and chamber

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advance in their paſſage up and down; ſo that if any veſſels are anchored therein, they are ſaid to lie in the fair-way.

FAIRFAX, Edward, natural ſon of Sir Thomas Fairfax, was an Engliſh poet who lived in the reigns of Elizabeth and James I. He wrote ſeveral poetical pieces, and was an accompliſhed genius. Dryden introduces Fairfax with Spenſer, as the leading writers of the times; and even ſeems to give the preference to the former in the way of harmony, when he obſerves that Waller owned himſelf indebted for the harmony of his numbers to Fairfax's *Godfrey of Boulogne*. He died about the year 1632, at his own houſe called *New-hall*, in the pariſh of Fuyſton, between Denton and Knareſborough, and lies under a marble ſtone.

Fairfax, *Sir Thomas*, general of the parliamentary forces againſt Charles I. in 1644. See (*Hiſtory of*) Britain, Nº 127. *et ſeq.* He reſigned in 1650; after which he lived privately, till he was invited by General Monk to aſſiſt him againſt Lambert's army. He cheerfully embraced the occaſion; and, on the third of December 1659, appeared at the head of a body of gentlemen of Yorkſhire; when, upon the reputation of his name, a body of 12,000 men forſook Lambert and joined him. He was at the head of the committee appointed by the houſe of commons to attend King Charles II. at the Hague, to deſire him ſpeedily to return to England; and having readily aſſiſted in his reſtoration, returned again to his ſeat in the country; where he lived in a private manner till his death, which happened in 1671, in the 60th year of his age.—He wrote, ſays Mr Walpole, Memorials of Thomas Lord Fairfax, printed in 1699; and was not only an hiſtorian, but a poet. In Mr Thoreſby's muſeum were preſerved in manuſcript the following pieces: The Pſalms of David, the Canticles, the Songs of Moſes, and other parts of Scripture, verſified; a poem on Solitude; Notes of Sermons, by his lordſhip, by his lady daughter of Horace Lord Vere, and by their daughter Mary the wife of George ſecond duke of Buckingham: and a Treatiſe on the Shortneſs of Life. But of all Lord Fairfax's works, ſays Mr Walpole, the moſt remarkable were the verſes he wrote on the horſe on which Charles II. rode to his coronation, and which had been bred and preſented to the king by his lordſhip. How muſt that merry monarch, unapt to keep his coutenance on more ſerious occaſions, have ſmiled at this awkward homage from the old victorious hero of republicaniſm and the covenant! He gave a collection of manuſcripts to the Bodleian library.

FAIRFORD, a town in Glouceſterſhire, with a market on Thurſdays. It is remarkable for the church, which has curious painted glaſs windows. They are ſaid to have been taken in a ſhip by John Tame, Eſq. towards the end of the 15th century, who built the church for their ſake. They are preſerved entire, and the figures are extremely well drawn and coloured. They repreſent the moſt remarkable hiſtories in the Old and New Teſtament. They are frequently viſited by travellers, and many go on purpoſe to view them, as one of the greateſt curioſities in England. The painter was Albert Durer. W. Long. 1. 46. N. Lat. 51. 42.

FAIRY, in ancient traditions and romances, ſigniſies a ſort of deity, or imaginary genius, converſant on the earth, and diſtinguiſhed by a variety of fantaſtical actions either good or bad.

They were moſt uſually imagined to be women of an order ſuperior to human nature, yet ſubject to wants, paſſions, accidents, and even death; ſprightly and benevolent while young and handſome; moroſe, peeviſh, and malignant, if ugly, or in the decline of their beauty; fond of appearing in white, whence they are often called the *white ladies*.

Concerning theſe imaginary beings, no leſs a perſon then Jervaiſe of Tilleberry, marſhal of the kingdom of Arles, who lived in the beginning of the 13th century, writes thus in a work inſcribed to the emperor Otho IV. "It has been aſſerted by perſons of unexceptionable credit, that fairies uſed to chooſe themſelves gallants from among men, and rewarded their attachment with an affluence of wordly goods; but if they married, or boaſted of a fairy's favours, they as ſeverely ſmarted for ſuch indiſcretion." The like tales ſtill go current in Languedoc; and throughout the whole province, there is not a village without ſome ancient ſeat or cavern which had the honour of being a fairy's reſidence, or at leaſt ſome ſpring where a fairy uſed to bathe. This idea of fairies has a near affinity with that of the Greeks and Romans, concerning the nymphs of the woods, mountains, and ſprings; and an ancient ſcholiaſt on Theocritus ſays, "The nymphs are demons which appear on the mountains in the figure of women:" and what is more ſurpriſing, the Arabs and other orientals have their *ginn* and *peri*, of whom they entertain the like notions.

But fairies have been likewiſe deſcribed as of either ſex, and generally as of minute ſtature, though capable of aſſuming various forms and dimenſions. The moſt charming repreſentation imaginable of theſe children of romantic fancy, is in the *Midſummer Night's Dream* of Shakeſpear; in referring to which, we no doubt have been anticipated by the recollection of almoſt every reader.

Spenſer's Faery Queene is an epic poem, under the perſons and characters of fairies. This ſort of poetry raiſes a pleaſing kind of horror in the mind of the reader, and amuſes his imagination with the ſtrangeneſs and novelty of the perſons who are repreſented in it; but, as a vehicle of inſtruction, the judicious object to it, as not having probability enough to make any moral impreſſion.

The belief of fairies ſtill ſubſiſts in many parts of our own country. The

"Swart fairy of the mine"

(of German extraction), has ſcarce yet quitted our ſubterraneous works; (*vid.* next article.) *Puck*, or *Robin Good-Fellow*, ſtill haunts many of our villages. And in many parts of Scotland, new born children are watched till the chriſtening is over, leſt they ſhould be ſtolen or changed by ſome of theſe fantaſtical exiſtences.

Fairy *of the Mine*; an imaginary being, an inhabitant of mines. The Germans believed in two ſpecies; one fierce and malevolent: the other a gentle race, appearing like little old men dreſſed like the miners, and not much above two feet high. Theſe wander about the drifts and chambers of the works; ſeem perpetually employed,

employed, yet do nothing; some seem to cut the ore, or fling what is cut into vessels, or turn the windlass: but never do any harm to the miners, unless provoked; as the sensible Agricola, in this point credulous, relates in his book *de Animantibus Subterraneis*.

Fairy Circle or *Ring*, a phenomenon pretty frequent in the fields, &c. supposed by the vulgar to be traced by the fairies in their dances. There are two kinds of it; one of about seven yards in diameter, containing a round bare path, a foot broad, with green grass in the middle of it. The other is of different bigness, encompassed with a circumference of grass. Mess. Jessop and Walker, in the Philosophical Transactions, ascribe them to lightning; which is thought to be confirmed by their being most frequently produced after storms of that kind, as well as by the colour and brittleness of the grass roots when first observed. Lightning, like all other fires, moves round, and burns more in the extremity than in the middle: the second circle arises from the first, the grass burnt up growing very plentifully afterwards. Others maintain that these circles are made by ants, which are frequently found in great numbers therein.—Mr Cavallo, in his treatise on electricity, does not think that lightning is at all concerned in the formation of them: "They are not (says he) always of a circular figure; and, as I am informed, they seem to be rather beds of mushrooms than the effects of lightning."

We have frequently observed beds of mushrooms arranged in a circular form like what are called fairy rings; but it will be difficult to account for the mushroom seed being disposed in this manner. It is probable that the seed is dispersed over the whole field, and remains dormant till it is acted on by some stimulus to excite its vegetating powers. Perhaps this stimulus is atmospheric electricity, which acting on particular spots only, produces on them an abundant crop of mushrooms, while none appear in other places.

