred in making experiments with the kite. Having on the 5th of July 1788, raised a kite with two hundred yards of string; when it had been flying for about an hour, a dark cloud appeared at a great distance, and changed the electricity from positive to negative. The electric power increased till the cloud became nearly vertical, when some large drops of rain fell; and Mr Bennet attempting to secure the string from wet, received such a strong shock in his arm, as deprived it for a few seconds of sensation. The explosion was heard at the distance of forty yards, like the loud crack of a whip.

497
Curious phenomenon observed by Mr Baldwin.

The following curious phenomenon was observed by Mr Loammi Baldwin, while raising an electrical kite in July 1771, during the approach of a severe thunderstorm. He observed himself to be surrounded by a rare medium of fire, which, as the cloud rose nearer the zenith, and the kite rose higher, continued to extend itself with some gentle faint flashes. Mr Baldwin felt no other effect than a general weakness in his joints and limbs, and a kind of listless feeling; all which, he observes, might possibly be the effect of surprise, though it was sufficient to discourage him from persisting in any farther attempt at that time. He therefore drew in his kite, and retired to a shop till the storm was over, and then went to his house, where he found his friends much more surprised than he had been himself; and who, after expressing their astonishment, informed him, that he appeared to them (during the time he was raising the kite) to be in the midst of a large bright flame of fire, attended with flashings; and, that they expected every moment to see him fall a sacrifice to the flame. The same was observed by some of his neighbours, who lived near the place where he stood *.

498
Cavallo's atmospherical electrometer.
Fig. 129.

Fig. 129. represents a very simple instrument, contrived by Mr Cavallo for making experiments on atmospherical electricity, and which, on several accounts, seems to be the most convenient for that purpose.

AB is a common jointed fishing-rod, without the last or smallest joint. From the extremity of this rod proceeds a slender glass tube C, covered with sealing-wax, and having a cork D, at its end, from which a pith-ball electrometer is suspended. HGI is a piece of twine fastened to the other extremity of the rod, and supported at G by a small string FG. At the end I of the twine a pin is fastened, which when pushed into the cork D, renders the electrometer E uninsulated.

When he would observe the electricity of the atmosphere with this instrument, he thrusts the pin I into the cork D, and holding the rod by its lower end A, projects it out from a window of the upper part of the house into the air, raising the end of the rod with the electrometer, so as to make an angle of about 50° or 60° with the horizon. In this situation he keeps the instrument for a few seconds, and then pulling the twine at H, disengages the pin from the cork D; which operation causes the string to drop in the dotted situation KL, and leaves the electrometer insulated and electrified, with an electricity contrary to that of the atmosphere.—This done, he draws the instrument into the room, and examines the quality of the electricity, without obstruction either from wind or darkness.

With this instrument he made observations on the electricity of the atmosphere, several times in a day for several months, and from them he deduces the following general observations, which seem to coincide with those made with the electrical kites.

1. That there is in the atmosphere, at all times, a quantity of electricity; for, whenever he used the above-described instrument, it always acquired some electricity.

2. That the electricity of the atmosphere, or fogs, is always of the same kind, namely positive; for the electrometer is always negative, except when it is evidently influenced by heavy clouds near the zenith.

3. That in general, the strongest electricity is observable in thick fogs, and also in frosty weather; and the weakest when it is cloudy, warm, and very near raining: but it does not seem to be less by night than in the day time.

4. That in a more elevated place, the electricity is stronger than in a lower one; for having tried the atmospherical electrometer, both in the stone and iron gallery on the cupola of St Paul's cathedral, Mr Cavallo found that the balls diverged much more in the latter than in the former less elevated place; hence it appears, that, if this rule takes place at any distance from the earth, the electricity in the upper regions of the atmosphere must be exceedingly strong.

499
His electrometer for rain.

Mr Cavallo has also contrived an instrument, which he calls his *electrometer for the rain*; this is merely an insulated instrument to catch the rain, and, by means of a pith-ball electrometer, to show the degree and quality of its electricity.

Fig. 130.

At fig. 130. is represented an instrument of this kind, which Mr Cavallo frequently used, and after several observations, found to answer very well. ABCI is a strong glass tube about two feet and a half long, having a tin funnel, DE, cemented to its extremity, which funnel defends part of the tube from the rain. The outside surface of the tube from A to B is covered with sealing-wax; so also is the part of it which is covered by the funnel. FD is a piece of cane, round which several brass wires are twisted in different directions, so as to catch the rain easily, and at the same time to make no resistance to the wind. This piece of cane is fixed into the tube, and a slender wire proceeding from it goes through the bore of the tube, and communicates with the strong wire AG, which is thrust into a piece of cork fastened to the end A of the tube. The end G of the wire AG is formed into a ring, from which is suspended a more or less sensible pith-ball electrometer, as occasion requires.

This instrument is fastened to the side of the window-frame, where it is supported by strong brass hooks at CB, which part of the tube is covered with a silk lace, in order to adapt it better to the hooks. The part FC is out of the window, with the end F a little elevated above the horizon. The remaining part of the instru-

---

* *Memoirs of the American Academy*, vol. i.

ment comes through a hole in one of the lights of the sash, within the room, and no more of it touches the side of the window than the part CB.

When it rains, especially in passing showers, this instrument, standing in the situation above described, is frequently electrified; and, by the diverging of the electrometer, the quantity and quality of the electricity of the rain may be observed, without any danger of a mistake. With this instrument, he observed, that the rain is generally, though not always, electrified negatively, and sometimes so strongly, that he has been able to charge a small coated phial at the wire AG.

This instrument should be fixed in such a manner, that it may be easily taken off from the window, and replaced again, as occasion requires; for it will be necessary to clean it very often, particularly when a shower of rain is approaching.

500 Use of his multiplier.

Mr Cavallo has also shewn how the electricity of the atmosphere may be observed by means of his multiplier, described in N° 255.

In order to examine the electricity of the atmosphere, he at first used to fix a long pointed wire into the socket of the plate A, and then exposed it to the open air. But he has lately used a much better method of accomplishing that object. He exposes, out of the window, an insulated stick of about five feet in length, and covered with tin-foil; and while he holds this apparatus by the extremity of its insulating handle, he touches with the other hand, for about two or three seconds, the lower part of the stick. By this means, the stick being free from points, acquires an electricity contrary to that of the surrounding air. Mr Cavallo then brings it within the room, and communicates that electricity to the plate A of the multiplier, &c. But the electricity so acquired by the insulated stick, is generally sufficient to affect an electrometer without the use of the multiplier. To examine the electricity of the rain, snow, hail, &c. the same apparatus must be exposed out of a window, but the stick must not be touched, for in this case, it acquires the same sort of electricity as that of the rain, snow, &c. and not the contrary sort, as when exposed to the air.

501 Observations by Mr Read.

Mr Read, in his "Summary View of the Spontaneous Electricity of the Earth and Atmosphere," observes, that the electricity of the atmosphere, in moderate weather, was always found to be positive; in storms and disturbed states of the air frequently negative; and suddenly and repeatedly changing from the one state to the other. Warm small rain was found to be very slightly electric; large drops, strongly; hail showers, the most intensely of all. In an easterly wind of long continuance, the electricity was so faint, as to require the nicest of all known tests for discovering its existence. The vapour of water, as soon as it had attained the height of five or six inches of insulation in the air, was found to be permanently and positively electrified; and the surface from which it evaporated, negatively. According to Mr Read, vapour has a greater capacity for electricity, or absorbs and requires more of fluid, than water in its denser state; and, therefore, rarefaction must diminish, and condensation increase, the sensible electric charge of the vapour. Hence, in serene weather, the atmosphere is subject to a regular flux and reflux, or increase and diminution of electricity twice in every twenty-four hours, depending on the action of the sun, and the consequent evaporation and state of the vapours. This diligent observer further remarks, that a limited portion of the earth's surface is often sensibly electrified; over it, there is always a proportionate state of the contrary electricity in the atmosphere; and when an electrified cloud is carried forward by wind, an equal and opposite electric charge keeps pace with it on the earth, till the two charges, becoming more augmented or approaching nearer to one another, or meeting with some conducting eminence, rush together and produce an explosion.

502 By M. Saussure.

Valuable experiments on atmospherical electricity, were made by M. Saussure in his excursions among the Alps. The instrument employed by M. Saussure is a modification of Cavallo's atmospherical electrometer, and is described under the article ELECTROMETER in the next volume.

The following are M. Saussure's observations on the electricity of the atmosphere.

503 Observations on atmospheric electricity.

Aerial electricity varies according to the situation; it is generally strongest in elevated and insulated situations; not to be observed under trees, in streets, in houses, or any inclosed places; though it is sometimes to be found pretty strong on quays and bridges. It is also not so much the absolute height of the places, as their situation: thus a projecting angle of a high hill will often exhibit a stronger electricity than the plain at the top of the hill, as there are fewer points in the former to deprive the air of its electricity.

The intensity of the atmospheric electricity is varied by a great many circumstances, some of which may be accounted for, others cannot. When the weather is not serene, it is impossible to assign any rule for their variation, as no regular correspondence can then be perceived with the different hours of the day, nor with the various modifications of the air. The reason is evident; when contrary and variable winds reign at different heights, when clouds are rolling over clouds, these winds and clouds, which we cannot perceive by any exterior sign, influence however the strata of air in which we make our experiments, produce these changes of which we only see the result, without being able to assign either the cause, or its relation. Thus, in stormy weather, we see the electricity strong, then null, and in a moment after rise to its former force; one instant positive, the next negative; without being able to assign any reason for these changes. M. Saussure says, that he has seen these changes succeed with such rapidity, that he had not time to note them down.

When rain falls without a storm, these changes are not so sudden; they are however very irregular, particularly with respect to the intensity of force; the quality thereof is more constant. Rain, or snow, almost uniformly gives positive electricity.

In cloudy weather, without rain or storms, the electricity follows generally the same laws as in serene weather.

Strong winds generally diminish its intensity; they mix together the different strata of the atmosphere, and make them pass successively towards the ground, and thus distribute the electricity uniformly between the earth and the air; M. Saussure has observed a strong electricity with a strong north wind (*la bise*).

The state of the air, in which the electricity is strongest,

strongest, is foggy weather: this is always accompanied with electricity, except when the fog is going to resolve into rain.

The most interesting observations, and those which throw the greatest light upon the various modifications of electricity in our atmosphere, are those that are made in serene weather. In winter, (during which most of M. Saussure's observations were made) and in serene weather, the electricity was generally weakest in an evening, when the dew had fallen, until the moment of the sun's rising; its intensity afterwards augmented by degrees, sometimes sooner, and sometimes later; but generally before noon, it attained a certain maximum, from whence it again declined, till the fall of the dew, when it would be sometimes stronger than it had been during the whole day; after which, it would again gradually diminish during the whole night; but is never quite destroyed, if the weather is perfectly serene.

504 Periodical flux and reflux observable in the electricity of the atmosphere.

Atmospherical electricity seems, therefore, like the sea, to be subject to a flux and reflux, which causes it to increase and diminish twice in 24 hours. The moments of its greatest force are some hours after the rising and setting of the sun; those when it is weakest, precede the rising and setting thereof. This will be farther explained in the following pages.

M. Saussure has given an instance of this periodic flux in electricity, on the 22d of February, 1785, (one of the coldest days ever remembered at Geneva); the hygrometer and thermometer were suspended in the open air, on a terrace exposed to the south-west; the electrometer, from its situation, indicated an electricity equal to what it would have shewn if it had been placed on an open plain. The height of the barometer is reduced to what it would have been if the mercury had been constantly at the temperature of 10 degrees of Reaumur's thermometer. The place of observation was elevated 60 feet above the level of the lake. The observations of the day preceding and following this great cold, are inserted in the following table; because it is pleasing to have the observations which precede and follow any singular phenomena. There was a weak south-west wind during the whole three days; and it is rather remarkable, that most of the great colds, which have been observed at Geneva, were preceded by, or at least accompanied with, a little south-west breeze.

TABLE.

				Barometer feet in height.			Thermometer.			Hygrom.		Electrom.		
	h.	m.												
Feb. 21st,	9	15	M	26	6	7	—	8	3	89	3	2	0	Pale sun, cloudy.
	11	10	M	26	6	5	—	4	3	83	9	1	6	Bright sun.
	2	10	E	26	6	1	—	0	2	69	6	1	1	The same.
	5		E	26	6	1	—	2	3	77	2	1	1	Setting sun.
	6		E	26	6	0	—	5	2	85		1	0	Cloudy in the S. W.
	7		E	26	6	2	—	6	8	89		1	8	Perfectly clear.
	8		E	26	6	3	—	10	0	95		2	0	Idem.
	9		E	26	6	3	—	10	6	97	5	1	8	Idem.
	10		E	26	6	1	—	9	9	95		1	2	Little cloud at horizon S.
	11		E	26	6	0	—	12	3	99	1	1	5	Idem more to S. W.
	12		E	26	5	15	—	12	5	Hoar frost		1	2	Idem.
22d,	1		M	26	6	0	—	14	3	Idem		0	9	Idem.
	2		M	26	6	8	—	14	5	Id.		1	2	Clouds increase and approach.
	6	15	M	26	5	7	—	15	0	Id.		0	8	Clear.
	7	30	M	26	5	4	—	14	7	Id.		1	2	Light fog.
	8	10	M	26	5	2	—	14	2	Id.		1	1	Idem.
	9	10	M	26	4	15	—	10	7	Id.		1	6	Idem.
	10	10	M	26	4	13	—	8	2	Id.		2	2	Thicker fog.
	11	10	M	26	4	3	—	4	8	Id.		1	8	Idem.
	1	10	E	26	4	0	—	4	9	Id.		1	7	Idem.
	2	20	E	26	3	14	+	0	6	82		1	4	Weak fog, pale sun.
	3	30	E	26	3	13	—	0	9	81	9	1	1	Cloudy pale sun.
	5		E	26	3	13	—	4	3	89		1	2	Less cloudy.
	6		E	26	3	14	—	4	4	91	2	2	2	More so.
	7		E	26	3	14	—	6	1	94		1	7	Idem.
	8		E	26	3	13	—	5	9	Id.		3	7	Cloudy, foggy in S. W.
23d,	0	45	M				—	4	1	Id.		1	0	Cloudy with more fog.
	8	5	M	26	5	0	—	1	0	81	3	1	2	Idem.
	10	7	M	26	5	5	—	0	0	76		0	8	Idem.
	3	45	E	26	6	8	+	0	5	76		Id.		Cloudy pale sun.
	5		E	26	6	14	—	0	3	75	3	1	0	Cloudy.
	6		E	26	7	3	—	0	7	74		0	8	Idem.
	7		E	26	7	9	—	1	7	79	7	2	2	Very clear.
	8		E	26	7	14	—	3	7	87	3	1	7	Cloudy.
	12		E	26	9	1	—	3	0	92		0	5	More so.

M for Morning, E for Evening.

From the first 18 observations of this table, when the sky was quite serene, we see that the electricity was pretty strong at nine in the morning; that from thence it gradually diminished till towards six in the evening, which was its first minimum; after which it increased again till eight, its second maximum; from whence it again gradually declined till six the next morning, which was the time of its second minimum; after which, it again increased till ten in the morning, which was the first maximum of the following day: as this was cloudy, the electric periods were not so regular.

505 Electricity weaker in summer than in winter.

The electricity of serene weather is much weaker in summer than in winter, which renders it more difficult to observe these gradations in summer than in winter: besides a variety of accidental causes, which at the same time render them more uncertain. In general, in summer, if the ground has been dry for some days, and the air is dry also, the electricity increases, from the rising of the sun till three or four in the afternoon, when it is strongest: it then diminishes till the dew begins to fall, which again reanimates it; though after this it declines, and is almost extinguished during the night.

But the serene days that succeed rainy weather in summer, generally exhibit the same diurnal periods or states of electricity, as are to be observed in winter.

506 Electricity of the air in serene weather naturally positive.

The air is invariably positive in serene weather, both in winter and summer, day and night, in the sun or in the dew. It would seem, therefore, that the electricity of the air is essentially positive, and that whenever it appears to be negative, in certain rains or in storms, it probably arises from some clouds, which have been exposed to the pressure of the electric fluid contained in the upper part of the atmosphere, or to more elevated clouds, that have discharged a part of their fluid upon the earth, or upon other clouds.

507 In order to find out the cause of these phenomena, M. Saussure instituted a set of experiments on evaporation, avoiding the use of Volta's condenser.

To produce a strong evaporation, he threw a mass of red-hot iron into a small quantity of water, which was contained in a coffee-pot, with a large mouth, and suspended by silk strings; by this he obtained a strong positive electricity, though, according to M. Volta's system, it ought to have been negative. The experiment was repeated several times, varying some of the circumstances, but the result was always the same.

As it was not easy to think so able a philosopher as M. Volta was deceived, it was necessary to try the experiment in a manner more analogous to that of M. Volta. A small chafing-dish was therefore insulated by silk cords, and the coffee-pot, with a small quantity of water, placed on it; one electrometer was connected with the coffee-pot, and another with the chafing-dish; the fire was raised by a pair of bellows: when the water had boiled strongly for a few minutes, both electrometers exhibited signs of electricity, which, on examination, was found to be negative; proving the truth of M. Volta's experiment. The evaporation produced by the effervescence of iron in the sulphuric acid, and by that of chalk in the same acid, gave also negative electricity.

It was now necessary to inquire, why the vapour, excited by the heated iron, produced positive electricity; while that from boiling water, in any other way, produced a negative electricity.

M. Saussure suspected, that the intensity of heat to which the water is exposed, by the contact of a body in a state of incandescence, was the cause of the electricity produced by its evaporation; and that a combination was then formed, by which a new quantity of the electric fluid was produced. This conjecture may at first sight seem improbable; but the quantity of electricity produced by this experiment will astonish those that repeat it; and this quantity is more surprising, because, if it is true, according to the system of M. Volta, that the vapours absorb, while they are forming, a quantity of the electric fluid, there must, therefore, be enough developed in this experiment, for the formation of the great quantity of vapours produced by the heated iron, and afterwards a sufficient quantity to electrify strongly the apparatus, and all these vapours.

This experiment shews clearly the cause of that prodigious quantity of electricity, which is unfolded in the eruption of volcanoes; as it is probable, that the water in these, from many circumstances, acquires a much greater degree of heat than is given to it in our experiments.

508 Explanation of the great quantity of electricity apparent in the eruptions of volcanoes.

To verify this conjecture, that it was in some measure the combustion of the water, or the iron, that produced the positive electricity, it was proper to try whether, by a regular moderation of the heat of the iron, positive electricity would always be obtained. This was essayed in the following manner: A large iron crucible, five inches high, four in diameter, and six lines thick, was heated red hot; then insulated; after which, small quantities of water were thrown into it, each projection of the water cooling more and more the crucible; thus descending by degrees till there was only sufficient heat to boil the water; carefully observing, and then destroying the electricity produced at each projection. The electricity was always positive or null; at the first projections it was very strong; it gradually diminished to the twelfth, when it was scarce sensible, though always with a tendency to be positive.

On repeating this experiment, and varying it in different ways, a remarkable circumstance was observed. When a small quantity of water was thrown into the crucible, the moment it was taken from the fire, while it was of a pale red, approaching what is called the white heat, no electricity was obtained.

This fact seemed to have some connection with another mentioned by Muschenbroeck, that water evaporates more slowly on a metal, or any other body, in a state of incandescence, than on the same body, heated only a small degree above boiling water. To examine this relation, and to find whether there was any between the periods of evaporation, and the production of electricity, M. Saussure made a great number of experiments, which are most accurately described in his excellent work; but as the detail would be much too long to be introduced in this article, we must content ourselves with presenting the reader with the heads thereof, and a description of the apparatus.

509 Experiments on evaporation.

The apparatus consisted of a pot of clay, well baked or annealed, fifteen lines thick, and four inches in diameter; this was insulated by a dry glass goblet; upon this pot was placed the crucible, or any other heated substance, on which the water was to be thrown, in order to be reduced into vapours; the crucible was contiguous to a wire connected with an electrometer; a measure, containing 54 grains weight of distilled water, was thrown upon the heated crucible; the time employed in the evaporation thereof was observed by a second watch; the electricity produced by this evaporation was noted. When this measure of water was reduced into vapour, the electricity of the apparatus was destroyed, and a fresh measure of water was thrown into the crucible; proceeding in the same manner till the crucible was almost cold.

The first experiment was with an iron crucible, from which it was found that Muschenbroeck was not right, in saying that the evaporation was slowest when the iron was hottest; for at the instant it was taken from the fire it required 19 seconds to evaporate the water, and took more time till the third projection, when it took 35 seconds, though from that period it employed less time, or, in other words, the evaporation accelerated in proportion as the iron cooled.

With respect to the electricity, it was at first 0, then positive, afterwards negative, then 0, and afterwards positive to the end of the experiment. The vapour was not visible till the 7th projection.

In the second experiment with the same crucible, though every endeavour was made use of to render them as similar as possible, the electricity was constantly positive.

The third experiment was with a copper crucible; here also the electricity was positive, and the longest time employed in evaporation was not the instant of the greatest heat. It was very curious to see the water endeavouring to gather itself into a globule, like mercury on glass; to be sometimes immoveable, and then to turn on itself horizontally, with great rapidity; sometimes throwing from some of its points a little jet, accompanied with a hissing noise.

The fourth experiment was with the same crucible; the electricity was at first negative, then constantly positive.

The fifth was with a crucible of pure silver; a considerable time was employed here in evaporating the same quantity of water; even in the instant of the greatest heat it took five minutes, six seconds; the electricity was weak; three times no electricity was perceived, five times negative electricity was discovered.

In a sixth experiment with the same crucible, a positive electricity was obtained, at the second projection; after which none of any kind was perceived.

The seventh, with the same, gave at first strong negative electricity, the second and third projection gave a weak positive electricity.

The eighth was made with a porcelain cup; here the evaporation was slower at the second, than the first projection; but from this it took longer time till it was cold, contrary to what happened with the metals; the electricity was always negative.

The ninth and tenth experiments, with the same cup, produced similar effects.

The eleventh experiment was with spirits of wine in a silver crucible; here there was no electricity produced at the two first projections, and what was afterwards obtained was negative.

Twelfth experiment with ether; here the electricity was also negative. These two inflammable fluids, in evaporating, followed the same laws as water, being dissipated at first most rapidly in the greatest heat, afterwards taking a longer and longer time before they were evaporated, to a certain period, then employing less time, or evaporating quicker, till the crucible was nearly cold.

Now as china and silver always produced negative electricity, while iron and copper have generally given positive electricity, we may conclude, that electricity is positive with those bodies that are capable of decomposing water, or of being decomposed themselves by their contact with the water; and negative with those which are not at all decomposed or altered.

If in the foregoing experiment, those substances which were susceptible of oxidation had constantly given a positive electricity, and those which do not oxidate had always given the negative; every thing would have been explained by these principles, and they would thence have acquired a greater degree of probability. But the phenomena have not always followed this law. We have seen iron and copper sometimes give a negative electricity, and silver the positive. The first case is not difficult to account for; it is well known with what facility iron and copper are oxidated in a brisk fire; they become covered with a scaly crust, which is not susceptible of any further alteration with the same heat. If the bottom of the crucible acquires this crusty coating, the drop of water placed thereon will be no longer in contact with an oxidable substance; there will be no further decomposition, no generation of the electric fluid: the vapours, however, which are still formed, will absorb a part of the fluid naturally contained in the apparatus, and this will therefore be electrified negatively. If some of the scales should be so far detached, that the water may gain some points of contact, the quantity thus generated may compensate for what is absorbed by the vapours, and thus the electricity will be null. If more are detached, it will superabound and be positive. From the same reasons, a large mass of water, by attacking the iron in a greater number of points, always gives positive electricity; and hence, also, a strong positive electricity is obtained, by throwing a piece of red-hot iron into a mass of water.

It is not so easy to explain why silver gives sometimes a positive electricity, but by supposing it to have been mixed with some substances capable of oxidation; and this the more, as the white porcelain always gave negative electricity. This supposition was verified by some subsequent experiments, in which the same silver, when purified, always gave a negative electricity.

M. Saussure owns himself incapable of explaining why heated charcoal always gives negative electricity; unless it can be attributed to the promptitude with which so rare a substance loses its heat, by the contact of water.

One fact astonished him, namely, that by combustion properly so called, although it is an evaporation, nay, the highest degree of evaporation, he never obtained any signs of electricity; though he tried to obtain it in a variety of ways. Probably, the current produced by the flame, disperses and dissipates the electricity as soon as it is formed. The case, however, must not be looked upon as general, because M. Volta obtained signs of electricity from bodies in combustion, by means of his condenser.

Another singular fact was, his not being able to obtain electricity without ebullition, though he endeavoured to compensate by the quantity of surface for the quantity of vapours that were elevated by boiling water; and indeed, the same quantity of water, if extended over too large a surface, will not give any electricity.

We shall resume this subject immediately, but must first conclude our observations on the phenomena of atmospherical electricity.

The following axioms with respect to atmospherical electricity, deduced by M. Cotte, after a long course of observations, merit attention.

510 Cotte's axioms.

1. Electricity manifests itself oftener without storms than with them.
2. It is produced more frequently by dry than by rainy clouds.
3. It is more frequently positive than negative, especially when occasioned by stationary clouds.
4. The atmosphere exhibits signs of electricity at all times by night or day.

511 Causes of atmospherical electricity.

In our endeavours to explain the production of natural electricity, we have nothing more to do, than to discover the various circumstances of the atmosphere, in which moisture is absorbed or precipitated.

512 Absorption and precipitation of aqueous particles.

It is necessary to recollect the proof furnished by numerous experiments, that when any portion of the atmosphere is in a state to take up an additional quantity of moisture, it is in a state at the same time to take up more electric fluid; and *vice versa*, when it is parting with its water, it is at the same time parting with its electric fluid. But in these cases, neither the superabundance nor the deficiency can produce a charge, unless there be some other part of the air contemporaneously in an opposite state, or in a disposition either to receive or give. It is, however, scarcely possible that this should not always happen; for our atmosphere is, throughout its vast dimensions, each moment agitated by millions of co-instantaneous changes, and for our purpose, it is of no consequence where the required change takes place. Were it New Holland, or at the Antipodes, a connection would be instantly formed between the remote but opposite situations, by the conducting power of the earth.

513 Violence of storms correspondent to these.

It is a necessary conclusion from what we have just said, that if the absorption of moisture by air, or the copious evaporation of it from the earth, be attended with a new accumulation of the fluid; then *where* this cause operates most powerfully, *there* its correspondent effect will be most sensible. We consequently find, that the most tremendous electrical phenomena belong to the countries within the tropics, or to that portion of our atmosphere which is loaded with moisture by the most powerful influence of the sun's rays. In like manner, within the limits of our own and other similar climates, electrical phenomena are greatest, both in force and frequency, during the hottest months of the year, or during the season in which our atmosphere is most copiously and rapidly charged, by absorbing the humidity of the ground.

514 Electrical appearances of volcanoes.

In the neighbourhood of Ætna and Vesuvius, during the period of their volcanic fury, surfaces, covering the dimensions of several square leagues, are sometimes scorched with red-hot lava, and every atom of their moisture is rapidly dissipated. At the same time the surrounding air is heated to a vast extent, and in this state swallows up an immense quantity of aqueous vapour: but contemporaneously with the operation of these causes assisting the natural sources of evaporation, according to the reports of all natural historians, an immense quantity of the electric fluid is accumulated and discharged.

515 Storms peculiar to the torrid zone.

Again, a dry wind passing over a moist soil is another modification of the cause we are applying; it produces a copious and rapid solution of the aqueous particles, and its consequent alteration of attractive force. Let us for instance, suppose a wind, which had passed over the deserts of Arabia, or that had been torrefied in its passage over a large extent of burning sands, to come in contact with a similar extent of marshy soil, or of any surface well drenched with water, a most abundant evaporation would necessarily take place, and with it an immense accumulation of the electric fluid. But subsequently, in case any power operated, which would take away the aqueous particles thus dissolved, and of course alter the degree of attractive force by which the collected electric fluid is suspended, we should find that the most dreadful thunder-storms would take place. This is really the case; for there is scarcely a region in the vast circle surrounding the immeasurable sands of Africa, which is not remarkable for storms and tempests.

On the side of Abyssinia, when the warm winds that have passed over the neighbouring deserts are condensed on its mountains, those deluges are collected, which form the inundations of the Nile.

On the coast of Guinea, the *harmattan*, which is a current of air so dry, as to wither and pulverize, by a complete absorption of all its juices, every substance that occurs in its passage, is no sooner mixed with that body of air which is cooled by the ocean, than it forms most terrific hurricanes of wind and lightning that are described by navigators. Along the Syrian regions, we learn from sacred authority, that the storms gather with such rapidity, that a cloud, which this instant might be covered with the hand, is within the interval of a few minutes, charged with water adequate to the inundation of a whole country.

516 Application of the various cases of precipitation.

Having specified the two most general causes of evaporation on the surface of this earth, let us now attend to the possible changes of the atmosphere, when by the operation of either, or both, it is charged with the electric fluid. All these changes are but different degrees of the same effect, viz. the condensation of moisture, and this condensation is in every case produced by an alteration of temperature, which may proceed,

517 Mixture of a colder with a warmer air.

1. From a mixture, or even the contact of a colder with a warmer air. When the smallest clouds are formed by such a mixture, an electric charge takes place, so that one part of the cloud has more, and the other less, than its natural share. Fogs, dews, and the slightest change of clear for hazy weather, commonly arise from a warmer atmosphere coming in contact with one of a lower temperature; but even these trifling degrees of condensation are always followed by signs of electricity *.

---

* Vide *Read on spontaneous Electricity.*

Atmospherical Electricity.

In this country, from its insular situation, which exposes it to the perpetual influence of varying winds, the air changes its appearances often many times in one day. But there is no degree of thick cloudiness or perfect clearness, of scattered clouds succeeding embodied masses of clouds, of small rain increasing to heavy, or *vice versa*, that is not attended with changes in the expressions of the elevated conductor, which never fails to vary with all the atmospheric condensations and rarefactions that take place.

It is, however, obvious, that the effect must be in proportion to the quantity and rapidity of the condensation. When, therefore, any body of air has been for a long time suspended over a surface of ground previously drenched with showers, and at the same time exposed to the violence of the sun's rays, a change in the direction of the wind, or such a change in the weight of the air as mixes the upper with the lower regions of the air, is almost always attended with a thunder-storm.

In tropical climates, for months together, scarcely a day passes, in which the calm atmosphere is not loaded by successive additions of moisture, till at last it becomes the reservoir of vast rivers and lakes, and of all the moisture that is spread over whole continents. But when this drought has reached its crisis, the sun crosses the line, the wind takes a new direction, a colder air mixes with that which is thus charged with vapours, and the condensation becomes so copious, as to inundate all the subjacent country. Confined to the proceedings of nature in this colder region, our imaginations have no images from which any such comparison can be made, as will communicate the least idea of the thunder attending a tropical hurricane.

The cause which we are now applying to the explanation of these natural appearances, will furnish us with an easy solution of a difficulty which has oppressed several theories of electricity, namely, that rapid generation and increase of the electric fluid which takes place in some thunder-storms. Even in this country, the succession of flashes is sometimes so quick, that one hundred and twenty have been known to follow each other in a minute. In Asia, this celerity of accumulation and discharge was so great, that Homer uses it as part of a simile, by which he paints the quick repetition of Agamemnon's sighs and pantings in an hour of distress.

It may be asked, if each distinct cloud is loaded with a distinct charge, and if each flash is a separate discharge of such a cloud, what is there, in our knowledge of natural powers, that will account for an innumerable repetition of these accumulations and discharges within a very short space of time, more especially when each of them is connected in our minds with the necessity of a distinct part of that time for its process? In other words, do we know of any cause that is adequate to the filling and emptying of the same portion of air every instant, for hours together?

On a hot summer's day it not unfrequently happens, that a fine blue sky will, within five seconds, be changed into one mass of clouds. If the cause which produced so great an effect, were supposed to be doubled in its power of condensation, the degree of electricity shown by the elevated conductor would be rather more than doubled, and its signs would be much stronger than in a common storm; we may hence conclude that the whole mass which might be thus formed in five seconds, would be loaded so as to have every part of it at the discharging height; but the mass might consist of hundreds of distinct clouds all in the same state, and consequently adequate to the production of several hundred flashes within a minute.

Atmospherical Electricity.

The collapse of aqueous particles, which would necessarily follow such a rapid succession of discharges as have been now proved to be possible, would produce a partial vacuum of great extent, and on all sides the heavier air would rush into it, and the upper and colder regions would press downwards, and by their condensing temperatures, would renovate all the accumulations and discharges which have been already described: a second collapse would follow a second series of thunder-strokes, and a partial vacuum additional to the former; a fresh portion of warm air would again rush in from all quarters, and a fresh mixture of cold air from the upper regions. It is scarcely necessary to show that this repetition of condensations may continue for hours, or till the air, which rushes in laterally, becomes of such a temperature, that its mixture with the colder air will not produce the condensations adequate to the collection of that quantity of electric fluid which is necessary for a discharge.

From this explanation, it is obvious that a central point must exist, at which the violence of every storm begins, and from which it is spread in all directions. A hurricane in the West Indies, though ruinous to many, is generally the more distinguishing calamity of one island, at which alone the wind is described as blowing from every point of the compass; while in every other island, it is represented as bearing down decisively from one quarter.

518
Heated air coming in contact with the cold earth.

2. The precipitation of aqueous particles when suspended by heat in air, is frequently the consequence of the loaded atmosphere's coming in contact with portions of the earth that are colder than itself. Such, particularly, are the summits of mountains, whose effect is great in proportion to the degree of their cold and the extent of their surface. It is, however, certain that condensations, when thus produced, are invariably attended by thunder-storms.

The uproar, and the splendour of the innumerable lightnings, which dart through all the entangled circuits of an abyss of thunder-clouds, are the immutable attributes of grandeur which belong to the Cordilleras; for they dam up, as it were, an immense flow of air, which is almost saturated with moisture by passing over several thousand leagues of land, exposed to the fury of a tropical sun.

In summer, the north-westerly winds that pass over France, are always condensed by the Alps; and in the night, during such a state of the atmosphere, to all those who live along the Saone and the upper part of the Rhone, these mountains are always brightened by electrical flashes and coruscations.

All ridges or chains of very high grounds, especially those which terminate extensive plains lying in the direction of their most common winds, are perpetually beclouded; and with a good conductor fixed on their summit, we should find that the signs of electricity were as constant as the condensations by which they are enveloped. But in proportion to the coldness, so is the subsequent change of temperature on the eminences diminished, and the electrical effect dependant on that change. It hence happens, that there are countries in the northern parts of Europe, the gloom of whose mists is never dispersed by a thunder-storm, excepting in the hottest season of summer.

519 Sudden interruption of the sun's influence.

3. When the sun, by directing its rays with force and abundance upon the earth for any length of time, has produced a considerable evaporation, the mere interruption of its influence will be attended with a discharge of the electric fluid; for the great source of change in our atmosphere is the ready influence of its upper regions, which are cold, on its lower regions when warmed; and any cause which mixes these together, must bring on a condensation of aqueous vapour. This mixture, however, takes place on the mere approach of night, as is evident from the change of temperature expressed by the thermometer, and the usual fall of the dews; we consequently find, that as night comes on, the signs of electricity always increase. When the weather is tolerably settled, or such that no other cause is active than that proceeding from the change of day for night, or night for day; then the signs of electricity gradually decrease from twelve o'clock at night till six in the morning; from this hour till nine, they gradually increase, when they become exceedingly weak, and continue so till four in the afternoon: the increase at this time recommences, and is very decisive in its appearance till about two hours after sunset, when it becomes stationary, and remains in this state, or decreasing, so as scarcely to be sensible, till the morning*.

The cause, whose operation we have now investigated in the production of its most feeble effects, may be easily applied to many other cases, in which similar but greater powers are displayed by nature. Let us suppose, that on a wide surface of ground, previously warmed by the sun, copious showers of rain had fallen, followed by a return of the sun's influence; in this case, the evaporation is necessarily very rapid, and the signs of electricity expressed by an elevated conductor are very strong.

When a copious production of electric fluid has attended a copious evaporation continued for several successive hours, a thunder-storm, or some striking electrical appearance will come on with the approach of night, for unless the barometer should suddenly rise, the condensation attending the evening's cold must be very considerable, and its usual consequences proportionally great. Such a day as we have just described, is usually followed by a violent thunder-storm. Indeed, there is scarcely an instance in which a moist ground, operated on for some hours by a clear sun, provided the wind continues to blow from the south-west or west, is not attended the following night by the appearance of falling stars, flashes of lightning, or the *Aurora Borealis*.

520 Effect of winds on the electricity of the atmosphere.

We have alluded to the connection of winds with the phenomena of atmospherical electricity. The influence of winds must depend on various circumstances; in some cases, they will tend to diminish electrical appearances, and in others, they may altogether destroy them. The current of air which proceeds from a mixture of two winds of different temperatures, is the effect of a condensation of vapour, that may be succeeded by the most violent storms. But if there should be two neighbouring regions, in one of which, the rays of the sun should co-operate with the moisture of the ground, in producing electricity, while in the other there should prevail a condensation favourable to the discharge of the electric fluid; a current of air would be produced that would act like a communicating rod between two opposite electrified surfaces, would exchange the situations of the charged bodies, and would consequently cause the new situation to counteract the effects produced in the last. This effect would be more sensible in proportion as the exchange has been more rapid, and accordingly we find, that during high winds, the electricity of the atmosphere is very small †.