FAITH, in *Philosophy* and *Theology*, that assent which we give to a proposition advanced by another, the truth of which we do not immediately perceive from our own reason or experience; or it is a judgment or assent of the mind, the motive whereof is not any intrinsic evidence, but the authority or testimony of some other who reveals or relates it. Hence, as there are two kinds of authorities and testimonies, the one of God, and the other of man, faith becomes distinguished into divine and human.

Divine Faith, is that founded on the authority of God; or it is that assent we give to what is revealed by God.

The objects of this faith, therefore, are matters of revelation. See Revelation and Religion.

Human Faith, is that whereby we believe what is told us by men. The object hereof is matter of human testimony and evidence. See Metaphysics.

Faith, in practical theology, makes the first of the theological virtues or graces.

Faith in God, in this sense, denotes such a conviction of his being, perfections, character, and government, as produces love, trust, worship, obedience, and resignation.

Faith in Christ, as it has been defined by some, is a mere assent to the gospel as true; according to others, it signifies such a persuasion that he is the Messiah, and such a desire and expectation of the blessings which he has promised in his gospel to his sincere disciples, as engage the mind to fix its dependence upon him, and subject itself to him in all the ways of holy obedience. See Theology.

Faith, likewise, in respect to futurity, is a moral principle, implying such a conviction of the reality and importance of a future state, as is sufficient to regulate the temper and conduct.

Faith, or *Fidelity* (*Fides*), was deified by the ancient Romans, and had a temple in the Capitol consecrated to her by Attilius Catalinus. Her priests wore white veils: unbloody sacrifices were offered to her, and the greatest oaths were taken in her name. Horace clothes her in white, places her in the retinue of Fortune, and makes her the sister of Justice, *Od.* 24, 35. l. i. Public Faith is represented in a great number of medals; sometimes with a basket of fruit in one hand, and some ears of corn in the other; and sometimes holding a turtle-dove. But the most usual symbol is two hands joined together. The inscriptions are generally, *Fides Augusti*, *Fides Exercitus*, or *Fides Militum*, &c.

FAITHFUL, an appellation assumed by the Mahometans. See Mahometans.

FAITHORN, William, an ingenious English artist, a native of London, was the disciple of Peak the painter, and worked with him three or four years. At the breaking out of the civil war, Peak espoused the cause of his sovereign: and Faithorn, who accompanied his master, was taken prisoner by the rebels at Baringhouse, from whence he was sent to London, and confined in Aldersgate. In this uncomfortable situation he exercised his graver; and a small head of the first Villars duke of Buckingham, in the style of Melan, is reckoned among his performances at that time. The solicitations of his friends in his favour at last prevailed; and he was released from prison, with permission to retire to the continent. In France he found protection and encouragement from the Abbé de Marolles; and it was at this time that he formed an acquaintance with Nanteuil, from whose instructions he derived very considerable advantages. About the year 1650 he returned to England, and soon after married the sister of a Captain Cround. By her he had two sons; Henry, who was a bookseller, and William an engraver in mezzotinto. Faithorn opened a shop near Temple-Bar, where he sold not only his own engravings, but those of other English artists, and imported a considerable number of prints from Holland, France, and Italy. About the year 1680, he retired from his shop, and resided in Printing-House Yard; but he still continued to work for the booksellers, especially Royston, Martin, and Peak the younger, his former master's brother. He painted portraits from the life in crayons; which art he learned of Nanteuil during his abode in France, He also painted in miniature; and his performances in both these styles were much esteemed. His spirits were broken by the indiscretion and dissipation of his son William; and a lingering consumption put an end to his life in 1691. He wrote a book *Upon Drawing, Graving, and Etching*, for which he was celebrated by his friend Thomas Flatman the poet.

FAKIRS, Indian monks or friars. They outdo the

the ſeverity and mortification of the ancient Anchorets or Solitaries. Some of them make a vow of continuing all their lifetime in one poſture, and keep it effectually. Others never lie down; but continue in a ſtanding poſture all their lives, ſupported only by a ſtick, or rope under their arm pits. Some mangle their bodies with ſcourges and knives. They look upon themſelves to have conquered every paſſion, and triumphed over the world; and accordingly ſcruple not, as if in a ſtate of innocence, to appear entirely naked in public.

The common people of Eaſt India are thoroughly perſuaded of the virtue and innocence of the fakirs; notwithſtanding which, they are accuſed of committing the moſt enormous crimes in private.

They have alſo another kind of fakirs, who do not practiſe ſuch ſeverities: theſe flock together in companies, and go from village to village; propheſying, and telling fortunes. They are wicked villains, and it is dangerous for a man to meet them in a lone place: nevertheleſs the Indian idolaters have them in the utmoſt veneration. They make uſe of drums, trumpets, and other muſical inſtruments, to rouſe their ſouls, and work themſelves up to an artificial ecſtaſy, the better to publiſh their pretended prophecies.

Some of the votaries of theſe ſages moſt devoutly kiſs their privy parts; and they receive this monſtrous declaration of reſpect with a kind of ecſtatic pleaſure. The moſt ſober and diſcreet Indians conſult them in this prepoſterous attitude; and their female votaries converſe with them a conſiderable time with the moſt indecent freedom.

The fire they burn is made of cows dung, dried in the ſun. When they are diſpoſed to ſleep, they repoſe themſelves on cows dung, and ſometimes on ordure itſelf. They are ſo indulgent towards every living creature, that they ſuffer themſelves to be overrun with vermine, or ſtung by inſects, without the leaſt reluctancy or complaint.

It is more than probable, thoſe Indian friars have ſome ſecret art to lull their ſenſes aſleep, in order to render themſelves in a great meaſure inſenſible of the exceſſive torments they voluntarily undergo. Ovington aſſures us, that "as he was one day in an aſſembly of fakirs, he obſerved, that they drank opiates infuſed in water; the intoxicating virtue thereof was enough to turn their brain."

The garment of the chief fakirs conſiſts of three or four yards of orange-coloured linen, which they tie round them, and a tiger's ſkin, which hangs over their ſhoulders. Their hair is woven in treſſes, and forms a kind of turban. The ſuperior of the fakirs is diſtinguiſhed from the reſt by having a greater number of pieces in his garment, and by a chain of iron, two yards long, tied to his leg. When he deſigns to reſt in any place, a garment is ſpread upon the ground; on which he ſits and gives audience, whilſt his diſciples publiſh his virtues.

Some perſons of quality in India have become fakirs: among others, five great lords belonging to the court of Schah Gehan, Mogul of the Indies. It is ſaid, there are about two millions of fakirs in the Eaſt Indies.

FALASHA, a people of Abyſſinia, of Jewiſh origin, deſcribed by Mr Bruce, who was at great pains to acquaint himſelf with their hiſtory by cultivating the friendſhip of the moſt learned perſons among them he could meet with.