Those who propose to make observations with the electrical kite, should have it constructed in the most simple manner, as it is liable to be injured or lost. An ordinary paper kite, about four feet in height, and two feet wide, is enough; when large it is troublesome, and requires a comparatively high wind to raise it. It requires to be varnished with drying oil to defend it from the rain. In raising or lowering it, the operator, for his security, should make a part of it bear constantly against a conducting rod fixed in the ground to leeward of him, and surmounted with a brass ball. Afterwards the string should communicate with an insulated conductor brought within two inches of the brass ball.

As the effects are greater in proportion to the height to which the kite rises and the length of the string, two or three are sometimes employed one above the other. These have each a long slit through the middle stick or straighter; and when the first kite has taken as much cord as it will carry, the end is passed through the slit of a second kite, and tied to its string, and when this has risen to its full height, another is added. But kites thus connected are sometimes acted on by opposite aerial currents, and the success of the experiments marred.

For permanent observations, however, a conducting rod elevated into the atmosphere, and fixed to a building, is required. It was with this apparatus that Beccaria made his regular observations.

Mr Cropse has more recently made numerous observations with an extensive atmospheric conductor, consisting of a copper wire $\frac{1}{16}$th of an inch thick, and a mile and a quarter long, afterwards shortened to 1800 feet. It was so contrived as to admit of being shifted in order to cleanse the insulators from spiders webs, and other conducting materials accidentally attached to them, and means of strong security were employed to resist the weight of numerous birds that were in the habit of perching on it. From the observations of this gentleman, the following deductions were made:

1. In the usual state of the atmosphere, its electricity is invariably positive. This is weakest in the night. It is weaker in the middle of the day than in the morning and afternoon.

2. Fogs, rain, snow, and hail, change the electric state of the wire. When these come on, it is usually negative, then often changes to positive, after they have begun, which increases, then gradually decreases, and

---

* Vide *Read on spontaneous Electricity.*

† *Morgan's Lectures*, vol. ii.

and changes every three or four minutes. Negative electricity is a sure indication of the approach of moist weather, or a thunder-cloud.

3. The approach of a thunder-cloud sometimes produces positive and at other times negative electricity, which increases, then disappears, and is succeeded by opposite signs. Such changes are often numerous, increasing in intensity at each repetition, and at last streams of sparks are transmitted from the conductor to the metallic ball, accompanied with a strong current of air, proceeding from the wire. At every flash of lightning, an explosive stream, accompanied with brilliant light and a peculiar noise, passes between the balls.

4. A driving fog or smart rain often produces effects nearly to the same extent as a thunder-cloud.

5. In cloudy weather, weak positive electricity usually prevails. If rain falls, it usually changes to negative; and the positive state is resumed when the rain ceases.

6. Positive electricity is stronger in clear frost than in a fine summer day.

The following list expresses the order of intensity of the electrical signs that occur on different occasions. 1. Regular thunder-clouds. 2. Driving fog and small rain. 3. A fall of snow, or a brisk hail-storm. 4. A smart shower, especially on a hot day. 5. Hot weather after wet days. 6. Wet weather after a series of dry days. 7. Clear frost. 8. Clear summer weather. 9. Sky obscured by clouds. 10. A mottled sky. 11. Sultry weather, with light hazy clouds. 12. A cold damp night. 13. Cold north east winds.

Chap. III. *Of the Aurora Borealis.*

Most of the luminous appearances in the atmosphere have of late been attributed to electricity. Of these we shall at present only consider the *Aurora Borealis*, or *Northern Lights*, reserving the account of other meteors for the article Meteorology.

The aurora borealis is usually of a reddish colour, inclining to yellow, sending out frequent coruscations of pale light, which seem to rise from the horizon in a pyramidal undulating form, shooting with great velocity towards the zenith. This light sometimes appears remarkably red, as it happened December 5. 1737.

521 Phenomena of the aurora borealis.

The aurora borealis appears frequently in the form of an arch; chiefly in spring and autumn, after a dry year. This arch is partly bright, partly dark, but generally transparent; and no change is found to be produced by it on the rays of light which pass through it. It sometimes produces a rainbow.

Mr Dalton, in his Meteorological Essays, gives the following account of an uncommonly fine aurora which appeared on the 13th of October 1792.

Attention was first excited by a remarkable redness of the clouds to the south, which afforded sufficient light to read by at eight o'clock in the evening, though there was no moon nor light in the north. A theodolite was placed to observe its altitude and bearing.

From $9\frac{1}{4}$ to 10 P. M. there was a large luminous horizontal arch to the southward, almost like those we see in the north; and one or more faint concentric arches northward. It was particularly noticed, that all of these seemed exactly bisected by the plane of the magnetic meridian. At half-past 10 streamers appeared very low in the S. E. running to and fro from W. to E. They increased in number, and began to approach the zenith apparently with an accelerated velocity; when, all on a sudden, the whole hemisphere was covered with them, and exhibited such an appearance as surpasses description. The intensity of the light, the prodigious number and volatility of the beams; the grand intermixture of all the prismatic colours in their utmost splendour, variegating the glowing canopy with the most luxuriant and enchanting scenery, afforded an awful, but at the same time, the most pleasing spectacle in nature. But the uncommon grandeur of the scene only lasted about one minute; the variety of colours disappeared, and the beams lost their lateral motion, and were converted, as usual, into the flashing radiations; but even then, it surpassed all other appearances of the aurora, from the whole hemisphere being covered with it.

Notwithstanding the suddenness of the effulgence at the breaking out of the aurora, there was a remarkable regularity in the manner. Apparently a ball of fire ran along from east to west, and the contrary, with a velocity so great, as to be barely distinguishable from one continued train which kindled up the several rows of beams one after another: these rows were situate before each other with the exactest order, so that the basis of each row formed a circle crossing the magnetic meridian at right angles; and the several circles rose one above another in such sort, that those near the zenith appeared more distant from each other than those near the horizon, a certain indication that the real distances of the rows were either nearly or exactly the same. And it was further observable, that during the rapid lateral motion of the beams, their direction in every two nearest rows was alternate; so that while the motion in one row was from E. to W. that in the next was from W. to E. The point to which all the beams and flashes of light uniformly tended, was in the magnetic meridian, and as near as could be determined between 15 and 20 degrees south of the zenith. The aurora continued, though diminishing in splendour, for several hours. Several meteors, (falling stars,) were seen at the time; they seemed below the aurora, and unconnected with it.

This kind of meteor, which becomes more uncommon as we approach towards the equator, is almost constant during the long winter of the polar regions, and appears there with the greatest lustre.

In the Shetland isles, the *merry dancers*, as the northern lights are there called, are the constant attendants of clear evenings, and afford great relief amid the gloom of the long winter nights. Their first appearance is commonly at twilight, near the horizon, of a dim colour, approaching to yellow; sometimes continuing in that state for several hours, without any perceptible motion; and afterwards breaking out into streams of stronger light, spreading into columns, and changing slowly into numberless different shapes, and varying in colour from all the tints of yellow, to the most obscure russet brown. They often cover the whole hemisphere, then exhibiting the most brilliant appearance. Their motions and change of form are at this time astonishingly rapid. They break out in places where none were seen before, skim briskly along the heavens,

heavens, are suddenly extinguished, and are succeeded by a uniform dusky tract. This again is brilliantly illuminated in the same manner, and as suddenly becomes a dark space. In some nights, they assume the appearance of large columns, on one side of the deepest yellow, and on the other gradually changing, till it becomes undistinguishable from the sky. They have generally a strong tremulous motion from one end to the other, continuing till the whole vanishes. As for us, who see only the extremities of these phenomena, we can have but a faint idea of their splendour and motions. They differ in colour according to the state of the atmosphere, and sometimes assuming the colour of blood, they make a dreadful appearance. The rustic sages who observe them become prophetic, and terrify the spectators with alarm of war, pestilence, and famine; nor indeed were these superstitious presages peculiar to the northern islands: appearances of a similar nature are of an ancient date; and they were distinguished by the appellations of *phasmata*, *trabes*, and *bolides*, according to their forms and colours. In old times they were either more rare or less frequently noticed; but when they occurred, they were supposed to portend great events, and the timid imagination formed of them aerial conflicts.

In the northern latitudes of Sweden and Lapland, the *aurora borealis* is not only an object of pleasing curiosity from the singular beauty of its appearance, but is extremely useful in affording to travellers, by its almost constant effulgence, a very brilliant light. In Hudson's bay, it is said to possess a variegated splendour, equalling that of the full moon. "In the north-eastern parts of Siberia," says Gmelin, "these northern lights are observed to begin with single bright pillars rising in the north, and almost at the same time in the north-east, which gradually increasing, comprehend a large space of the heavens, rush about from place to place with incredible velocity, and finally almost cover the whole sky up to the zenith, and produce an appearance as if a vast tent was spread in the heavens, glittering with gold, rubies, and sapphire. A more beautiful spectacle cannot be painted; but whoever should see such a northern light for the first time, could not behold it without terror. For however fine the illumination may be, it is attended, as I have learned, with such a hissing, cracking, and rushing noise through the air, as if the largest fireworks were playing off. To describe what they then hear, they make use of the expression *spolochi chodjat*, i. e. "the raging host is passing." The hunters who pursue the white and blue foxes on the confines of the Icy sea, are often overtaken with these northern lights. Their dogs are then so frightened, that they will not move, but lie obstinately on the ground till the noise has passed. Commonly clear and calm weather follows this kind of northern lights. I have heard this account, not from one person only, but confirmed by the testimony of many who have spent part of several years in these very northern regions, and inhabited different countries from the Yenisei to the Lena; so that no doubt of its truth can remain. This seems, indeed, to be the birth-place of the *aurora borealis* *."

This account of the noises attending the aurora borealis, allowing for some degree of exaggeration, has been corroborated by other testimonies, as those of Nairne and Cavallo.

522 Aurora australis.

Similar appearances have likewise been observed towards the *south* pole, and are therefore called *auroræ australes*. The best account of these is given by Mr Forster, who in his voyage round the world with Captain Cook, says that he observed them in high southern latitudes, though attended with phenomena somewhat different from those observed here. "On February 17. 1773, in south lat. 68°, a beautiful phenomenon (he says), was observed during the preceding night, which appeared again this and several following nights. It consisted of long columns of a clear white light, shooting up from the horizon to the eastward, almost to the zenith, and gradually spreading on the whole southern part of the sky. These columns were sometimes bent sidewise at their upper extremities, and though in most respects similar to the northern lights (aurora borealis) of our hemisphere, yet differed from them in being always of a whitish colour, whereas ours assume various tints, especially those of a fiery and purple hue. The sky was generally clear when they appeared, and the air sharp and cold, the thermometer standing at the freezing point."

The periods of the appearances of the aurora borealis are very inconstant. In some years they occur very frequently, and in others they are more rare; and it has been observed that they are more common about the time of the equinoxes than at other seasons.

Dr Halley has given us a sort of chronological history of the appearances which may be ranked under the *aurora borealis*; but for his account of the individual cases we must refer to his paper in the Philosophical Transactions abridged, vol. iv.

The particular part of the atmosphere in which these appearances take place, or the height above the earth to which they extend, is by no means certain; various philosophers have attempted to ascertain the height of various *auroræ boreales* by trigonometrical calculation; some have estimated them at a few hundreds, others at some thousands of miles above the earth; but the results of their admeasurements are so contradictory, that they cannot be relied on.

523 Evidence for its electrical origin.

The evidence which we have for considering the *aurora borealis* as an effect of electricity, chiefly consists of the following arguments.

1. If lightning be an effect of electricity, the same cause must, at a certain height in the atmosphere, produce such an appearance as is exhibited by the *aurora borealis*. The passage of the electric matter through air rarefied to a certain degree, is attended with all the undulating coruscations of this meteor. Indeed there is scarcely a single circumstance attending the passage of a spark or a charge through an exhausted tube, that does not bear a resemblance to something observed in the northern lights. The same peculiar motion, the same variety of colour, the same rapid alternations of flashes, occur both in the experiment, and in the natural phenomenon; the streams of light in both are vivid and pointed; and if, in the experiment, the exhaustion has been properly managed, some parts of the light will be marked with that reddish tinge, which in the *aurora borealis* has so often struck the vulgar mind with terror and consternation. The experiments now alluded

---

* Phil. Trans. vol. lxxiv. p. 228.

alluded to are those of the *conducting glass tube*, the *luminous conductor*, and the *aurora borealis* described in N° 188—190.

The lowest estimate of the distance of the aurora borealis from the surface of the earth, that of Mr Cavendish, is 71 miles. Now, at 70 the air is 1,048,576 times more rare than at the surface of the earth, a degree of rarefaction beyond the power of any air-pump.

2. The striking distance of a charge of electric fluid passing through the air, increases according to the rarefaction of that medium. If, therefore, two clouds in opposite states of electricity have no other circuit, it is probable that they will be discharged through the higher regions of the atmosphere, more especially if they are at such an elevation, as renders their communication with the earth impracticable.

3. The same causes which tend to produce such an accumulation of electricity in the atmosphere as will bring on a thunder-storm, have been found, in certain seasons, and in the more northern climates, to be attended with an aurora borealis.

It must be confessed, however, that Mr Brook and Mr Bennet, in their observations on the electricity of the atmosphere during an *aurora borealis*, could observe no particular signs of increased electricity, more than would have occurred in a serene sky without any such appearance.

4. A magnetic needle commonly appears a little disturbed during a strong *aurora borealis*.

There are striking circumstances of connection between magnetism and electricity, which we shall fully illustrate in the article Magnetism. The luminous beams of this meteor are in a direction parallel to the dipping needle. See Dalton's *Meteorological Essays*. This author shows, in a satisfactory manner, that the apparent convergence of the beams, and also the greater thickness and length of them in the magnetic equator, declining as we proceed to the zenith, is explained by the supposition of parallel beams, equal to one another in length, and in closeness of mutual apposition. He calculates these beams to be 75 miles long, and 7½ in diameter.

524
Theory of
hese appearances.

A considerable difficulty attends even the most received thories of the *aurora borealis*, viz. the light appearing always to strike from the poles towards the equator, rather than in the contrary direction. Perhaps this may be explained in the following manner. We shall assume the three following axioms.

1. *That all electrics when considerably heated, become conductors of electricity.*

2. *That, è converso, non-electrics when subjected to violent degrees of cold, ought to become electrics.*

3. *That cold must also increase the electric powers of such substances as are already electric.*

The air, all round the globe, at a certain height above its surface, is found to be exceedingly cold, and, as far as experiments have yet determined, exceedingly electrical. The inferior parts of the atmosphere between the tropics, are violently heated during the daytime, by the reflection of the sun's rays from the earth. Such air will, therefore, be a kind of conductor, and much more readily part with its electricity to the clouds and vapours floating in it, than the colder air towards the north and south poles. Hence the prodigious appearances of electricity in these regions, shewing itself in thunder and other tempests of the most terrible kind. Immense quantities of the electric fluid are thus communicated to the earth; and the inferior warm atmosphere having once exhansed itself, must necessarily be recruited from the upper and colder region. This becomes very probable from what the French mathematicians observed when on the top of one of the Andes. They were often involved in clouds, which, sinking down into the warmer air, appeared there to be highly electrified, and discharged themselves in violent tempests of thunder and lightning; while in the mean time, on the top of the mountain, they enjoyed a calm and serene sky. In the temperate and frigid zones, the inferior parts of the atmosphere, never being so strongly heated, do not part with their electricity so easily as in the torrid zone, and consequently do not require such recruits from the upper regions; but notwithstanding the difference of heat observed in different parts of the earth near the surface, it is very probable that at considerable heights the degrees of cold are nearly equal all round the globe. Were there a like equality in the heat of the under part, there could never be any considerable loss of equilibrium in the electricity of the atmosphere; but as the hot air of the torid zone is perpetually bringing down vast quantities of electric matter from the cold air that lies about it; and as the inferior parts of the atmosphere lying towards the north and south poles do not conduct in any great degree; it thence follows, that the upper parts of the atmosphere lying over the torrid zone will continually require a supply from the northern and southern regions. This easily shews the necessity of an electric current in the upper parts of the atmosphere from each pole towards the equator; and thus we are also furnished with a reason why the *aurora borealis* appears more frequently in winter than in summer; namely, because at that time the electric power of the inferior atmosphere is greater on account of the cold than in summer; and consequently the abundant electricity of the upper regions must go almost wholly off to the equatorial parts, it being impossible for it to get down to the earth; hence also the *aurora borealis* appears very frequent and bright in the frigid zones, the degree of cold in the upper and under regions of the atmosphere being much more nearly equal in these parts than in any other. In some parts of Siberia particularly, this meteor appears constantly from October to Christmas, and its coruscations are said to be very terrifying. Travellers agree that here the *aurora borealis* appears in its greatest perfection; and it is to be remarked, that Siberia is one of the coldest countries in the world. In confirmation of this it may also be observed, that from the experiments hitherto made with the kite, the air appears considerably more electrical in winter than in summer, though the clouds are known to be often most violently electrified in the summer time; a proof, that the electricity naturally belonging to the air, is in summer much more powerfully drawn off by the clouds than in winter, owing to the excess of heat.

A considerable difficulty, however, still remains from the upright position which the streams of the *aurora borealis* are generally supposed to have; whereas, according to our hypothesis, they ought rather to run directly from north to south. Dr Halley answered this difficulty by supposing his *magnetic effluvia*, (to which

Atmospherical Electricity.

he attributed this phenomenon), to pass from pole to pole in arches of great circles, arising to a great height above the earth, and consequently darting from the places whence they arose like the radii of a circle; in which case, being set off in a direction nearly perpendicular to the surface of the earth, they must necessarily appear erect to those who see them from any part of the surface, as is demonstrated by mathematicians. It is also reasonable to think that they will take this direction rather than any other, on account of their meeting with less resistance in the very high regions of the air than in such as are lower.

But the greatest difficulty still remains; for we have supposed the equilibrium of the atmosphere to be broken in the day time, and restored only at night; whereas, considering the immense velocity with which the electric fluid moves, the equilibrium ought to be restored in all parts almost instantaneously; yet the *aurora borealis* never appears except in the night, although its brightness is such as must sometimes make it visible to us did it really exist in the day time.

In answer to this it must be observed, that though the passage of electricity through a good conductor is almost instantaneous, yet through a bad conductor it takes some time in passing. As our atmosphere, therefore, unless very violently heated, is but a bad conductor of electricity: though the equilibrium in it is broken, it can by no means be instantaneously restored. Add to this, that as it is the action of the sun which breaks the equilibrium, so the same action, extending over half the globe, prevents almost any attempt to restore it till night, when flashes arise from various parts of the atmosphere, gradually extending themselves with a variety of undulations towards the equator.

The noise, which is said to have accompanied the aurora on some occasions, is unaccountable, for this reason, that at the heights at which it occurs there is no medium capable of transmitting sound.

CHAP. IV. *Of Meteors.*

525 Electrical explanation of meteors.

METEORS or fire-balls are of two kinds, the one of considerable apparent size, moving progressively over a considerable space, sometimes dispersing in sparks and accompanied by the fall of stones, which, when examined, have been always found of the same composition. These have never been explained in a satisfactory or even a plausible manner, and atmospheric electricity does not afford data adequate to this object. As these stones contain iron, they may be connected in some form with magnetism, and perhaps at the same time with the electrical phenomena of the aurora borealis. The other kind of meteors presents more precise analogies with electricity. These are commonly called *falling stars*, and the name is very significant of their appearance. They present a set of phenomena intermediate between the aurora borealis of the upper regions and the lightning which occurs near the surface of the earth; and as these two sets of appearances are very similar to the transmission of electricity through rarefied air on the one hand, and through air of the common density on the other, so the appearance of falling stars may be imitated by the transmission of moderate electrical charges through air of an intermediate density. The experiment has often been performed with long glass tubes, the air of which has been moderately rarefied. These facts countenance the conclusion, that they arise from electrical discharges taking place at considerable heights in the atmosphere, but far beneath the region of the aurora. This doctrine is also countenanced by the general aspect of the phenomena.

PART VI.

OF THE EFFECTS OF ELECTRICITY ON VEGETABLE LIFE.

526 Experiments on vegetation by

IT has been much disputed whether electricity produces *any* effects on vegetables; and the experiments that have been made with the view of ascertaining this point are most contradictory.

527 Mr Maimbray.

The first electrician who seems to have attended to this subject of enquiry was Mr Maimbray of Edinburgh, who, in the year 1746, electrified two myrtles during the whole month of October (i. e. we suppose, for some hours every day). The consequence was, that in the following summer, these electrified myrtles put forth buds and blossoms sooner than their neighbours who had been left to nature *.

[527] Abbé Nollet.

Mr Maimbray was soon followed by the Abbé Nollet, who made some comparative experiments on the germination of seeds under similar circumstances, except that one plot was electrified three or four hours every day for fifteen days. The result of these experiments was similar to that of Mr Maimbray's*.

528 M. Achard.

Similar experiments were made by M. Achard of Berlin, and several other philosophers, but still with the same result; till Dr Ingenhousz instituted a very complete set of experiments on the electrification of plants, which were communicated to the world through the medium of Rozier's Journal, at first by M. Swankhardt, and afterwards by Dr Ingenhousz himself, in consequence of some severe animadversions which the communication of M. Swankhardt had called from M. Duvernier. By these experiments the faith of philosophers with respect to the effect of electricity on vegetation was staggered, as they were attended with results very opposite to those of Maimbray, Nollet and Achard. 529 Dr Ingenhousz.

530 by Dr Carmoy and l'abbé Ormoy.

Experiments have also been made by Dr Carmoy and the abbé D'Ormoy, rather more favourable to the first opinion; but the manner in which the electricity was applied appears very equivocal, as it is found that even shocks do not pass through the body of the plant, but merely over its surface *.

531 By the abbé Bertholon.

But the most complete set of experiments on this subject has been made by the Abbé Bertholon, and these we shall give more in detail.

" In the first place (says the Abbé,) there is continually

---

† *Priestley's History*, Part viii. sect. 4.

* *Nollet Researches.*

* *Morgan's Lectures*, vol. ii.

ally and everywhere diffused in the atmosphere (particularly in the upper regions) a considerable quantity of the electric fluid.

532
Electro-vegetometer described.

" This principle being granted; in order to remedy the deficiency of electric fluid which is supposed hurtful to vegetation, we must erect in the spot which we want to fecundate the following new apparatus, which has had all possible success, and which I shall call by the name of the *electro-vegetometer*. This machine is as simple in its construction as efficacious in its manner of acting; and I doubt not but it will be adopted by all those who are sufficiently instructed in the great principles of nature.

Fig. 131.

" This apparatus is composed of a mast AB, fig. 131. or a long pole thrust just so far into the earth as to stand firm and be able to resist the winds. That part of the mast which is to be in the earth must be well dried at the fire; and you must take care to lay on it a good coat of pitch and tar after taking it from the fire, that the resinous particles may enter more deeply into the pores of the wood, which will then be dilated, at the same time that its humidity will be expelled by the heat. Care must likewise be taken to throw around that part fixed in the earth a certain quantity of coal dust, or rather a thick layer of good cement, and to build besides a base of mason-work of a thickness and depth proportionable to the elevation of the instrument, so as to keep it durable and solid. As to the portion of it above the ground, it will be sufficient to put upon it some coats of oil paint, except one chooses rather to lay on a coat of bitumen the whole length of the piece.

" At the top of the mast there is to be put an iron console or support C; whose pointed extremity you are to fix in the upper end of the mast, while the other extremity is to terminate in a ring, in order to receive the hollow glass tube which is seen at D, and in which there is to be glued an iron rod rising with the point E. This rod, thus pointed at its upper extremity, is completely insulated, by reason of its keeping a strong hold of a thick glass tube, which is filled with a quantity of bituminous matter, mixed with charcoal, brick-dust, and glass-powder; all together forming a sufficiently good and strong cement for the object in view.

" To prevent rain wetting the glass tube, care must be taken to solder to the rod E a funnel of white-iron; which consequently is entirely insulated. From the lower extremity of the rod E hangs a chain G, which enters into a second glass tube H, supported by the prop I. The lower end of the above-mentioned chain rests upon a circular piece of iron wire, which forms a part of the horizontal conductor KLMN. In L is a breaker with a turning joint or hinge, in order to move to the right or left the iron rod LMN; there is likewise another in Q, to give still greater effect to the circular movement. O and P are two supports terminating in a fork, where there is fixed a silken cord tightly stretched, in order to insulate the horizontal conductor: in N are several very sharp iron points.

533
Another form of this instrument.
Fig. 132.

" In fig. 132. you see an apparatus in the main like the former, but with some difference in the construction. At the upper extremity of the mast *a b* there is bored a hole into which enters a wooden cylinder *c*, which has been carefully dried before a great fire, in order to extract its humidity, dilate its pores, and saturate it with tar, pitch, or turpentine, applied at repeated intervals. The more heat the wood and bituminous matter receives, the more the substance penetrates, and the insulation will be the more complete. It is moreover proper to besmear the circumference of the little cylinder with a pretty thick coat of bitumen. This preparation being made, we next insert the cylinder *c* into the hole *b* of the mast; and it is easy to join together these two wooden pieces in the most perfect manner.

" At the upper extremity of the cylinder *c* we strongly attach an iron rod *g f*; which, instead of one, is terminated by several sharp points, all of gilded iron. In *e* you see a branch of iron resembling the arm of an iron crow, from whence hangs an iron chain *h i*, at the end of which there is hooked a piece of iron resembling a mason's square, and ending in a fork. The piece of iron *l* is a ring with a handle entering a little into the glass tube *m* filled with mastich, in the same manner as does the iron rod *n*. The conductor *p o* is to be considered as an additional piece to act in that marked *p*. There are likewise put iron spikes in *q*: the support *s* resembles those of O and P in the former figure. In this new machine you can lengthen or shorten the horizontal conductor as you please; and as the iron ring *l* turns freely in a circular gorge made in the mast, the conductor is enabled to describe the entire area of a circle.

534
Effects of these instruments.

" The construction of this *electro-vegetometer* once well understood, it will be easy for us to conceive its effects. The electricity which prevails in the aerial regions will soon be drawn down by the elevated points of the upper extremity.

" The electric matter brought down by the point *E*, or by those marked *f f f*, will be necessarily transmitted both by the rod and chain; because the insulation produced at the upper extremity of the mast completely prevents its communication with the timber. The electric fluid passes from the chain to the horizontal conductor *KM* or *n o*: it then escapes by the points at *P* and *q*.

535
Method of using them.

" The manner of using this instrument is not more difficult than the knowledge either of its construction or effects. Suppose, for example, we are to place it in the midst of a kitchen garden. By making the horizontal conductor turn round successively, you will be able to carry the electricity over the whole surface of the proposed ground. The electric fluid, thus drawn down, will extend itself over all the plants you want to cultivate; and this at a time when there is little or no electricity in the lower regions nigh the surface of the earth.

" On the other hand, when it happens that the electric fluid shall be in too great abundance in the atmosphere, in order to take off the effect of the apparatus in K, fig. 131. and in *n*, fig. 132. you have only to hang to it an iron chain reaching to the ground, or else a perpendicular iron rod, which will have the same effect, *viz.* that of destroying the insulation, and of insensibly transmitting the electric fluid in the same proportion as it is drawn by the points; so that there shall never be an overcharge of this fluid in the instrument, and its effect shall be either something or nothing, according as you add or remove the second chain or the additional rod.

" There will be nothing to fear from the spontaneous discharge of this apparatus, because it is terminated below by proper points in P and *q* of both machines: However, it will be easy to furnish one, by means of which we may approach the apparatus with perfect security; it is only necessary to hold the hand before it. This has the form of a great C, and is of a height equal to the distance that takes place betwixt the horizontal conductor and the surface of the earth. This discharger near the middle must be furnished with a glass handle; and at that extremity which is directed towards the conductor, there must hang an iron chain made to trail on the ground. This instrument is an excellent safeguard. See fig. 133. Fig. 133.

536 Great advantages to be expected from these instruments.

"By means of the electro-vegetometer just now described, one may be able to accumulate at pleasure this wonderful fluid, however diffused in the regions above, and conduct it to the surface of the earth, in those seasons when it is either scantily supplied, or its quantity is insufficient for vegetation; or although it may be in some degree sufficient, yet can never produce the effects of a multiplied and highly increased vegetation. So that by these means we shall have an excellent vegetable manure or nourishment brought down as it were from heaven, and that too at an easy expence; for after the construction of this instrument, it will cost nothing to maintain it: It will be moreover the most efficacious you can employ, no other substance being so active, penetrating, or conducive to the germination, growth, multiplication, or reproduction of vegetables. This heavenly manure is that which nature employs over the whole habitable earth; not excepting even those regions which are esteemed barren, but which, however, are often fecundated by those agents which nature knows so well to employ to the most useful purposes. Perhaps there was nothing wanting to bring to a completion the useful discoveries that have been made in electricity, but to show this so advantageous an art of employing electricity as a manure; consequently, that all the effects which we have already mentioned depend upon electricity alone; and lastly, that all these effects, viz. acceleration in the germination, the growth, and production of leaves, flowers, fruit, and their multiplication, &c. will be produced, even at a time when secondary causes are against it: and all this is brought about by the electric fluid, which we have the art of accumulating over certain portions of the earth, where we want to raise those plants that are most calculated for our use. By multiplying these instruments, which are provided at little expence (since iron rods of the thickness of one's finger, and even less, are sufficient for the purpose), we multiply their beneficial effects, and extend their use *ad infinitum*.

"This apparatus having been raised with care in the midst of a garden, the happiest effects were perceived, viz. different plants, herbs, and fruits, in greater forwardness than usual, more multiplied, and of better quality. At the same time it was observable, that, during the night, the points N and *q*, as well as the upper extremities, were often garnished with beautiful luminous sparks. These facts are analogous to an observation which I have often made, viz. that plants grow best and are most vigorous near thunder-rods, where their situation favours their developement. They likewise serve to explain why vegetation is so vigorous in lofty forests, and where the trees raise their heads far from the surface of the earth, so that they seek, as it were, the electric fluid at a far greater height than plants less elevated; while the sharp extremities of their leaves, boughs, and branches, serve as so many points granted them by the munificent hand of nature, to draw down from the atmosphere that electric fluid, which is so powerful an agent in forwarding vegetation, and in promoting the different functions of plants.

537 Vegetation most vigorous near thunder rods.

538 How to augment the powers of vegetation by artificial electricity.

"It is not only by means of the electricity in the atmosphere collected by the above apparatus, that one can supply the electric fluid, which is so necessary to vegetation; but the electricity named *artificial* answers the same purpose. However astonishing the idea may be, or however impossible it may appear to realize it, yet nothing will be found more easy upon trial. Let us suppose that one wants to augment the vegetation of trees in a garden, orchard, &c. without having recourse to the apparatus destined to pump down as it were the electricity from the atmosphere: it is sufficient to have a large insulating stool. This may be made in two ways; either by pouring a sufficient quantity of pitch and melted wax upon the above stool, whose borders being more raised than its middle, will form a kind of frame; or more simply, the stool (which is likewise called the *insulator*) shall only be composed of a plate longer than broad, supported by four glass pillars, like those used for electrical machines. One must take care to place above the insulator a wooden tray full of water, and to cause mount upon the stool a man carrying a small pump in the form of a syringe. If you establish a communication between the man and an electrical machine put in motion (which is easily done by means of a chain that connects with the conductor of the machine), then the man thus insulated (as well as every thing upon the stool) will be able, by pushing forward the sucker, to water the trees, by pouring upon them an electrical shower; and thus diffusing over all the vegetables under its influence a principle of fecundity that exerts itself in an extraordinary manner upon the whole vegetable economy; and this method has moreover this advantage, that at all times and in all places it may be practised and applied to all plants whatever.

"Every one knows that the electricity is communicated to the water thus employed; and it would be easy to obtain the most ample conviction (if any one doubted it), by receiving upon his face or hand this electrical shower; he immediately feels small punctures or strokes, which are the effects of the sparks that issue from each drop of water. This is perceived most sensibly if there is presented a metal dish to this electrical dew; for at the very instant of contact, brilliant flashes are produced.

"That the electricity received by the man from the chain may be communicated to the tray, we must put a small cake of white iron, upon the end of which he may place his foot. The tray filled with water is a kind of magazine or reservoir to serve as a continual supply to the pump. After watering one tree, you transport the stool to a second, a third, and so on successively; which is done in a short time, and requires very little trouble.

"Instead of the chain, it is better to employ a cord or twist of pinchbeck or any other metal: by means of which

Effects of Electricity on Vegetation.

which there can be no loss of the electric matter, as there is in the case of the chain by the ring points. Moreover, this metal cord or thread being capable of being untwisted and lengthened, there will be no occasion for transporting so often the electrical machine. It is almost needless to add, that this string or metallic cord, which is always insulated, may rest upon the same kind of supports with those which have been exhibited in OP and *s* of fig. 131. and 132. This method is simple, efficacious, and nowise expensive, and cannot be too much employed.

539 Easy method of applying electricity in this manner.

"If one wants to water either a parterre or common garden, beds and platforms of flowers, or any other plots in which are sown grain or plants of different ages and kinds, no method is more easy and expeditious than the following: Upon a small carriage with two wheels there is placed a framed insulator in form of a cake of pitch and rosin, as we have mentioned before in N° 538. The carriage is drawn the whole length of the garden by a man or horse fixed to it. In proportion as you draw the carriage, the metallic cord winds itself upon a bobbin, which turns as usual. This last is insulated, either because the little apparatus that sustains the bobbin is planted in a mass of rosin (when you choose the axle to be of iron), or else because this moveable axis is a tube of solid glass. There must also be a support which serves to prevent the gold thread or the metallic cord from trailing on the ground, and thus dissipating the electricity; and, moreover, it serves for an insulator. To accomplish this last purpose, it is necessary that the ring into which it passes be of glass. One may likewise employ the insulators and supports marked OP and *s*, in fig. 131. and 132. If a gardener, mounted upon an insulator, holds in one hand a pump full of water, and with the other takes hold of a metallic cord, in order to transmit the electricity which comes from the conductor; in this case, the water being electrified, you will have an electrical shower; which falling on the whole surface of the plants which you want to electrify, will render the vegetation more vigorous and more abundant. A second gardener is to give additional pumps full of water to him who is upon the insulator, when he shall have emptied those he holds; and thus in a little time you will be able to electrify the whole garden. This method takes hardly longer time than the ordinary one; and although it should be a little longer, the great advantages resulting from it will abundantly recompense the small additional trouble.

"By repeating this operation several days successively, either upon seed sown or plants in a state of growth, you will very soon reap the greatest advantages from it. This operation, equally easy with the preceding described upon the subject of watering trees, has been put in practice with the greatest success. Several other methods, answering the same purpose, might be devised; but they are all of them pretty similar to that just described.

540 o electri- water pt in re- rvoirs, c.

"I cannot finish this article without mentioning another method relative to the present object, although it be much less efficacious than the preceding ones. It consists in communicating to water kept in basons, reservoirs, &c. (for the purpose of watering), the electric fluid, by means of a good electrical machine. To this end, one must plaster over with a bituminous cement all the interior surface of the bason destined to receive the water that serves for irrigation; the nature of this cement answering the purpose of insulation, will prevent the electric fluid that communicates with the water from being dissipated; and the water thus charged with electricity will be the more fitted for vegetation.

Effects of Electricity on Vegetation.

541 Vegetables injured by the electric shock.

"If the deficiency of the electric fluid, or rather a small quantity of it, is apt to be hurtful to vegetables, a too great abundance of this matter will likewise sometimes produce pernicious effects. The experiments made by Messrs Nairne, Banks, and other learned men of the Royal Society of London, prove sufficiently this truth. An electric battery, very strong, was discharged upon a branch of balsam still holding by its trunk. Some minutes after, there was observed a remarkable alteration in the branch, of which the less woody parts immediately withered, dropped towards the ground, died next day, and in a short time entirely dried up; at the same time that another branch of the same plant that had not been put under the electric chain, was not in the smallest degree effected.

"This experiment repeated upon other plants showed the same effects; and it was remarked that the attraction, occasioned by a strong discharge of the electricity, produced an alteration different according to the different nature of the plants. Those which are less woody, more herbaceous, more aqueous, experience in proportion, impressions that are stronger and much more speedy in their operation.

"A branch of each of the following plants, composing an electrical chain, it was observed by these able philosophers, that the balsam was affected by the discharge of the battery in a few moments after, and perished next day. The leaves of a marvel of Peru did not drop till the day following that; and the same phenomenon happened to a geranium. Several days elapsed before there was observed any fatal effect on the cardinal flower. The branch of a laurel did not show any symptoms till after the lapse of about 15 days, after which it died; but it was a full month before they perceived any sensible change on the myrtle; at the same time they constantly observed that the bodies of those plants and branches which had formed no part of the chain, continued to be fresh, vigorous, and covered with leaves in good condition *.

"It hardly ever happens that the superabundance of the electric fluid existing in a small portion of the atmosphere where a plant is situated, can be so great as that which took place by the explosion of the strong battery of Mr Nairne, directed particularly upon one branch; or if this should happen, it can only be upon a few individual plants in a very small number."