According to the accounts received from them, the Falaſha are the deſcendants of thoſe Jews who came from Paleſtine into Ethiopia, as attendants of Menilek the ſon of the queen of Sheba or Saba by Solomon. They agree in the relations given by the Abyſſinians of that princeſs, but deny that the poſterity of thoſe who came with Menilek ever embraced the Chriſtian religion, as the Abyſſinians ſay they did. They ſay, that at the decline of the Jewiſh commerce, when the ports of the Red ſea fell into the hands of other nations, and no intercourſe took place betwixt them and Jeruſalem, the Jewiſh inhabitants quitted the ſea coaſts and retired into the province of Dembea. While they remained in the cities on the Red ſea, they exerciſed the trade of brick and tile making, pottery, thatching houſes, &c. and after leaving the ſea-coaſts, they choſe the country of Dembea on account of the plenty of materials it afforded for exerciſing the trades they profeſſed. Here they carried the art of pottery to a great degree of perfection, multiplied exceedingly, and became very numerous and powerful about the time that the Abyſſinians were converted to Chriſtianity. As this event was accounted by them an apoſtaſy from the true religion, they now ſeparated themſelves from the Abyſſinians, and declared one Phineas, of the line of Solomon, their king. Thus they ſay, they have ſtill a prince of the houſe of Judah for their ſovereign, though their aſſertion is treated with contempt, and a nickname beſtowed on the Falaſhan family by the other Abyſſinians. About the year 960, the queen of this people, after extirpating the Abyſſinian princes on the rock Damo, aſſumed the ſovereignty of the whole empire, which they retained for ſome time; but their power being by degrees reduced, they were obliged to take up their reſidence among the rugged mountains of Samen; one of which they choſe for their capital, and which has ever ſince been called the *Jew's Rock*. About the year 1600, they were almoſt entirely ruined by an overthrow from the Abyſſinians, in which both their king and queen were ſlain; ſince which time they have been in ſubjection to the emperors of that country, but are ſtill governed by their own princes. When Mr Bruce was in Abyſſinia they were ſuppoſed to amount to about 100,000 effective men. Gideon and Judith were the names of the king and queen at that time; and theſe, according to our author, ſeem to be preferred to others for the royal family.

The language of this people is very different from the Hebrew, Samaritan, or any other which the Jews ever ſpoke in their own country. On being interrogated concerning it by Mr Bruce, they ſaid, that it was probably one of thoſe ſpoken by the nations on the Red ſea, among whom they had ſettled at their firſt coming. They arrived in Abyſſinia ſpeaking Hebrew, and with the advantage of having books in that language; but had now forgot it, which indeed is not to be wondered at, as they had loſt their Hebrew books, and were entirely ignorant of the art of writing. At the time of their leaving Jeruſalem, they were in poſſeſſion both of the Hebrew and Samaritan copies of the law; but when their fleet was deſtroyed in the time of Rehoboam, and no farther communication with Jerusalem took place, they were obliged to use translations of the Scriptures, or those copies which were in possession of the shepherds, who, they say, were all Jews before the time of Solomon. On being asked, however, where the shepherds got their copy, and being told, that, notwithstanding the invasion of Egypt by Nebuchadnezzar, there was still a communication with Jerusalem by means of the Ishmaelite Arabs through Arabia, they frankly acknowledged that they could nor tell: neither had they any memorials of the history either of their own or any other country; all that they believed in this case being derived from mere tradition, their histories, if any existed, having been destroyed by the famous Moorish captain Gragné. They say that the first book of Scripture they received was that of Enoch; and they place that of Job immediately after it, supposing that patriarch to have lived soon after the flood. They have no copy of the Old Testament in the Falasha language, what they make use of being in that of Geez. This is sold to them by the Abyssinian Christians, who are the only scribes in that country. No difference takes plaoe about corruptions of the text; nor do the Falasha know any thing of the Jewish Talmud, Targum, or Cabala. See ABYSSINIA.

FALCADE, in the manege, the motion of a horse when he throws himself upon his haunches two or three times, as in very quick curvets; which is done in forming a stop and half stop. See STOP.

FALCATED, something in the form of a sickle: thus the moon is said to be *falcated* when she appears horned.

FALCO, the eagle and hawk, a genus of birds belonging to the order of accipitres. See ORNITHOLOGY *Index*.

FALCON, or FAUCON, a bird of prey of the hawk kind, superior to all others for courage, docility, gentleness, and nobleness of nature *. Several authors take the name *falcon* to have been occasioned by its crooked talons or pounces, which resemble a falx or sickle. Giraldus derives it *à falcando*, because it flies in a curve.

* See *Falco*.

The falcon, or falcon gentle, is both for the fist and for the lure. In the choice, take one that has wide nostrils, high and large eyelids, a large black eye; a round head, somewhat full on the top; barb feathers on the clap of the beaks, which should be short, thick, and of an azure colour; the breast large, round, and fleshy; and the thighs, legs, and feet, large and strong, with the sear of the foot soft and bluish: the pounces should be black, with wings long and crossing the train, which should be short and very pliable.

The name *falcon* is restrained to the female: for the male is much smaller, weaker, and less courageous, than the female; and therefore is denominated *tassel*, or *tircelet*. The falcon is excellent at the river, brook, and even field; and flies chiefly at the larger game, as wild goose, kite, crow, heron, crane, pye, shoveler, &c. For further particulars, see FALCONRY and HAWKING.

The custom of carrying a falcon extended to many countries, and was esteemed a distinction of a man of rank. The Welsh had a saying, That you may know a gentleman by his hawk, horse, and greyhound. In fact, a person of rank seldom went without one on his hand. Harold, afterwards king of England, is painted going on a most important embassy, with a hawk on his hand and a dog under his arm. Henry VI. is represented at his nuptials, attended by a nobleman and his falcon. Even the ladies were not without them in earlier times; for in an ancient sculpture in the church of Milton Abbas, in Dorsetshire, appears the consort of King Athelstan with a falcon on her royal fist tearing a bird.

FALCONER, a person who brings up, tames, and makes, that is, tutors and manages, birds of prey; as falcons, hawks, &c. See FALCONRY.

The grand signior, it is said, usually keeps 6000 falconers in his service.—The French king had formerly a grand falconer, which was an office dismembered from that of great hunter, *grand veneur*. Historians take notice of this post as early as the year 1250.

A falconer should be well acquainted with the quality and mettle of his hawks, that he may know which of them to fly early and which late. Every night after flying he should give them casting; one while plumage, sometimes pellets of cotton, and at another time physic, as he finds necessary. He ought also every evening to make the place clean under the perch, that by her casting he may know whether she wants scouring upwards or downwards. Nor must he forget to water his hawk every evening, except on such days as she has bathed; after which, at night, she should be put into a warm room, having a candle burning by her, where she is to sit unhooded, if she be not ramage, that she may pick and prune herself.—A falconer should always carry proper medicines into the field, as hawks frequently meet with accidents there. Neither must he forget to take with him any of his hawking implements; and it is necessary he should be skilful in making lures, hoods of all sorts, jesses, bewets, and other furniture. Neither ought he to be without his coping irons, to cope his hawk's beak when overgrown, and to cut her pounces and talons as there shall be occasion: nor should his cauterizing irons be wanting.

FALCONER, *William*, an ingenious Scots sailor, who, about the year 1762, came up to London with a pretty pathetic poem, called the *Shipwreck*, founded on a disaster of his own experience. The publication of this piece recommended him to the late duke of York; and he would in all probability have been suitably preferred, if a second shipwreck, as may be supposed, had not proved fatal to him, and to many gentlemen of rank and fortune with whom he sailed. In 1770, he went out a volunteer in the Aurora frigate, sent to carry Messrs Vansittart, Scrafton, and Ford, the supervisors appointed to regulate our East India settlements; which vessel, after it had touched at the Cape of Good Hope, was never more heard of. Before his departure, he published a very useful Marine Dictionary, in one volume 4to.

FALCONRY, a kind of sport or amusement, respecting the antiquity of which different opinions have been entertained by the learned. It is denied by Blondus, Laurentius Valla, and others, that the ancient Greeks knew any thing about falconry; but the learned Professor Beckmann, on the most unequivocal authority, maintains that they did. He admits that they might be ignorant of the art of hawking, or of chaſing game with birds trained for that purpoſe; but he contends that they employed ſome ſpecies of the moſt rapacious of the winged tribe in hunting and fowling. In the days of Cteſias, the Indians hunted hares and foxes by means of rapacious birds; and Ariſtotle ſays expreſsly, "In Thrace, the men go out to catch birds with hawks. They beat the reeds and buſhes which grow in marſhy places, in order to raiſe the ſmall birds, which the hawks purſue and drive to the ground, where the fowlers kill them with poles."