PART

---

* *Phil. Trans.* vol. lxiv.

PART VII.

DEVELOPEMENT OF ELECTRICITY IN ANIMALS.

CERTAIN animals, which have been observed to communicate sudden and strange sensations by simple contact with their bodies, or even through the medium of other substances, without such contact, have been found to owe this property to the faculty of transmitting electrical shocks of greater or less intensity, a faculty which is exercised by the instrumentality of peculiar organs.

542 The raia torpedo.

One of these animals is well known under the name of the *torpedo*. It is a fish of the ray kind, and denominated by naturalists the *raia torpedo*. It lives in the seas of the southern parts of Europe, and is also frequently found on the southern shores of this island. Its benumbing powers have been long known. The electrical nature of these powers was ascertained by Mr Walsh, in a paper addressed to Dr Franklin, from la Rochelle, the place where his observations were made, and inserted in the Philosophical Transactions for 1773. It is by touching the upper surface of the animal with one hand, and the lower with the other, that the shocks are most readily felt. They are extremely frequent, especially when the animal is dying, though then much feebler. They take place both when the animal is in the water and in the air; and are particularly powerful in the moment of separating him from the surface of the water, or bringing him in contact with it. The most remarkable movement in the body of the animal accompanying these shocks is a drawing in of the eyes, which at other times are very prominent. The electrical organs of the animal occupy a large space between the vital organs and the fins on each side, and they consist of cylindrical bodies, or rather prisms of various hexagonal irregular sections, generally resembling the cells of a honeycomb. The longitudinal direction of these bodies is right across the thickness of the animal, reaching nearly to the skin at both ends, being separated from it by two thin fasciæ. These columnar bodies consist of numerous partitions, about 150 in an inch, between which a gelatinous substance is interposed. The columns themselves are about $\frac{1}{5}$ of an inch in diameter. The number of them forming an organ on each side has been sometimes found to be 470. The identity of the shock communicated by this animal with electricity is proved by its passing through all conducting substances, and them only, as well as by the kind of sensation produced. It has not however been seen to generate the electric spark, or the snapping noise in its passage through air. The anatomy of this animal is described by Mr John Hunter, in another paper contained in the same volume. In order to shew how the electrical nature of the shocks given by the torpedo is sufficiently consistent with the absence of all electrical sparks, and of snapping noise, Mr Cavendish shews, by an able series of experiments and of calculations, contained in the Philosophical Transactions for 1776, that it is sufficiently explained by the great quantities of contrary electricities generated in the parts of the animal which are in opposite directions, together with the small intensity of the charge. The intensity, or tendency to equilibrium by transmission, is that power which is indicated by the different electrometers; but this intensity diminishes in proportion to the surface over which any charge is diffused. It will not now pass through an equal interval of air between two conducting surfaces; yet it will display the powerful effects of the amount of transmission by other tests, such as the shock given to an animal placed in the electrical circuit, and the mechanical action exerted on substances placed in its way. Now, when the torpedo produces a charge in the electrical organs of its own body, by a voluntary exertion, this charge has for its surface all the thin membranes forming the septa into which the columnar bodies are divided. As the charge of which a battery is susceptible is also in proportion to the thinness of the partitions, this circumstance is, in the structure of the torpedo, highly favourable to the accumulation of such a large quantity of a charge, with so little intensity, as fully to account for it not exhibiting the phenomena now alluded to, and not even being communicable between the links of a metallic chain, notwithstanding the strength of the shock which it gives to an animal body. Mr Cavendish made experiments with an artificial torpedo, first of wood and then of leather, soaked with sea water. He made an electric charge of a given intensity, and a given quantity, to pass from the upper to the lower surface, also through the human body, to try the strength of the shock through a metallic chain, and making trials of the electric spark and snapping noise. From the reduction of the latter phenomena, in proportion as his charge approached in circumstances to that which may be supposed to exist in the living animal, he drew the inference, that the deficiency of these phenomena was no evidence against the electrical nature of the shock of the torpedo. Another anomaly had presented itself, in the transmission of the shock through the human body, even while the surfaces of the animal were connected by the water in which the animal was immersed. This also was satisfactorily explained by experiment; and to this object the artificial torpedo was principally applied.

Another electrical animal, possessed of still greater powers, is the *gymnotus electricus*, which is found in the rivers of South America. It is a large animal, nearly of the shape of an eel, and is called the *electric eel*. Its length is from three to four feet in those which have been described from actual examination, but it is said that some are much larger. The vital organs are situated close to the head, and are of no greater length than the head itself: the anus being in a part which we should call the neck of the animal. The rest of the length is occupied with the electric organs, the back-bone with its muscles and tail, the spinal cord, the great sympathetic nerves, and the air bladder. The electric organs consist of two pairs, one near

ELECTRICITY. PLATE CLXXXVII.

Fig. 1.

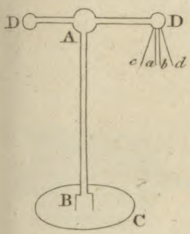


Fig. 2.

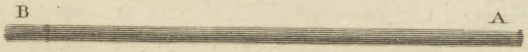


Fig. 4.

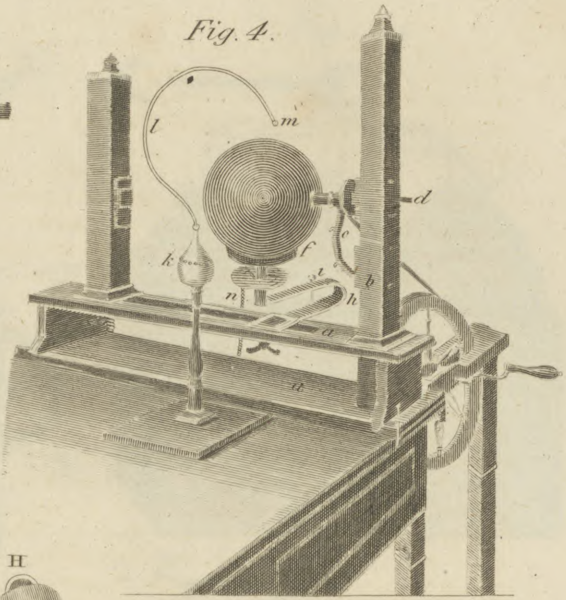


Fig. 5.

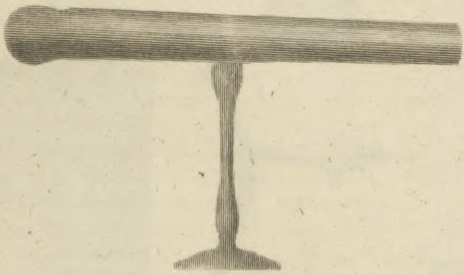


Fig. 3.

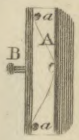


Fig. 6.

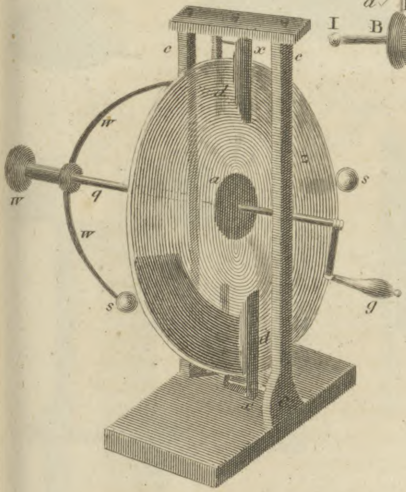


Fig. 7.

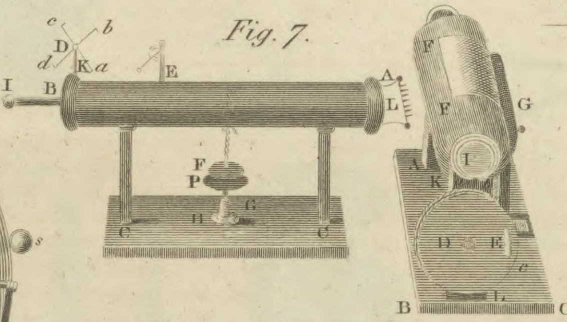


Fig. 9.

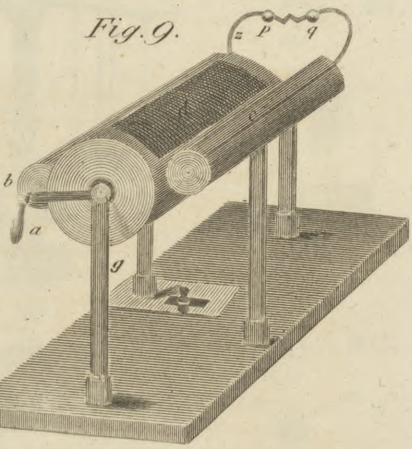


Fig. 8.

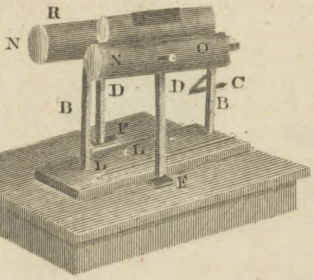


Fig. 11.

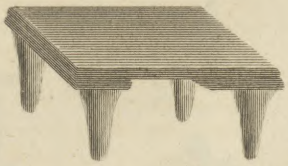
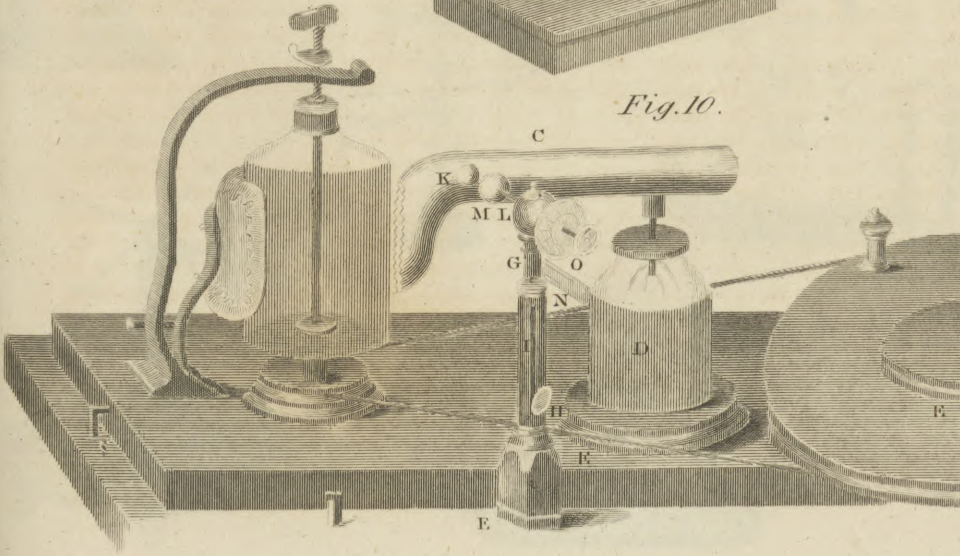


Fig. 10.



E. Mitchell sculp!

Fig. 12.

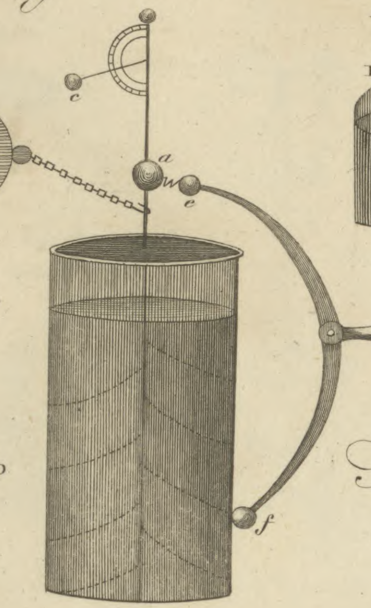


Fig. 13.

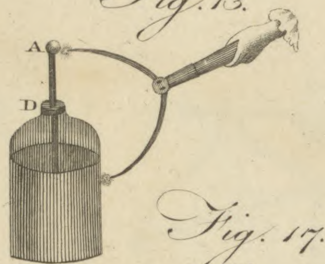


Fig. 14.

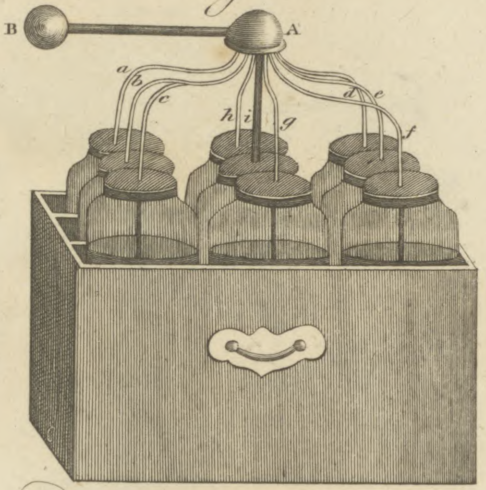


Fig. 17.

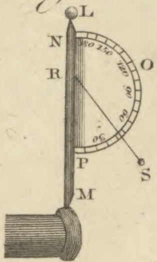


Fig. 15.

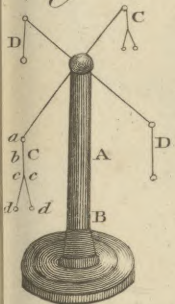


Fig. 16.

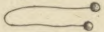


Fig. 21.

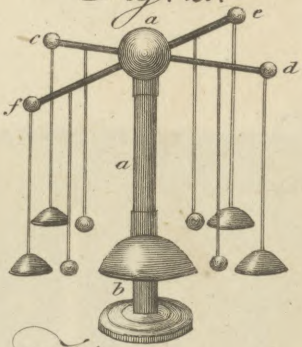


Fig. 20.

Fig. 22.

Fig. 18.

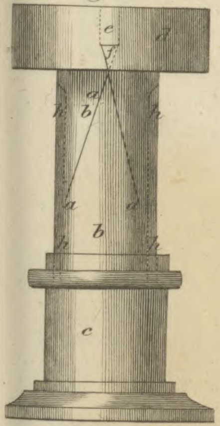


Fig. 19.

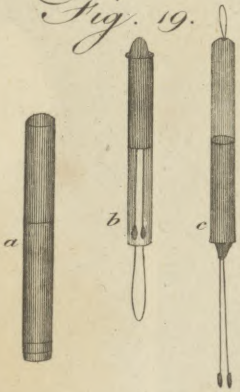


Fig. 23.

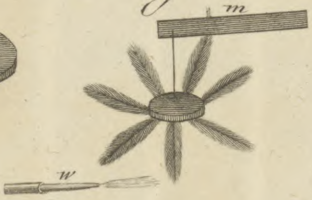


Fig. 24.

Fig. 26.

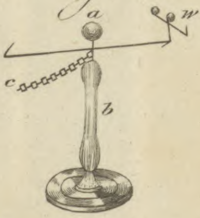


Fig. 27.

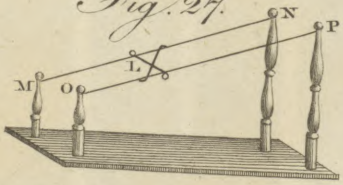


Fig. 25.

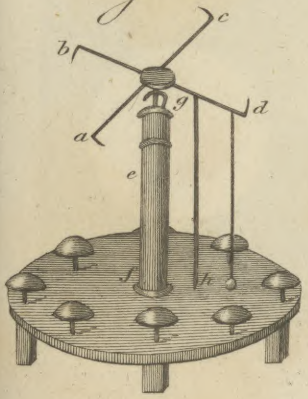
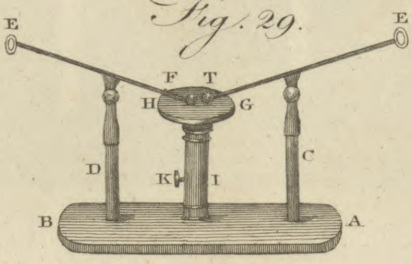


Fig. 28.

Fig. 29.



A. Bell Prin. Wal. Sculptor fecit.

ELECTRICITY. PLATE CLXXXIX.

Fig. 30.

Fig. 31.

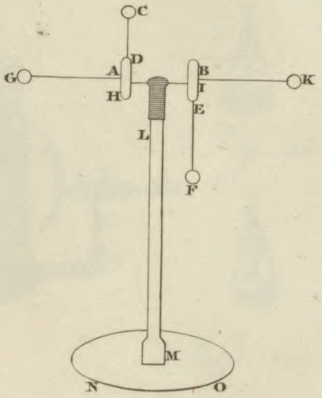


Fig. 34.

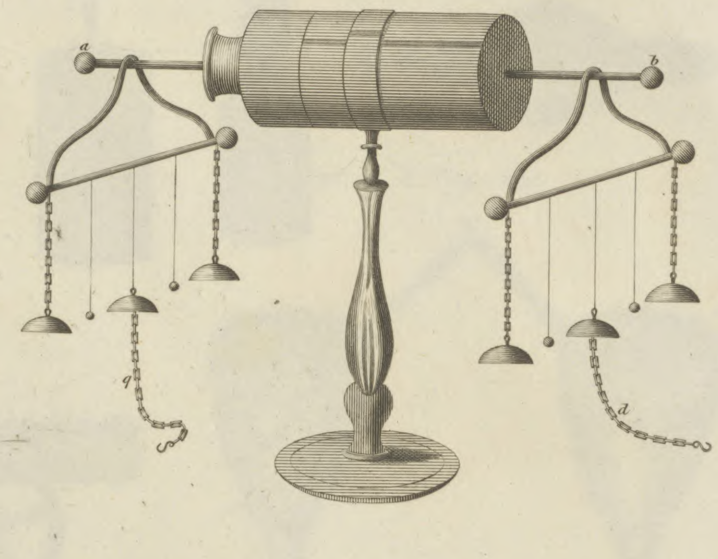


Fig. 33.

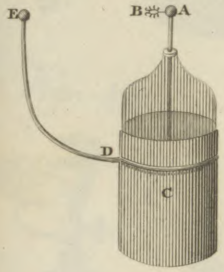


Fig. 32.

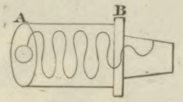


Fig. 41.

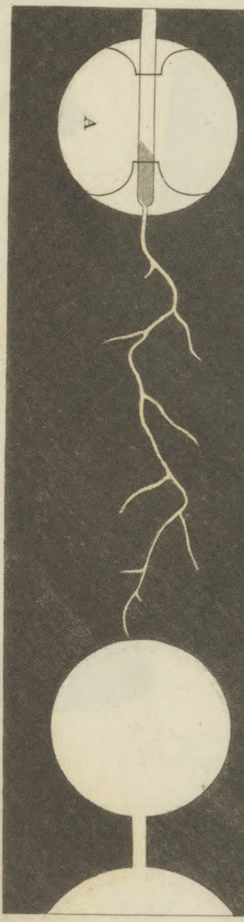


Fig. 40.