Reſpecting Thrace, which is ſituated above Amphipolis, a wonderful circumſtance is related, which to many may appear almoſt incredible. We are informed that boys went into the fields, and purſued birds by the aſſiſtance of hawks. When they found a convenient place for their purpoſe, they called their hawks by their particular names, which came immediately on hearing their voices, and purſued the birds into the buſhes, where the boys killed them with ſticks, and thus made them their prey. When the hawks themſelves laid hold of any birds, they threw them to the fowlers, and received, for their fidelity, a ſhare of the game. If we add the ſpaniel, now employed to find out the game, the hood placed upon the head of the hawk, and the thong for holding it, we may clearly perceive in theſe ancient accounts the practice of modern times. Falconers ſtill give a portion of the game to the hawk, as was the uſual practice of the boys at Thrace.

According to the teſtimony of Phile, Pliny, Ælian, and others, the birds were ſometimes driven into nets by the hawks employed in theſe ſports. From India and Thrace, therefore, it ſeems manifeſt, that the Greeks obtained their firſt information as to the method of fowling with birds of prey; but they themſelves do not appear to have adopted the practice at a very early period. In Italy, however, it muſt have been extremely well underſtood, ſince it is mentioned by Martial and Apuleius as a thing everywhere known. After being once known, it was never totally forgotten; but it ſhared the fate of other inventions in this reſpect, that it was originally admired, and afterwards much neglected, by which means it received no material improvements for a conſiderable time; yet it was at length brought to the utmoſt perfection. We find mention made of this ſport in the Roman laws, and in many authors of the fourth and ſubſequent century. In the time of Conſtantine the Great, Julius Firmicus Maternus aſſures us, according to the ſuperſtitious notions of that period, that ſuch as are born under certain ſigns, will become great ſportſmen, and keep hounds and falcons. Sidonius, who flouriſhed about the end of the fifth century, praiſes Herdicius, the brother of his wife, becauſe he was the firſt in his territories who practiſed hunting and fowling with dogs and hawks.

Falconry appears to have been carried to the greateſt perfection, and to have been much eſteemed at the chief courts of Europe, ſo early as the 12th century, for which reaſon ſome have aſcribed the invention to the emperor Frederic I. whereas he appears to have been only the firſt who introduced the practice into Italy, according to the teſtimony of Rodericus and Collenuccio; and Frederic II. wrote a book entitled, *De arte venandi cum avibus*, to which the practice has been much indebted. Falconry has had a number of admirers among the fair ſex, perhaps in a ſuperior degree to any other ſport or amuſement whatever of a ſimilar nature; but their attachment was deſtroyed by the invention of gunpowder, which was accompanied both with alarm and danger. We conclude our remarks on the hiſtory of falconry with an obſervation of Demetrius, who flouriſhed in the 13th century, and who expreſsly wrote at large upon this ſubject. He deſires ſportſmen to ſay their prayers (Τον Θεον επικαλεσαντες) before they go out to the field, which appears wholly incompatible with the practice of modern times, and ſeems as impious as to crave aſſiſtance of God when preparing for a piratical expedition.

Falconry, the art of training all manner of hawks, but more eſpecially the larger ones called *falcons*, to the exerciſe of hawking. See Hawking.

When a falcon is taken, ſhe muſt be ſeeled in ſuch a manner, that, as the ſeeling ſlackens, ſhe may ſee what proviſion lies before her; but care ought to be taken, not to ſeel her too hard. A falcon or hawk newly taken ſhould have all new furniture, as new jeſſes of good leather, mailled leaſhes with buttons at the end, and new bewets. There ſhould alſo be provided a ſmall round ſtick, to ſtroke the hawk; becauſe, the oftener this is done, the ſooner and better will ſhe be manned. She muſt alſo have two good bells, that ſhe may be found when ſhe ſcattereth. Her hood ſhould be well faſhioned, raiſed, and emboſſed againſt her eyes, deep, and yet ſtrait enough beneath, that it may faſten about her head without hurting her; and her beak and talons muſt be a little coped, but not ſo near as to make them bleed.

If it be a ſoar-falcon, which had already paſſed the ſeas, ſhe will indeed be harder to reclaim, but will prove the beſt of falcons. Her food muſt be good and warm, and given her twice or thrice a-day, till ſhe be full gorged: the beſt for this purpoſe is pigeons, larks, or other live birds; becauſe ſhe muſt be broken off by degrees from her accuſtomed feeding. When ſhe is fed, you muſt hoop and lure, as you do when you call a hawk, that ſhe may know when you intend to give her meat. On this occaſion ſhe muſt be unhooded gently; and after giving her two or three bits, her hood muſt be put on again, when ſhe is to get two or three bits more. Care muſt be taken that ſhe be cloſe ſeeled; and after three or four days, her diet may be leſſened: the falconer ſetting her every night to perch by him, that he may awaken her often in the night. In this manner he muſt proceed, till he find her to grow tame and gentle; and when ſhe begins to feed eagerly, he may give her a ſheep's heart. He may now begin to unhood her in the day time; but it muſt be far from company, firſt giving her a bit or two, then hooding her gently, and giving her as much more. When ſhe is ſharp ſet, he may now unhood her, and give her ſome meat juſt againſt his face and eyes, which will make her leſs afraid of the countenance of others. She muſt be borne continually on the fiſt, till ſhe is properly manned, cauſing her to feed in company, giving her in the morning, about ſunriſe, the wing of a pullet; and in the evening, the foot of a hare or coney, cut off above the joint, ſlayed and laid in water, which being ſqueezed, is to be given her with the pinion of a hen's wing. For two or three days give her waſhed meat, and then plumage in more or leſs quantity as ſhe is thought to be more or leſs foul within. After this, being hooded again, ſhe is is to get nothing till ſhe has gleamed and caſt, when a little hot meat may be given her in company; and, towards evening, ſhe may be allowed to plume a hen's wing in company alſo. Cleanſe the feathers of her caſting, if foul and ſlimy; if ſhe be clean within, give her gentle caſtings; and when ſhe is reclaimed, manned, and made eager and ſharp ſet, he may venture to feed her on the lure.

However, three things are to be conſidered before the lure be ſhowed her; 1. That ſhe be bold and familiar in company, and not afraid of dogs and horſes. 2. Sharp ſet and hungry, having regard to the hour of morning and evening, when you would lure her. 3. Clean within, and the lure well garniſhed with meat on both ſides; and when you intend to give her the length of a leaſh, you muſt abſcond yourſelf.

She muſt alſo be unhooded, and have a bit or two given her on the lure as ſhe ſits on your fiſt; afterwards take the lure from her, and hide it that ſhe may not ſee it; and when ſhe is unſeeled, caſt the lure ſo near her, that ſhe may catch it within the length of her leaſh, and as ſoon as ſhe has ſeized it, uſe your voice as falconers do, feeding her upon the lure, on the ground, with the heart and warm thigh of a pullet.

Having ſo lured your falcon, give her but little meat in the evening; and let this luring be ſo timely, that you may give her plumage, and a juck of a joint next morning on your fiſt. When ſhe has caſt and gleamed, give her a little reaching of warm meat. About noon, tie a creance to her leaſh; and going into the field, there give her a bit or two upon her lure: then unwind the creance, and draw it after you a good way; and let him who has the bird hold his right hand on the taſſel of her hood, ready to unhood her as ſoon as you begin to lure; to which if ſhe come well, ſtoop roundly upon it, and haſtily ſeize it, let her caſt two or three bits thereon. Then, unſeizing and taking her off the lure, hood her and give her to the man again; and, going farther off, lure and feed her as before.