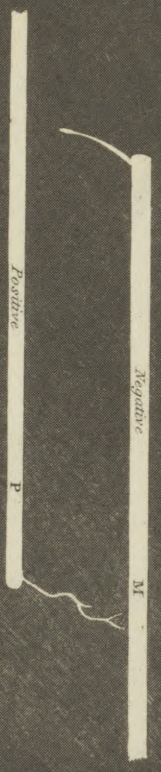


Fig. 39.

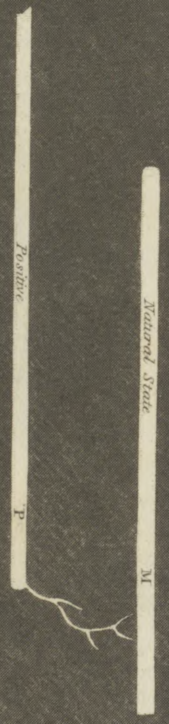


Fig. 38.

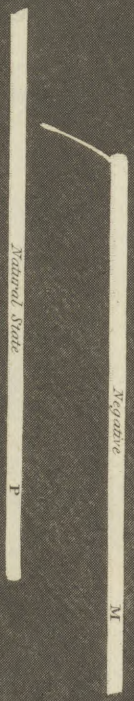


Fig. 37.

Fig. 35.

Fig. 36.

Engraved by W. Archibald Edin^r.

ELECTRICITY. Plate CXC.

Fig. 42.

Fig 43.

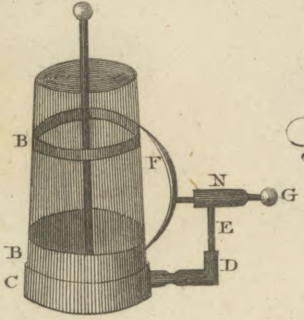


Fig. 44.

Fig. 45.

Fig. 46.

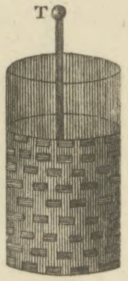


Fig. 47.

Fig. 48.

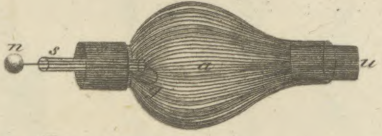


Fig. 51.

Fig. 49.

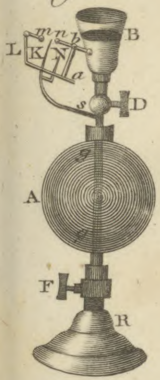


Fig. 50.

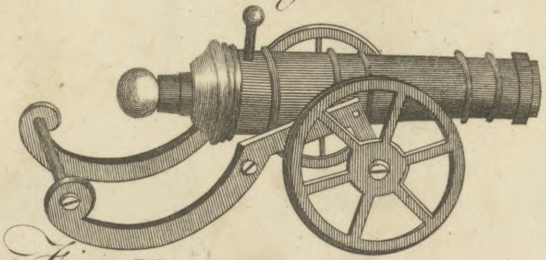


Fig. 52.

Fig. 53.

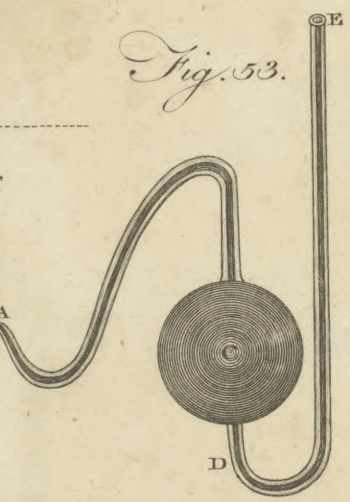


Fig. 54.

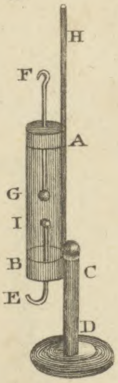


Fig. 55.

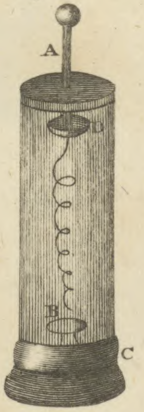


Fig. 56.

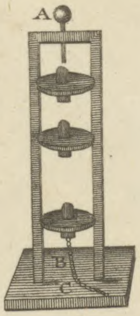


Fig. 58.

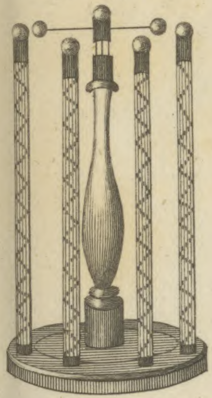


Fig. 57.

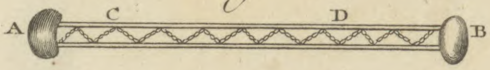


Fig. 61.

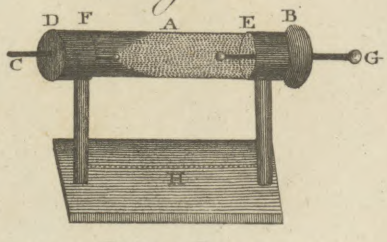


Fig. 59.

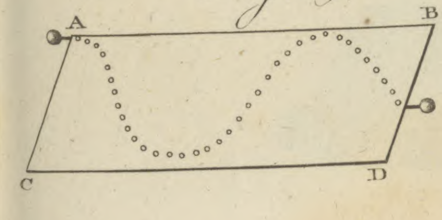
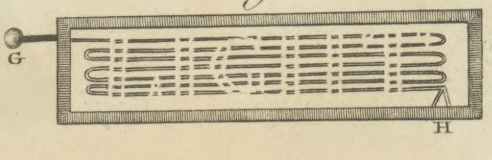


Fig. 60.



A. Bell Prin. Wal. Sculptor fecit.

ELECTRICITY.

PLATE CXCI.

Fig. 62.

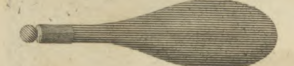


Fig. 63.

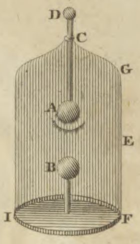


Fig. 64.

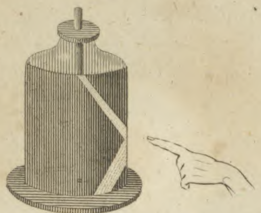


Fig. 65.

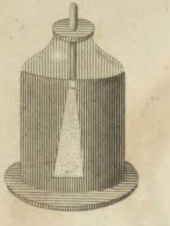


Fig. 66.

Fig. 70.

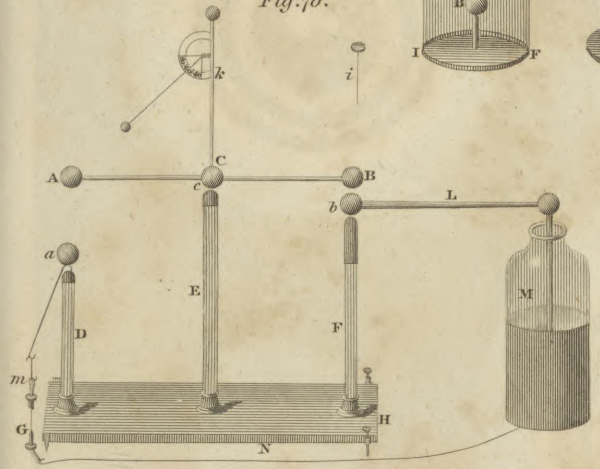


Fig. 68.

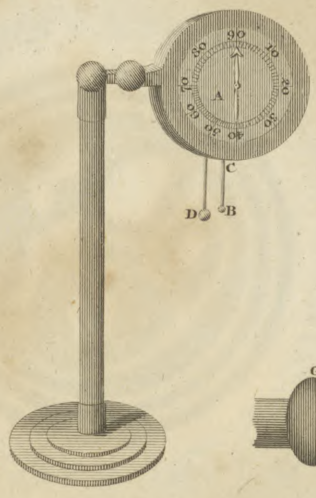


Fig. 69.

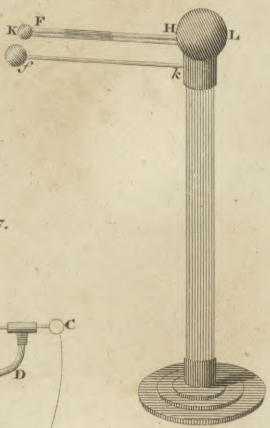


Fig. 67.

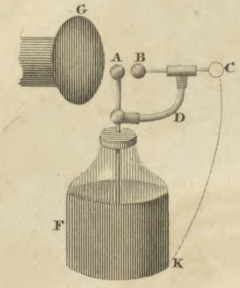


Fig. 72.

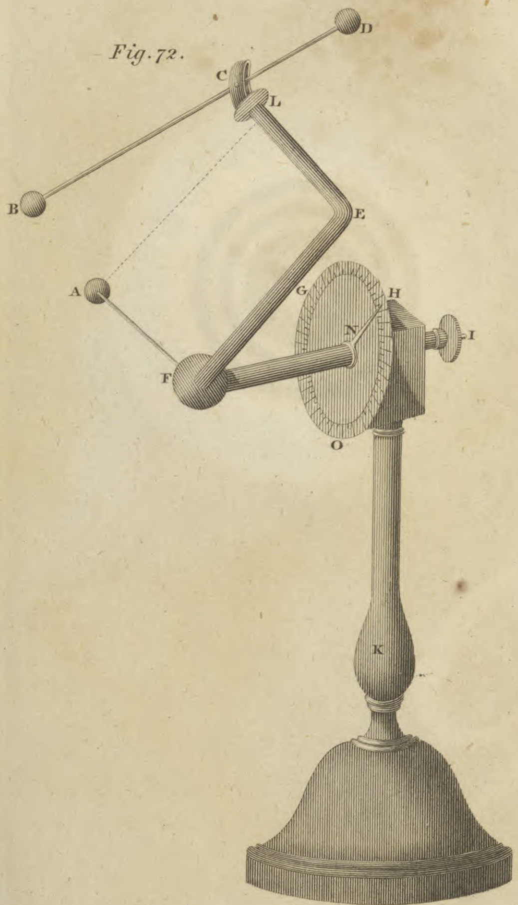


Fig. 71.

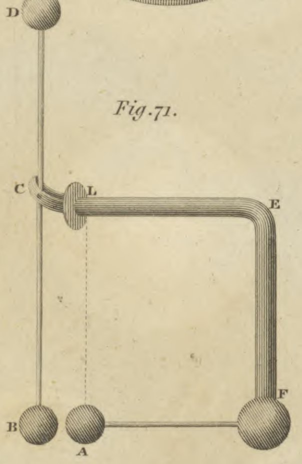


Fig. 74.

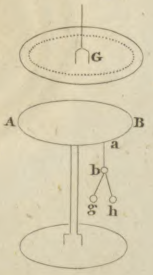
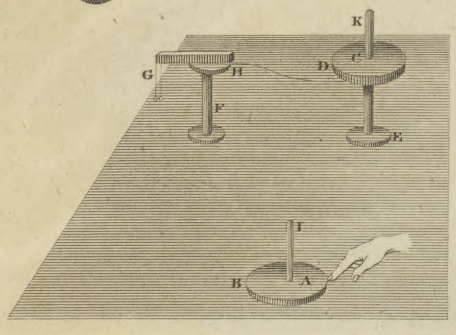


Fig. 73.



Engd. by W. Archibald Edinr.

Eng^d by W. Archibald Edin^r

ELECTRICITY.

PLATE CXCIII.

Fig. 75.

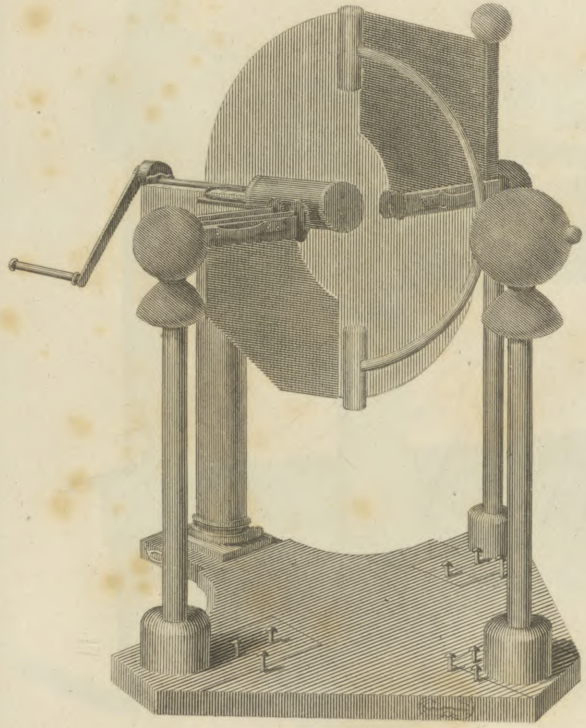


Fig. 77.

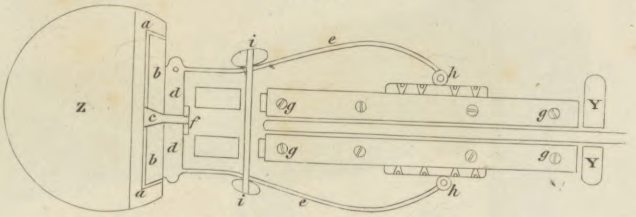


Fig. 78.

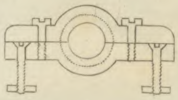
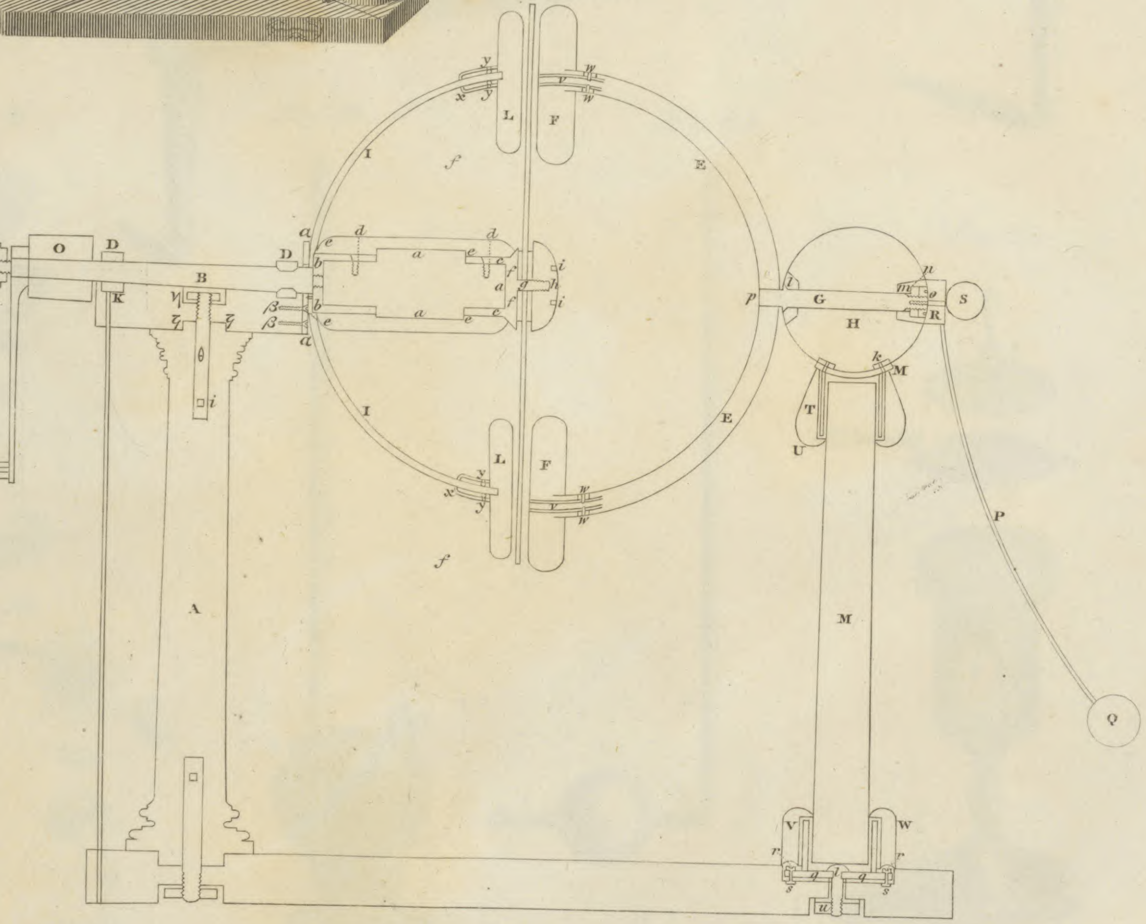


Fig. 76.



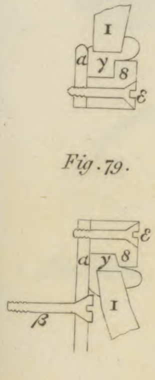


Fig. 79.

Engd. by W. Archibald Edinr.

ELECTRICITY. PLATE CXCIV.

Fig. 80.

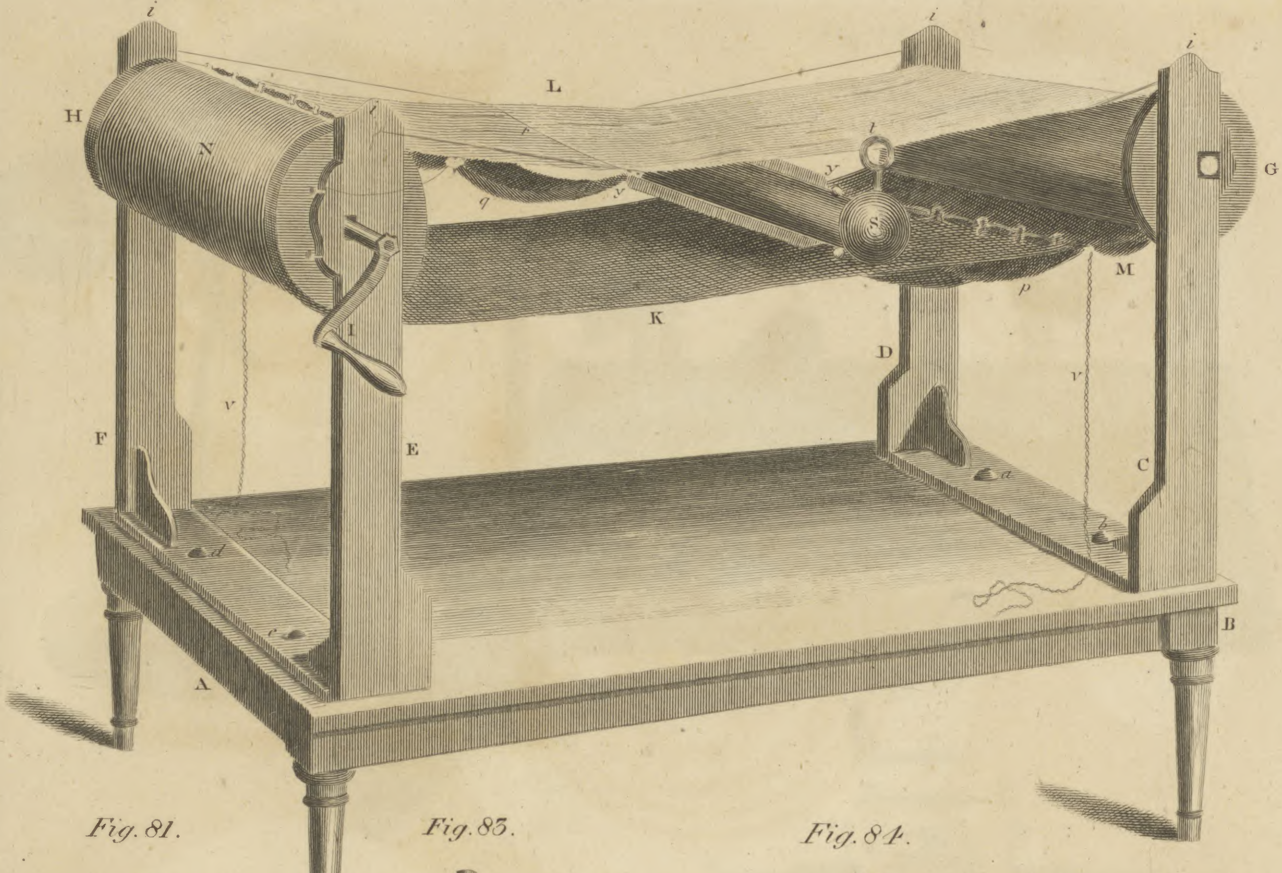


Fig. 81.

Fig. 82.

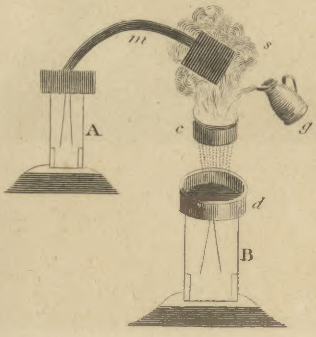


Fig. 83.

Fig. 84.

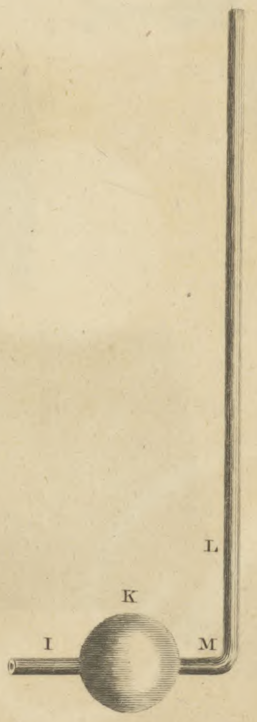


Fig. 85.

E. Mitchell sculpt.

ELECTRICITY. PLATE CXCV.

Fig. 86

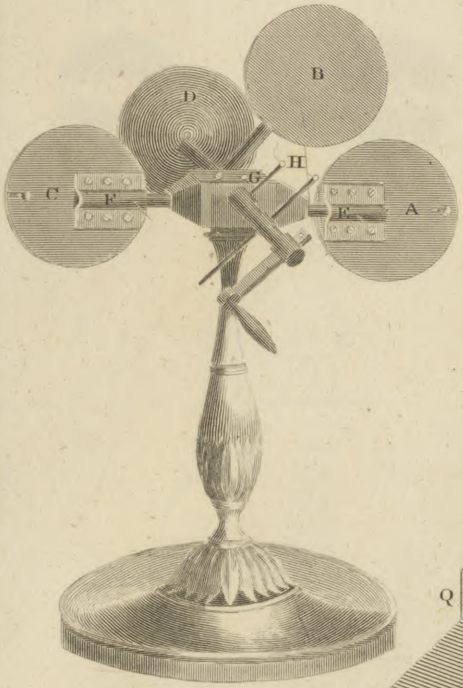


Fig. 88.

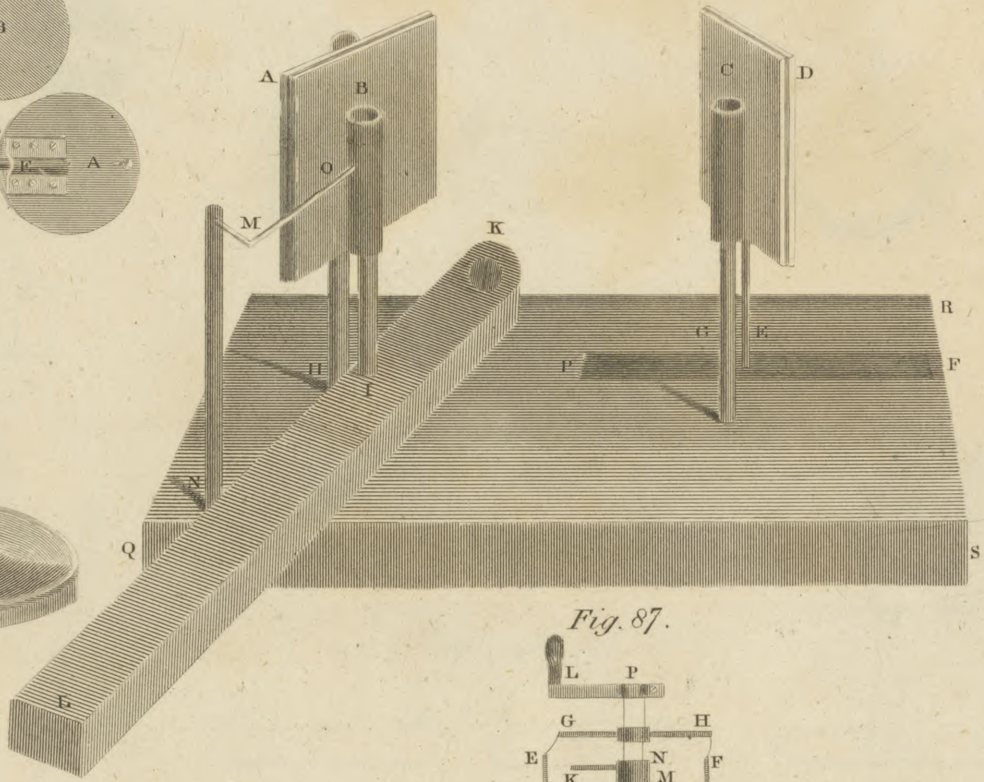


Fig. 87.

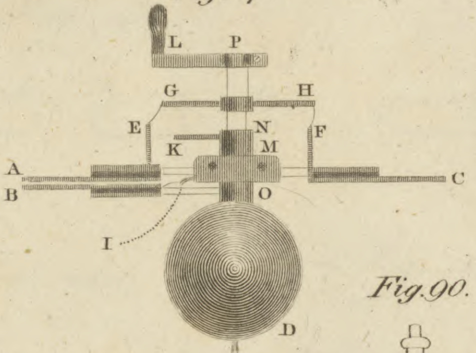


Fig. 89.

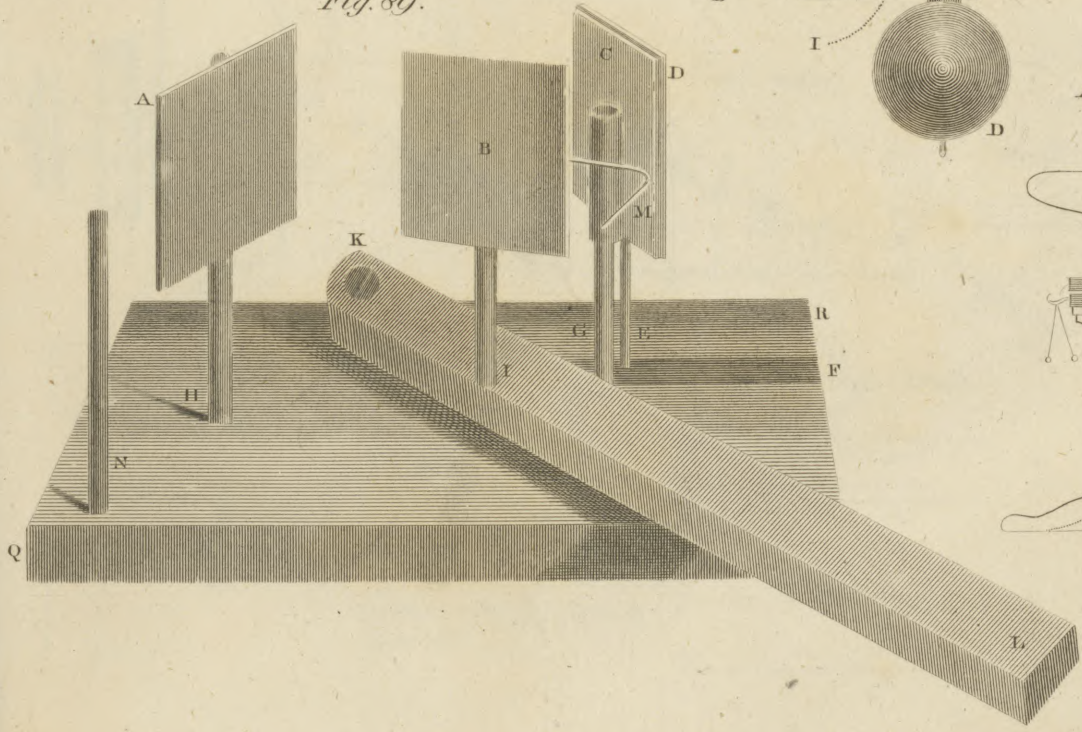
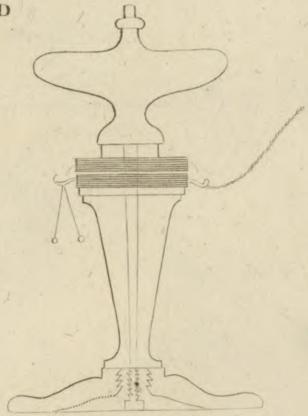


Fig. 90.



E. Mitchell sculp.^{t}

Fig. 91.

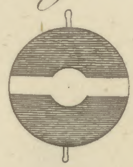


Fig. 92.

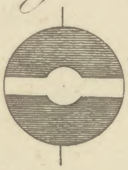


Fig. 93.

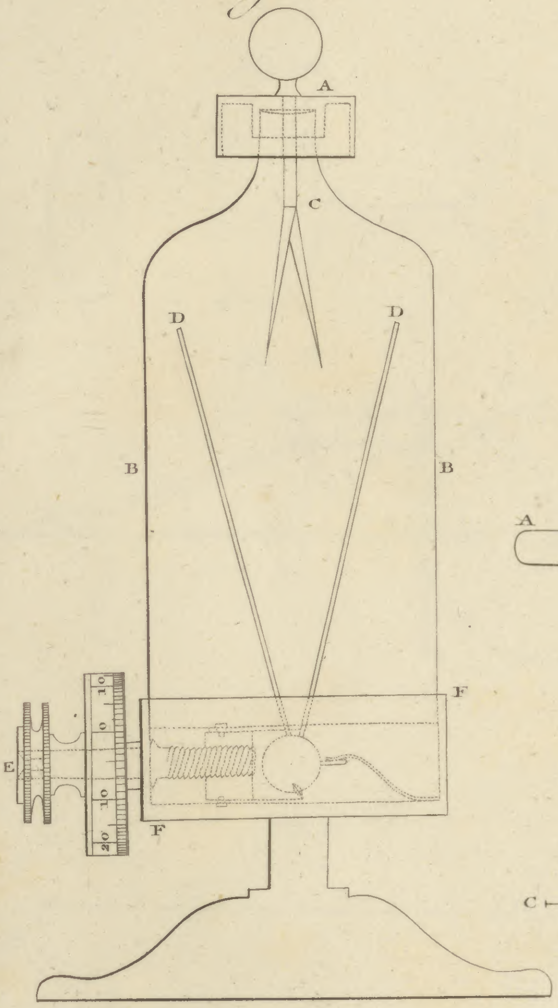


Fig. 94.

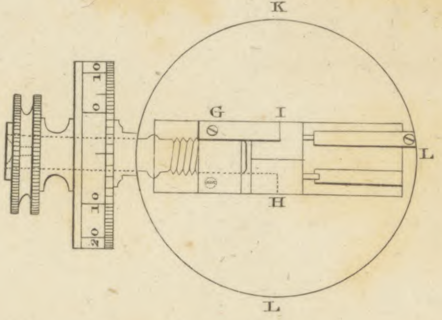


Fig. 95.

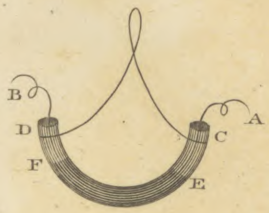


Fig. 96.

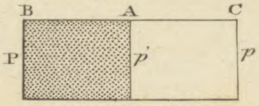


Fig. 97.

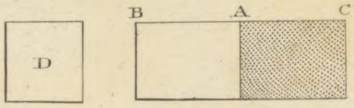


Fig. 98.

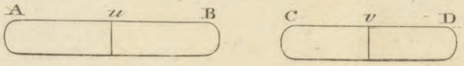


Fig. 99.

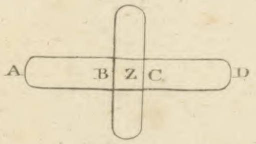


Fig. 100.

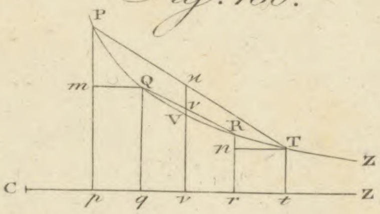


Fig. 101.

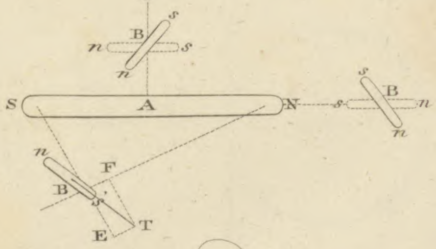


Fig. 102.

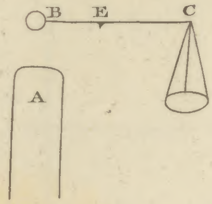


Fig. 103.

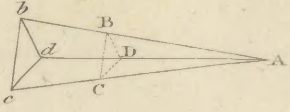


Fig. 104.

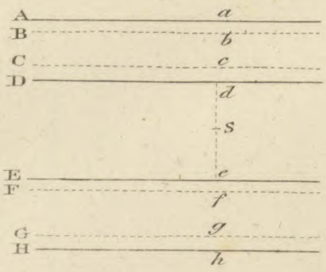


Fig. 105.

E. Mitchell sculp.

ELECTRICITY. PLATE CXCVII.

Fig. 106.

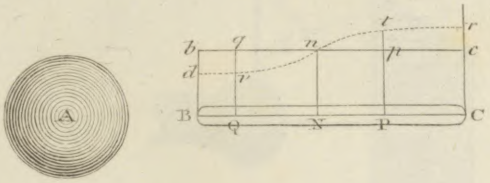


Fig. 107.

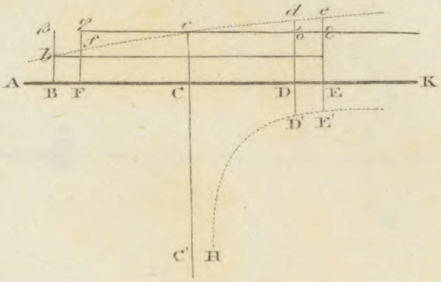


Fig. 108.

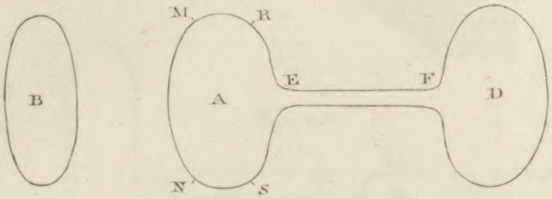


Fig. 109.

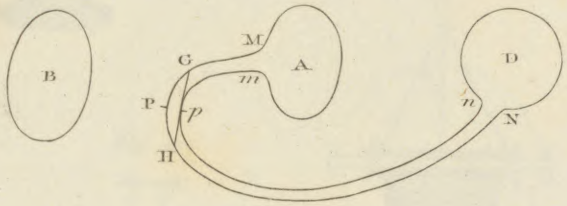


Fig. 110.

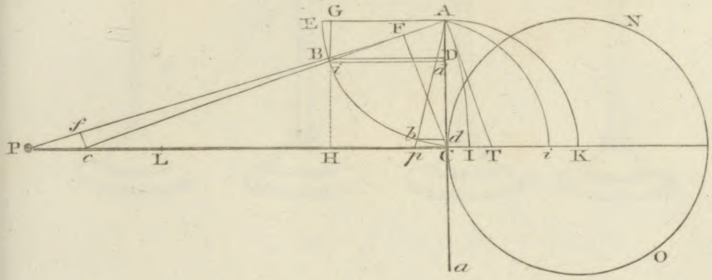


Fig. 111.

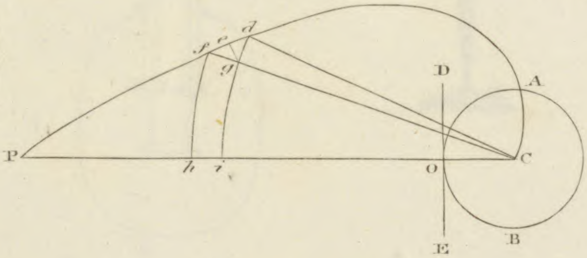
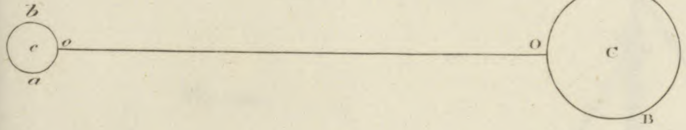


Fig. 112.



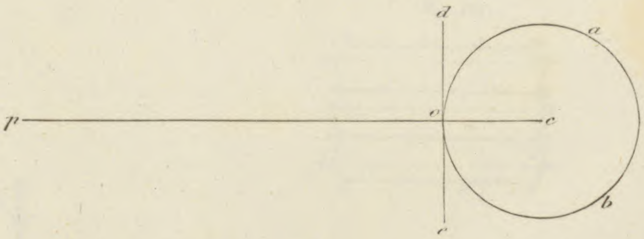


Fig. 113.