In this manner is the falconer to proceed, luring her every day farther and farther off, till ſhe is accuſtomed to come freely and eagerly to the lure; after which ſhe may be lured in company, taking care that nothing affright her. When ſhe is uſed to the lure on foot, ſhe is to be lured on horſeback; which may be effected the ſooner, by cauſing horſemen to be about her when ſhe is lured on foot.

When ſhe has grown familiar to this way, let ſomebody on foot hold the hawk, and he on horſeback muſt call and caſt the lure about his head, the holder taking off the hood by the taſſel; and if ſhe ſeize eagerly on the lure without fear of man or horſe, then take off the creance, and lure her at a greater diſtance. And if you would have her love dogs as well as the lure, call dogs when you give her her living or plumage. See Hawking.

FALERII, in *Ancient Geography*, a town of Etruria, on the weſt or right ſide of the Tiber; Faliſci, the people of the town and territory. The territory was famous for its rich paſtures; hence the *gramen Faliſcum* in authors. Eutropius and Frontinus call the town *Faliſci;* which, according to the laſt, was ſurnamed *Colonia Junonia*. The Faliſci are called *Æqui* by Virgil; becauſe they afforded ſupplemental laws to the 12 tables, (Servius). Here they made an excellent ſauſage, called *Venter Faliſcus* (Martial).

When the Faliſci were beſieged by Camillus, a ſchoolmaſter went out of the gates of the city with his pupils, and propoſed to betray them into the hands of the Roman enemy, that by ſuch a poſſeſſion he might eaſily oblige the place to ſurrender. Camillus heard the propoſal with indignation, and ordered the man to be ſtripped naked, and whipped back to the town by thoſe whom his perfidy wiſhed to betray. This inſtance of generoſity operated upon the people ſo powerfully that they ſurrendered to the Romans.

FALERNUS, *Mons Maſſicus* ſo called, (Martial); Falernus ager, a diſtrict at the foot of Mount Maſſicus in Campania; famous for its generous wines, (Horace, Pliny). Now called *Monte Maſſico*.

FALISCI. See Falerii.

FALKIA, a genus of plants belonging to the hexandria claſs. See Botany *Index*.

FALKIRK, a town of Stirlingſhire in Scotland, ſituated in W. Long. 3. 48. N. Lat. 56. 20. It is a large ill built place, and is ſupported by great fairs for black cattle from the Highlands, it being computed that 24,000 head are annually ſold there. A great deal of money is alſo got here by the carriage of goods landed at Carron wharf to Glaſgow. This town is remarkable for a battle fought in its neighbourhood between Edward I. of England, and the Scots commanded by the ſteward of Scotland, Cummin of Badenoch, and Sir William Wallace. The latter had been inveſted with the ſupreme command; but perceiving that this gave umbrage to the nobility, he reſigned his power into the hands of the noblemen above mentioned, reſerving to himſelf only the command of a ſmall body who refuſed to follow another leader. The Scots generals placed their pikemen along the front, and lined the intervals between the three bodies of which their army was compoſed, with archers: and dreading the great ſuperiority of the Engliſh cavalry, endeavoured to ſecure their front by palliſadoes tied together with ropes. The battle was fought on the 22d of July 1298. The king of England divided his army likewiſe into three bodies; and by the ſuperiority of his archers, defeated the Scots with great ſlaughter. Wallace alone preſerved entire the troops he commanded; and retiring behind the Carron, marched leiſurely along the banks of that river, which protected him from the enemy. In this battle fell John de Graham, a gentleman much celebrated for his valour, and ſtyled the *right hand* of the gallant Wallace. His epitaph is ſtill to be ſeen on a plain ſtone in the churchyard of Falkirk. On the 18th of January 1746, a battle was fought here between the king's forces commanded by General Hawley, and the Highlanders headed by Charles Stuart. The former was ſeized with a panic, and fled: but Colonel Huſk with two regiments, who kept their ground, prevented the Highlanders from purſuing their victory. Extenſive ruins are perceived in the neighbourhood of this town, ſuppoſed by ſome antiquarians to have been the capital of the Pictiſh government; but others believe them to be the remains of ſome Roman ſtations.

FALKLAND, a ſmall town of Fifeſhire in Scotland, made a royal burgh by James II. in 1458. Here ſtood one of the ſeats of the Macduffs earls of Fife. On the

Falkland, Fall. the attainder of Munro Stewart, the 17th earl, it became forfeited to the crown in 1424. James V. who grew very fond of the place, enlarged and improved it. The remains evince its former magnificence and elegance, and the fine taste of the princely architect. The gateway is placed between two fine round towers; on the right hand joins the chapel, whose roof is of wood, handsomely gilt and painted, but in a most ruinous condition. Beneath are several apartments. The front next to the court was beautifully adorned with statues, heads in bass relief, and elegant columns not reducible to any order, but of fine proportion, with capitals approaching the Ionic scroll. Beneath some of these pillars was inscribed I. R. M. G. 1537. or *Jacobus Rex, Maria de Guise*.—This place was also a favourite residence of James VI. on account of the fine park and plenty of deer. The east side was accidentally burnt in the time of Charles II. and the park ruined during Cromwell's usurpation, when the fine oaks were cut down in order to build the fort at Perth.—This place gives title of viscount to the English family of Carey; Sir Henry Carey being so created by James VI. 1620. His son was the celebrated Lucius, who sacrificed his life in a fit of loyal despair at the battle of Newbury, and from whom the present family is lineally descended.

FALKLAND, *Lord*. See CAREY.

FALL, the descent of a heavy body towards the centre of the earth. It is also the name of a measure of length used in Scotland, containing six ells.

FALL of Man, in sacred history, that terrible event by which sin and death were introduced into the world. See ADAM, and ANTEDILUVIANS, and *Original SIN*. The account which Moses gives of this transaction is extremely brief and concise. The serpent, he informs us, being more subtle than any beast of the field, asked the woman, whether it was true that God had not granted her and her husband leave to eat of every tree in the garden? She answered, That God had allowed them to eat of all, except only the fruit of the tree in the midst of the garden; which he commanded they should not taste, nor so much as touch, lest they should die. The serpent replied, That they should not die; for God knew the virtue of the tree; and that, so soon as they ate of it, their eyes would be opened, and they would become like gods, knowing good and evil. Eve, seeing the fruit tempting to the view, took of the fruit and ate; and gave also to her husband of it, and he did eat. Immediately the eyes of both were opened; when perceiving they were naked, they sewed fig leaves together and made themselves aprons. Adam and Eve, hearing the voice of God walking in the garden in the cool of the day, hid themselves among the trees; but, on God's calling for Adam, he excused himself for not appearing, because he was naked. God demanded of him, who it was that told him he was naked; and whether he had disobeyed his command, in eating the forbidden fruit? Adam confessed that the woman had offered him the fruit, and he had tasted it. She, being examined likewise, acknowledged what she had done; but said, the serpent had seduced and deceived her. God then proceeded to judgment; he first cursed the serpent above all beasts, and condemned him to go on his belly, and eat the dust; adding, that he would put enmity between him and the woman, and their offspring; that the seed of the woman should bruise the serpent's head, who should bruise the other's heel. The woman was subjected to the pains of childbirth, as well as to the dominion of her husband; and as to the man, God cursed the ground for his sake, declaring, that it should bring forth thorns and thistles, and he should earn his bread by the sweat of his brow, till he returned to the dust, from whence he was taken. At last, having clothed them both with skins, he turned them out of the garden, lest they should take of the tree of life, and eat, and live for ever: then, to prevent any attempt to return to their former habitation, he placed cherubims at the east of the garden, and a flaming sword which turned every way, to guard the passage to the tree of life.