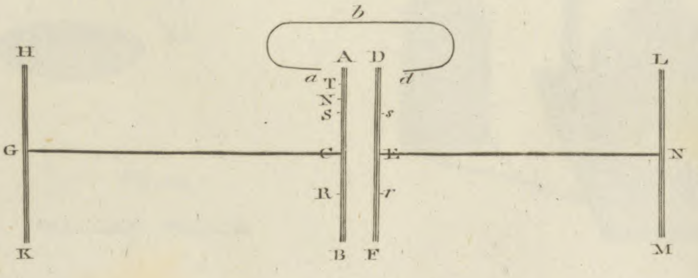
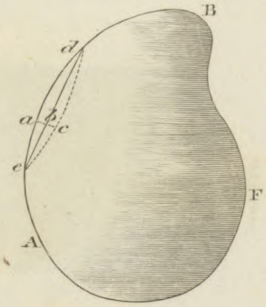


Fig. 114.



W. Archibald sculp.^t

ELECTRICITY.

PLATE CXCVIII.

Fig. 117.

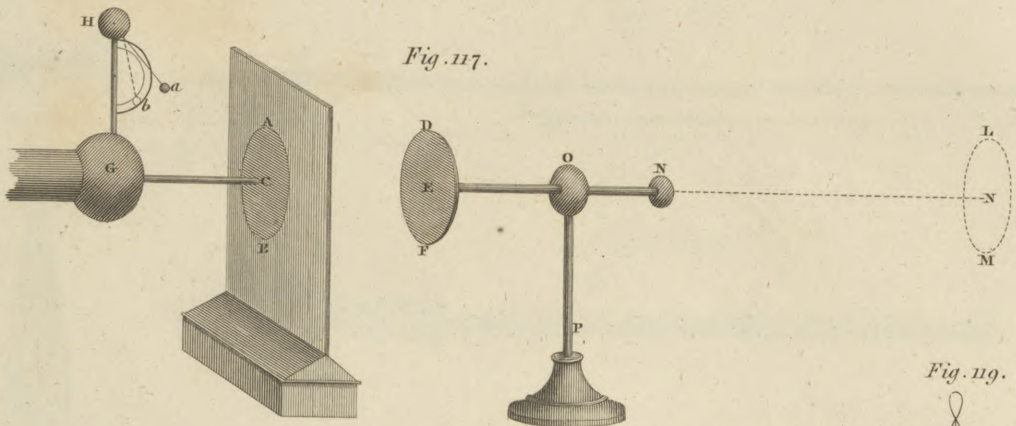


Fig. 115.

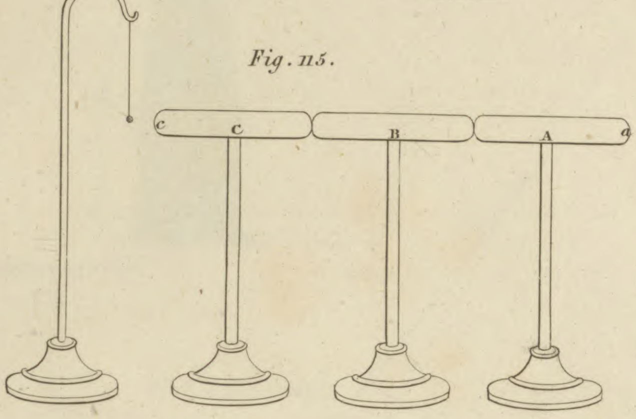


Fig. 118.

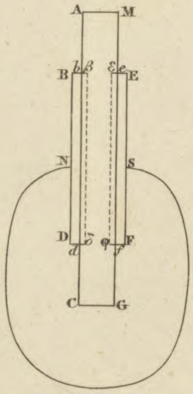


Fig. 119.

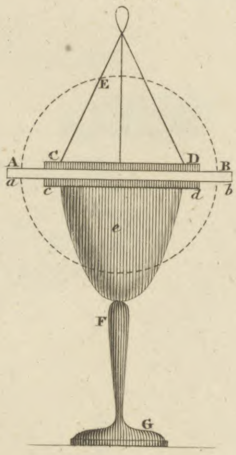


Fig. 116.

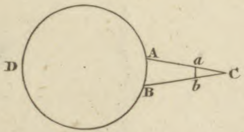


Fig. 121.

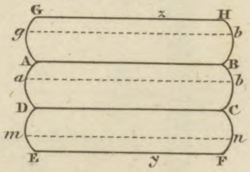


Fig. 123.

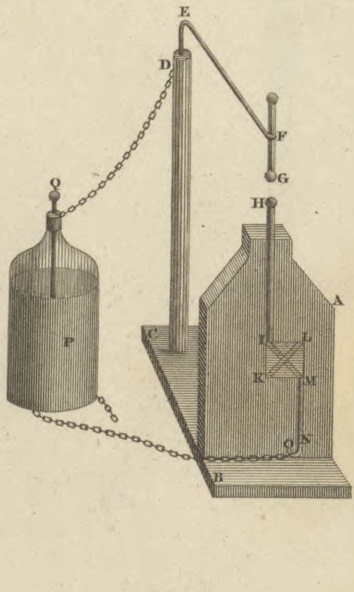


Fig. 120.

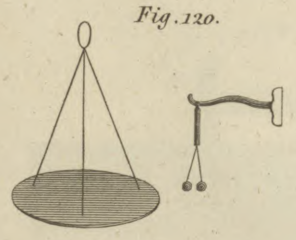


Fig. 122.

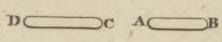
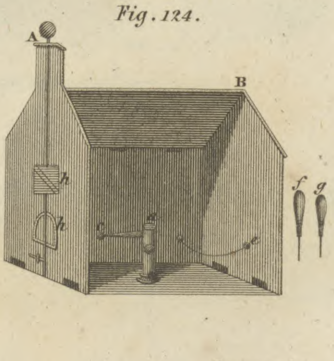


Fig. 124.



Turner sculp.

Plate CXCIX.

Fig. 125.

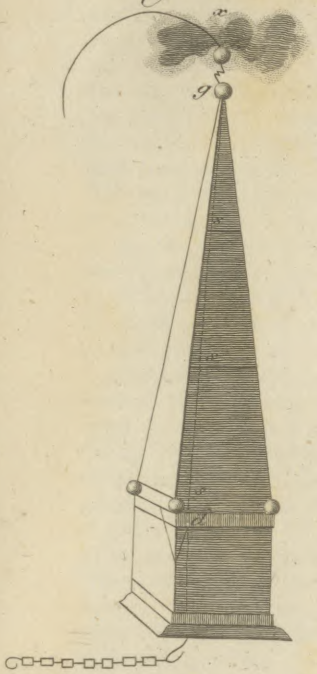


Fig. 129.

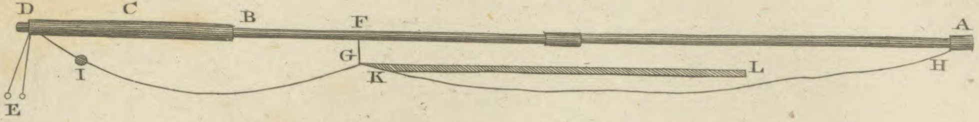


Fig. 130.

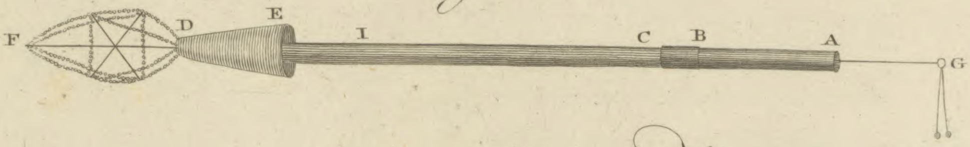


Fig. 126.

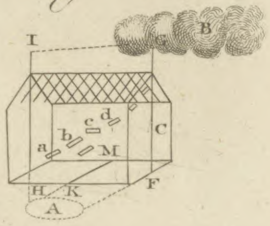


Fig. 127.

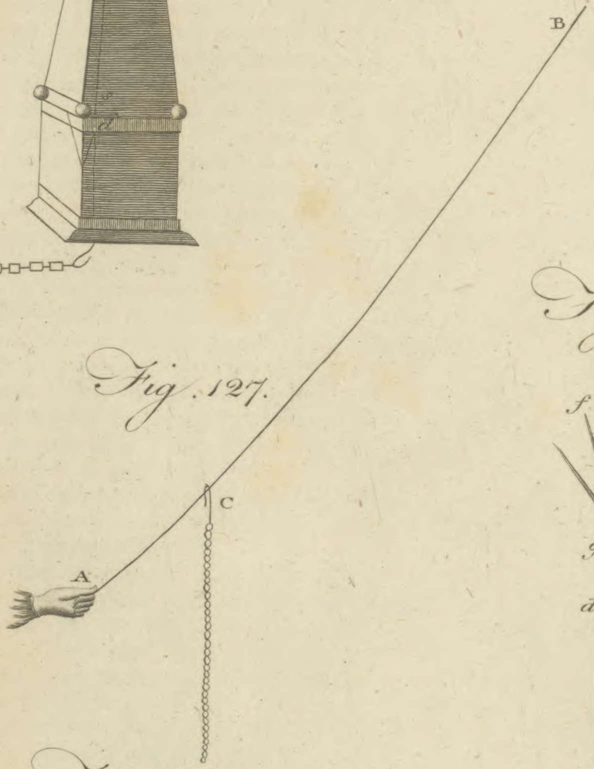
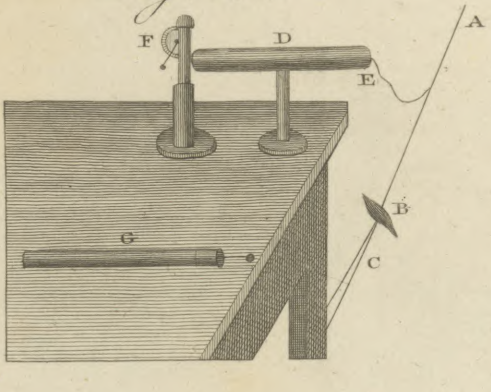


Fig. 128.



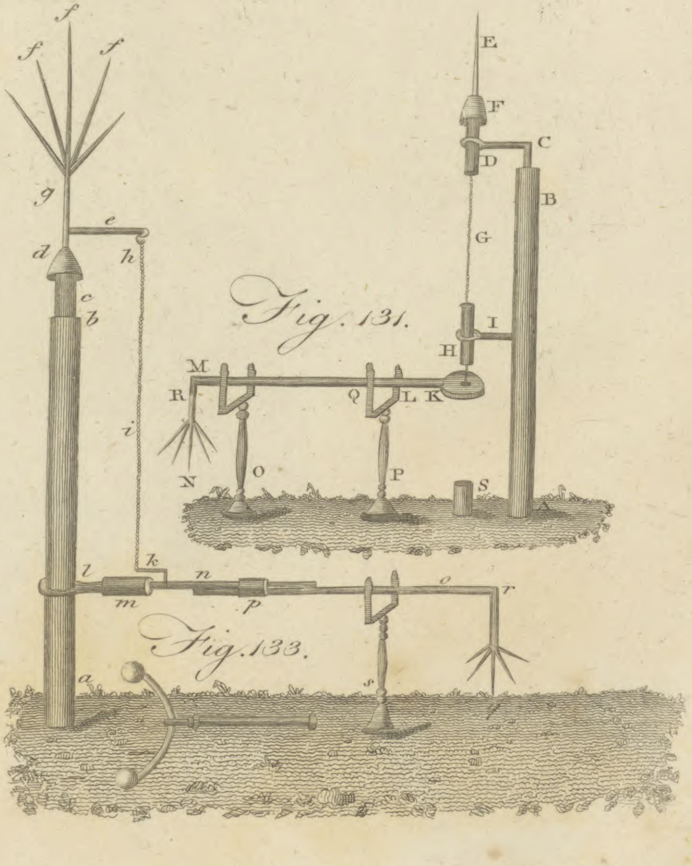


Fig. 132.

Fig. 131.

Fig. 133.

A.Bell Prin. Wal. Sculptor fecit

near the spine, and attached to its muscles and to the air-bladder above, and separated into a right and left organ by a septum. The other pair, which is much smaller, is beneath the former. The space separating the right from the left is occupied by the muscles which move the long abdominal fin. These organs consist of numerous membranes, lying horizontally over one another, and connected by numerous septa. They are supplied with numerous nerves of great magnitude, both from the spinal cord and the great sympathetics. The shocks communicated by this animal are much stronger than those which the torpedo gives, so that it is impossible, on account of their violence, to extend our knowledge of the physiology of the animal by handling it freely in its living state. It communicates at pleasure a shock to an animal at a short distance from it in the water. This is its first object in securing its prey. It swims up near to a fish, looks at it, then conveys to it a shock, which either instantly kills it, or stuns it so that it is deprived of all voluntary motion. When its end is not fully accomplished, it gives a second and stronger shock; very often it kills in this manner fishes which are larger than itself, and which it either cannot or will not eat. This shock is proved to be as decidedly electrical as that of the raia torpedo. The particulars of the experiments made by Dr Williamson, and also an anatomical account of it by Mr John Hunter, with large plates, are contained in the 65th volume of the Philosophical Transactions.

543 The silurus electricus.

A third electrical fish, is the *silurus electricus*, which differs in the situation and form of its peculiar organs from both of the two preceding. These organs form a universal envelope over the body, immediately under the skin. They consist of a collection of cellular tissue, so compact, that it might at first view be considered as a stratum of fat; but, when minutely examined, it is found to consist of tendinous fibres, forming a reticulation, the meshes of which require the aid of a magnifying power to distinguish them: these are filled with a gelatinous substance.

Thus it appears, that neither the situation of the electric organs, nor the form of the cells, is to be considered as constant in animals of this description. It is also discovered, by anatomical examination, that no branch of the nervous system is particularly set apart for this set of organs, as the nerves sent to it are different in all the species. The essential circumstances are, multiplied aponeuroses, with extensive surfaces, forming numerous cells, and these cells filled with gelatinous matter, and supplied with nerves of great size and length. Other species of rays, besides the torpedo, have a collection of gelatine, in a part of the body corresponding to the electric organ of the raia torpedo; but it is not separated into numerous minute portions by close aponeurotic cells. It lies in large continuous quantities, in lengthened cavities, communicating with the surface by open orifices; and hence the nerves distributed to it, though of considerable size, are incapable of eliciting from it any electrical phenomena.

Other two fishes are known to possess a similar power, viz. the *trichiurus indicus*, and the *tetraodon electricus*, both found in the Indian seas: but we know nothing of the distinguishing characters of their electric organs.

544 Electricity of the human body.

Electrical phenomena, occasionally developed by other animals, and also by the human body, have been recorded by naturalists and historians, both ancient and modern. In some individuals it has been excited by stroking their own hair backwards, or by combing. Some people have habitually observed electrical light to be given out when their shirts were moved. This has occasionally been remarked to occur in cases of disease, such as consumption. It has been further observed that, besides these palpable appearances of occasional occurrence, others are capable of being regularly produced by motion of the body, provided the clothes are of the same temperature with the body itself, and there is no perspiration present. This electricity is made apparent by the condenser, when it has been excited while the body was insulated. A quantity is present, independently of motion. It is different in degree in different persons. It differs in kind on different occasions, and even varies in this respect in the course of one experiment. On the whole, however, it is naturally positive. When it is negative, the body is in an unnatural state. Cold weakens it, or reduces it to zero, or changes it to the negative form. Lassitude has a similar operation. Sudden and violent motion changes every kind of animal electricity to the opposite. Continual straining of the thoughts is favourable to positive electricity. The breath has no effect on it, and does not sensibly conduct it. Such are the leading results made on this subject by the delicate experiments of Mr Hemmer, an account of which is contained in the 5th volume of the Philosophical Magazine.

PART VIII.

APPLICATION OF ELECTRICITY TO MEDICINE.

AT one time, the powers of electricity over the animal economy, were represented by some persons in Italy as so remarkable, that a suspicion of exaggeration and fable was naturally excited. It was asserted, that by means of the electrical shock, the virtues of medicinal drugs held in the hand were diffused through the whole body. The abbé Nollet and others exposed, by a set of careful experiments, the imposture of these pretensions, in a visit which they paid to Italy for the express purpose of investigating the subject. Other similar frauds have been practised upon this subject, which it would serve no purpose to describe.

545 Mode of applying it to medical uses.

But there can be no doubt, that the application of electricity has, in many instances of disease, proved useful. Shocks may be communicated in quick succession, and of a regulated strength, by means of a Leyden jar fitted up with Lane's electrometer. Two directors of metal are employed, with a metallic ball at one end of

Medical Electricity.

each, and at the other a glass handle; by means of which it may be applied by an operator placed without the electrical circle. These directors are applied to the two opposite extremities of the part through which the shocks are to be transmitted, and they are connected with the opposite sides of the electric jar, by means of flexible conductors, such as metallic wires.

546 Successful cases.

Mr Carpue has published several cases of success, along with some failures, under the use of electricity.

In contractions depending on an affection of a nerve, it has sometimes been effectual.

In cases of rigidity, it has frequently given relief when long persevered in.

In sprains, relaxations, and similar cases, after inflammation has subsided, it is applied with good effect.

Indolent tumours, and even scirrhus of the mammæ and testicles, have yielded to strong sparks and slight shocks.

In deafness, sparks thrown on the mastoid process of the temporal bone, and round the meatus externus, usually afford relief, and occasionally produce a perfect cure.

Opacity of the cornea is sometimes cured by electricity, applied by means of a wooden point for ten minutes daily, for a length of time. It is most particularly apt to yield when originating in the smallpox.

Amaurosis has sometimes been successfully treated by the same means.

Suppressed menstruation has been relieved, but not retention of the catamenia.

In a few cases of pain and swelling of the knee, relief has been effectually obtained.

In chronic rheumatism the success is very frequent.

Chorea has been frequently relieved; palsy occasionally. In epilepsy Mr Carpue never found it successful.

It must, however, be remarked, that the indiscriminate employment of this powerful agent, especially in shocks of inordinate strength sent through the brain or spinal cord, is often productive of great and permanent mischief; so that it is necessary for the medical practitioner to be guarded in the employment of it: and it ought not, without due precaution, to be applied to the human constitution for purposes of curiosity or amusement.

INDEX.

END OF THE SEVENTH VOLUME.

DIRECTIONS FOR PLACING THE PLATES of Vol. VII.

Part I.

Plate CLXVIII. to face	Page 162
CLXIX.	180
CLXX.	172
CLXXI.—CLXXIV.	214
CLXXV.	250
Plate CLXXVI. to face	Page 280
CLXXVII.—CLXXXIII.	324

Part II.

CLXXXIV.—CLXXXVI.	498
CLXXXVII.—CXCIX.	808