This concise account being, at first view, encumbered with some difficulties, several learned and pious men have been inclined to believe the whole ought to be taken in an allegorical sense, and not according to the strictness of the letter: they allege, that the ancients, and particularly the eastern nations, had two different ways of delivering their divinity and philosophy, one popular, and the other mysterious; that the Scripture uses both occasionally; sometimes accommodating itself to the capacities of the people, and at other times to the real but more veiled truth; and that, to obviate the many difficulties which occur in the literal history of this sad catastrophe, the safest way is to understand it as a parabolical story, under which the real circumstances are disguised and concealed, as a mystery not fit to be more explicitly declared.

Though it cannot be denied that some of the ancient philosophers affected such an allegorical way of writing, to conceal their notions from the vulgar, and keep their learning within the bounds of their own school; yet it is apparent Moses had no such design; and as he pretends only to relate matters of fact, just as they happened, without art or disguise, it cannot be supposed but that this history of the fall is to be taken in a literal sense, as well as the rest of his writings. It is generally agreed, that the serpent which tempted Eve was the devil, who envying the privileges of man in innocence, tempted him, and was the cause of his forfeiting all those advantages which he had received from God at his creation; and that to this end he assumed the form of a serpent. These interpretations are supported by many passages of Scripture, where the devil is called the *serpent*, and the *old serpent*, (See John viii. 44. 2 Cor. xi. 3. and Rev. xii. 9.) Some believe that the serpent had then the use of speech, and conversed familiarly with the woman, without her conceiving any distrust of him; and that God, to punish the malice with which he had abused Eve, deprived him of the use of speech. Others maintain, that a real serpent having eaten of the forbidden fruit, Eve from thence concluded, that she too might eat of it without danger; that in effect she did eat of it, and incurred the displeasure of God by her disobedience. This, say these last authors, is the plain matter of fact which Moses would relate under the allegorical representation of the serpent conversing with Eve.

The opinion of such as believe this was not a real serpent, but only the devil under that name, is no less liable

liable to exception than any of the rest. For though the devil is frequently styled in Scripture the *serpent*, and the *old serpent*, yet why he should be called the *most subtle beast of the field*, we cannot conceive; neither will the punishment inflicted on the serpent suffer us to doubt, but that a serpent's body at least was employed in the transaction.

The nature of the forbidden fruit is another circumstance in this relation that has occasioned no less variety of conjectures. The Rabbins believe it was the vine; others that it was wheat; and others, from the circumstance of Adam and Eve's covering themselves with fig leaves immediately after their transgression, tell us, that this fruit must have been the fig; some think it was the cherry; and the generality of the Latins will have it to be the apple.

Those who admire allegorical interpretations, will have the forbidden fruit to have been no other than the sensual act of generation, for which the punishment inflicted on the woman was the pain of childbearing. But this opinion has not the least foundation in the words of Moses, especially if we consider that Adam knew not his wife till after their expulsion out of Paradise.

Many have been the suppositions and conjectures upon this subject in general; and some have so far indulged their fancy in the circumstances of the fall, that they have perverted the whole narration of Moses into a fable full of the most shameful extravagancies.

FALLACY, a deception, fraud, or false appearance.

The Epicureans deny that there is any such thing as a fallacy of the senses: for, according to them, all our sensations and perceptions, both of sense and phantasy, are true; whence they make sense the primary criterion of truth.

The Cartesians, on the other hand, maintain, that we should suspect as false, or at most as dubious, every thing that presents itself to us by means only of the external senses, because they frequently deceive us. They add, that our senses, as being fallacious, were never given us by nature for the discovery of truth, or the contemplation of the principles of things; but only for pointing out to us what things are convenient or hurtful to our bodies.

The Peripatetics keep a middle course. They say, that if a sensible object be taken in its common or general view, the sense cannot be deceived about it; but that if the object be taken under its specific view, the sense may be mistaken about it, from the want of the dispositions necessary to a just sensation, as a disorder in the organ, or any thing uncommon in the medium: thus, in some disorders of the eye, all objects appear yellow; a stick in water appears broken or crooked, &c.

FALLING SICKNESS, or EPILEPSY. See MEDICINE *Index*.

FALLING-STARS. See STAR.

FALLOPIAN TUBES, in *Anatomy*, two ducts arising from the womb, one on each side of the fundus, and thence extended to the ovaries, having a considerable share in conception. They are called *tubæ*, from their form, which bears some resemblance to a trumpet; and their denomination *Fallopianæ*, they take from Gabriel Fallopius, mentioned in the next article. See ANATOMY *Index*.

FALLOPIUS, GABRIEL, a most celebrated physician and anatomist, was born at Modena in Italy, in the year 1523, and descended of a noble family. He made several discoveries in anatomy, one of which was that of the tubes, called from him the *Fallopian tubes*. He travelled through the greatest part of Europe, and obtained the character of being one of the ablest physicians of his age. He was made professor of anatomy at Pisa in the year 1548, and at Padua in the year 1551: here he died in 1562, aged 39. His writings, which are numerous, were first printed separately, and afterwards collected under the title of "Opera genuina omnia, tam practica quam theoretica, in tres tomos distributa." They were printed at Venice in 1585 and in 1606, at Francfort in 1600, *cum operum appendice*; and in 1606, in folio.

FALLOW, a pale red-colour, like that of brick half burnt; such is that of a fallow deer.

FALLOW Field, or *Fallow ground*; land laid up, or that has been untilled for a considerable time.

FALLOWING *of* LAND, a particular method of improving land. See AGRICULTURE *Index*.

FALMOUTH, a port town of Cornwall in England, situated in W. Long. 5. 30. N. Lat. 50. 15. on a fine bay on the English channel. It is the richest and most trading town of the county, and larger than any three of its boroughs that send members to parliament. It is so commodious a harbour, that ships of the greatest burden come up to its quay. It is guarded by the castle of St Mawes and Pendennis, on a high rock at the entrance: and there is such shelter in the many creeks belonging to it, that the whole royal navy may ride safe here in any wind, it being next to Plymouth and Milford-Haven, the best road for shipping in Great Britain. It is well-built; and its trade is considerably increased since the establishment of the packet-boats here for Spain, Portugal, and the West Indies, which not only bring vast quantities of gold in specie and in bars, on account of the merchants in London; but the Falmouth merchants trade with the Portuguese in ships of their own, and they have a great share also in the gainful pilchard trade. The custom-house for most of the Cornish towns, as well as the head collector, is settled here, where the duties, including those of the other ports, are very considerable. It is a corporation, governed by a mayor and alderman. Here is a market on Thursday, and fairs July 27. and October 30.

FALSE, in general, something contrary to truth, or not what it ought to be: thus we say a false action, false weights, false claim, &c.

FALSE Action, if brought against one whereby he is cast into prison, and dies pending the suit, the law gives no remedy in this case, because the truth or falsehood of the matter cannot appear before it is tried: and if the plaintiff is barred, or non-suited at common law, regularly all the punishment is amercement.

FALSE Imprisonment, is a trespass committed against a person, by arresting and imprisoning him without just cause, contrary to law; or where a man is unlawfully detained without legal process: and it is alfo ufed for a writ which is brought for this trefpafs. If a perfon be any way unlawfully detained, it is falfe imprifonment; and confiderable damages are recoverable in thofe actions.

False News, fpreading of, in order to make difcord between the king and nobility, or concerning any great man of the realm, is punifhable by common law with fine and imprifonment; which is confirmed by ftatutes Weftm. 1. 3 Edw. I. cap. 34. 2 Ric. II. ftat. 1. cap. 5. and 12 Ric. II. cap. 11.

False Oath. See Perjury.

False Prophecy. See Prophecy.

False Quarter, in *Farriery*. See Quarters, Farriery *Index*.

False Bay, a bay lying to the eaftward of the Cape of Good Hope; frequented by veffels during the prevalence of the north-wefterly winds, which begin to exert their influence in May, and render it dangerous to remain in Table bay. It is terminated to the eaftward by Falfe Cape, and to the weftward by the Cape of Good Hope. It is 18 miles wide at its entrance, and the two capes bear due eaft and weft from each other.

FALSI crimen, in the civil law, is fraudulent fubornation or concealment, with defign to darken or hide the truth, and make things appear otherwife than they are. The *crimen falfi* is committed, 1. By words, as when a witnefs fwears falfely. 2. By writing, as when a man antedates a contract, or the like. 3. By deed, as when he fells by falfe weights and meafures.

FALSIFY, in *Law*, is ufed for proving any thing to be falfe. Hence we find,

Falsifying a record, for fhowing it to be erroneous. Thus lawyers teach, that a perfon purchafing land of another, who is afterwards outlawed of felony, &c. may falfify the record, not only as to the time wherein the felony is fuppofed to have been committed, but alfo as to the point of the offence. But where a man is found guilty by verdict, a purchafer cannot falfify as to the offence; though he may for the time, where the party is found guilty generally in the indictment, becaufe the time is not material upon evidence.

FALSTAFF. See Fastolff.

FALX, in *Anatomy*, a part of the dura mater, defcending between the two hemifpheres of the brain, and feparating the fore part from the hinder. It is called *falx*, i. e. "fickle," becaufe of its curvature, occafioned by the convexity of the brain. It divides the brain as low as the corpus callofum.

FAMA clamosa, in the judicial procedure of the church of Scotland, a ground of action before a prefbytery againft one of its members, independent of any regular complaint by a particular accufer. See Presbytery.

Any perfon who is of a good character, may give to the prefbytery a complaint againft one of their members; but the prefbytery is not to proceed to the citation of the perfon accufed, until the accufer under his hand gives in the complaint, with fome account of its probability, and undertakes to make out the libel, under the pain of being confidered as a flanderer. When fuch an accufation is brought before them, they are obliged candidly to examine the affair. But, befides this, the prefbytery confiders itfelf obliged to proceed againft any of its members, if a fama clamofa of the fcandal is fo great that they cannot be vindicated unlefs they begin the procefs. This they can do without any particular accufer, after they have inquired into the rife, occafion, and authors, of this report. It is a maxim in the kirk of Scotland, that religion muft fuffer if the fcandalous or immoral actions of a minifter are not corrected. And wherever a minifter is reputed guilty of any immorality (although before the moft popular preacher in the kingdom), none almoft will attend upon his miniftry. Therefore the prefbytery, for the fake of religion, is obliged to proceed againft a minifter in cafe of a fama clamofa. This, however, is generally done with great tendernefs. After they have confidered the report raifed againft him, then they order him to be cited, draw out a full copy of what is reported, with a lift of the witneffes names to be led for proving this allegation. He is now to be formally fummoned to appear before them; and he has warning given him, at leaft 10 days before the time of his compearance, to give in his anfwers to what is termed the *libel*; and the names of the witneffes ought alfo to be fent him. If at the time appointed the minifter appear, the libel is to be read to him, and his anfwers are alfo to be read. If the libel be found relevant, then the prefbytery is to endeavour to bring him to a confeffion. If the matter confeffed be of a fcandalous nature, fuch as uncleannefs, the prefbytery generally depofe him from his office, and appoint him in due time to appear before the congregation where the fcandal was given, and to make public confeffion of his crime and repentance. If a minifter abfent himfelf by leaving the place, and be contumacious, without making any relevant excufe, a new citation is given him, and intimation is made at his own church when the congregation is met, that he is to be holden as confeffed, fince he refufed to appear before them; and accordingly he is depofed from his office.

FAME, a heathen goddefs, celebrated chiefly by the poets. She is feigned to have been the laft of the race of Titans produced by the earth, to have her palace in the air, and to have a vaft number of eyes, ears, and tongues. She is mentioned by Hefiod, and particularly defcribed by Ovid and Virgil.

FAMES canina, the fame with Bulimy.

FAMIA, or Afamia, the modern name of one of the ancient Apameas. See Apamea.

FAMILIARS of the Inquisition, perfons who affift in apprehending fuch as are accufed, and carrying them to prifon. They are affiftants to the inquifitor, and called *familiars*, becaufe they belong to his family. In fome provinces of Italy they are called *crofs-bearers*, and in others the *fcholars of St Peter the martyr*; and they wore a crofs before them on the outfide garment. They are properly bailiffs of the inquifition; and the vile office is efteemed fo honourable, that noblemen in the kingdom of Portugal have been ambitious of belonging to it. Nor is this furprifing, when it is confidered that Innocent III. granted very large indulgences and privileges to thefe familiars; and that the fame plenary indulgence is granted by the pope to every fingle exercife of this office, as was granted by the Lateran council to thofe who fuccoured the Holy Land. When feveral perfons are to be taken up at the fame time, thefe familiars are commanded

manded to order matters, that they may know nothing of one another's being apprehended; and it is related, that a father and his three sons, and three daughters, who lived together in the same house, were carried prisoners to the inquisition without knowing any thing of one another's being there till seven years afterwards, when they that were alive were released by an act of faith.

FAMILY denotes the persons that live together in one house, under the direction of one head or chief manager. It also signifies the kindred or lineage of a person; and is used by old writers for a hide or portion of land sufficient to maintain one family. See HIDE.

FAMILY, in *Natural History*, a term used by authors to express any order of animals, or other natural productions of the same class.

FAMINE, dearth, or scarcity of food. For preservatives against hunger in times of famine, see the article HUNGER.

FAN, a machine used to raise wind, and cool the air by agitating it.

That the use of the fan was known to the ancients is very evident from what Terence says,

Cape hoc flabellum, *et ventulum huic sic facito;*

and from Ovid, Art. Amand. I. 161.

Profuit et tenues ventos movisse flabello.

The fans of the ancients were made of different materials; but the most elegant were composed of peacocks feathers, or perhaps painted so as to represent a peacock's feather.

The custom which now prevails among the ladies, of wearing fans, was borrowed from the east, where the hot climate renders the use of fans and umbrellas almost indispensable.

In the east they chiefly use large fans made of feathers, to keep off the sun and the flies. In Italy and Spain they have a large sort of square fans, suspended in the middle of their apartments, and particularly over the tables: these, by a motion at first given them, and which they retain a long time on account of their perpendicular suspension, help to cool the air and drive off flies.

In the Greek church, a fan is put into the hands of the deacons in the ceremony of their ordination, in allusion to a part of the deacon's office in that church, which is to keep the flies off the priests during the celebration of the sacrament.

What is called a *fan* amongst us and throughout the chief parts of Europe, is a thin skin, or piece of paper, taffety, or other light stuff, cut semicircularly, and mounted on several little sticks of wood, ivory, tortoiseshell, or the like. If the paper be single, the sticks of the mounting are pasted on the least ornamented side: if double, the sticks are placed betwixt them. Before they proceed to place the sticks, which they call *mounting the fan*, the paper is to be plaited in such a manner, as that the plates may be alternately inward and outward.

It is in the middle of each plait, which is usually about half an inch broad, that the sticks are to be pasted; and these again are to be all joined and rivetted together at the other end; they are very thin, and scarcely exceed one-third of an inch in breadth; and where they are pasted to the paper, are still narrower, continuing thus to the extremity of the paper. The two outer ones are bigger and stronger than the others. The number of sticks rarely exceeds 22. The sticks are usually provided by the cabinetmakers or toymen; the fan-painters plait the papers, paint, and mount them.

The common painting is either in colours or gold leaf, applied on a silvered ground, both prepared by the goldbeaters. Sometimes they paint on a gold ground, but it is rarely; true gold being too dear, and false too paltry. To apply the silver leaves on the paper, they use a composition, which they pretend is a great secret, but which appears to be no other than gum arabic, sugar-candy, and a little honey, melted in common water, and mixed with a little brandy. This composition is laid on with a sponge; then laying the silver leaves thereon, and pressing them gently down with a linen ball stuffed with cotton, they catch hold, and adhere together. When, instead of silver, gold ground is laid, the same method is observed. The ground being well dried, a number of the papers are well beaten together on a block, and by this means the silver or gold get a lustre as if they had been burnished.

FAN is also an instrument to winnow corn. The machine used for this purpose by the ancients seems to have been of a form similar to ours. The fan, which Virgil calls *mystica vannus Iacchi*, was used at initiations into the mysteries of the ancients: For as the persons who were initiated into any of the mysteries, were to be particularly good, this instrument, which separates the wheat from the chaff, was the fittest emblem that could be of setting apart the good and virtuous from the vicious and useless part of mankind. It is figuratively applied in a similar manner in Luke iii. 17.

FANATICS, wild, enthusiastic, visionary persons, who pretend to revelation and inspiration.

The ancients called those *fanatici* who passed their time in temples (*fana*), and being often seized with a kind of enthusiasm, as if inspired by the divinity, showed wild and antic gestures. Prudentius represents them as cutting and slashing their arms with knives. Shaking the head was also common among the fanatici; for Lampridius informs us, that the emperor Heliogabalus was arrived at that pitch of madness, as to shake his head with the gashed fanatics. Hence the word was applied among us to the Anabaptists, Quakers, &c. at their first rise, and is now an epithet given to the modern prophets, Muggletonians, &c.

FANCY, or imagination. See IMAGINATION.

FANIONS, in the military art, small flags carried along with the baggage.

FANNERS, a machine for winnowing corn, or for separating the chaff from the grain. See, for its description, MECHANICS.

FANSHAW, SIR RICHARD, famous for his embassies and writings, was the tenth and youngest son of Sir Henry Fanshaw of Ware Park in Hertfordshire, where it is supposed he was born about the year 1607. He distinguished himself so early by his abilities, that in 1635 he was taken into government employments by King Charles I. and sent resident to the court of Spain; whence being recalled in the beginning of the troubles in 1641, he adhered to the royal interest, and was employed in several important matters of state. During his vacant hours he wrote divers poems, and made several translations. At the Restoration it was expected he would have been made one of the secretaries of state: however, he was made master of the requests; a station in those times of considerable profit. Afterwards, on account of his skill in the Latin language, he was made secretary for that tongue. In 1661, he was sent envoy to the king of Portugal. In 1662, he was again sent to that court with the title of *ambassador*, and negotiated the marriage of his master King Charles II. with the infanta Donna Catherina. Upon his return he was made one of the privy council. In 1664, he was sent ambassador to both the courts of Spain and Portugal; at which time the foundation of peace betwixt those crowns and England was laid by him. His conduct during his former employments in those courts gained him such high esteem there, that his reception was magnificent, exceeding all that were before, which those kings declared was not to be a precedent to succeeding ambassadors. He died at Madrid in 1666, on the very day he had fixed for setting out on his return to England. Besides some original poems, and other translations, he published a translation of Bathista Guarini's *Pastor Fido*, and another of the *Lusiad* of Camoens. Among his posthumous publications are, "Letters during his embassies in Spain and Portugal; with his life prefixed."

FANTASIA, in the Italian music, signifies *fancy*; and is used for a composition, wherein the composer ties himself to no particular time, but ranges according as his fancy leads, amidst various movements, different airs, &c. This is otherwise called the *capricious style*: before sonatas were used, there were many of this kind, some of which remain even now.

FANUM, among the Romans, a temple or place consecrated to some deity. The deified men and women among the heathens had likewise their *fana*; even the great philosopher Cicero erected one to his daughter Tullia.

Fanum Vacunæ, in *Ancient Geography*, a village of the Sabines, situated between Cures and Mandela; where stood the temple of Vacuna, goddess of the idle or unemployed, in an old decayed state: and hence the epithet *putre*, used by Horace. Now called *Vocone*, in the Ecclesiastic State.

FARANDMAN, a traveller, or merchant stranger, to whom, by the laws of Scotland, justice ought to be done with all expedition, that his business or journey be not hindered.

FARCE, was originally a droll, petty show, or entertainment, exhibited by charletans, and their buffoons, in the open street to gather the crowd together.—The word is French, and signifies literally, "forcemeat or stuffing." It was applied on this occasion, no doubt, on account of the variety of jests, gibes, tricks, &c. wherewith the entertainment was interlarded. Some authors derive farce from the Latin *facetia*; others from the Celtic *farce*, "mockery;" others from the Latin *farcire*, "to stuff."

At present it is removed from the street to the theatre; and instead of being performed by merry-andrews to amuse the rabble, is acted by comedians, and become the entertainment of a polite audience. Poets have reformed the wildness of the primitive farces, and brought them to the taste and manner of comedy. The difference between the two on our stage is, that comedy keeps to nature and probability, and therefore is confined to certain laws prescribed by ancient critics; whereas farce disallows of all laws, or rather sets them aside on occasion. Its end is purely to make merry; and it sticks at nothing which may contribute thereto, however wild and extravagant. Hence the dialogue is usually low, the persons of inferior rank, the fable or action trivial or ridiculous, and nature and truth everywhere heightened and exaggerated to afford the more palpable ridicule.

FARCIN, or FARCY, a disease in horses, and sometimes in oxen, &c. somewhat of the nature of a scabies or mange. See FARRIERY *Index*.

FARDING-DEAL, the fourth part of an acre of land. See ACRE.

FARE, most commonly signifies the money paid for a voyage, or passage by water; but, in London, it is what persons pay for being conveyed from one part of the town to another in a coach or chair.

FAREWELL-CAPE, the most southerly promontory of Greenland, in W. Long. 50°, and N. Lat. 60°

FARIN, or FARM. See FARM.

FARINA, a Latin term signifying meal, or the flour of corn. See CORN.

Farina Fœcundans, among *Botanists*, the supposed impregnating meal or dust on the apices or antheræ of flowers. See POLLEN.

The manner of gathering the farina of plants for microscopical observations is this: Gather the flowers in the midst of a dry sunshiny day when the dew is perfectly off, then gently shake off the farina, or lightly brush it off with a soft hair-pencil, upon a piece of white paper; then take a single talc or isinglass between the nippers, and, breathing on it, apply it instantly to the farina, and the moisture of the breath will make that light powder stick to it. If too great a quantity be found adhering to the talc, blow a little of it off; and, if there is too little, breathe upon it again, and take up more. When this is done, put the talc into the hole of a slider, and, applying it to the microscope, see whether the little grains are laid as you desire; and if they are, cover them up with another talc, and fix the ring; but be careful that the talcs do not press upon the farina in such a manner as to alter its form.

FARLEU, money paid by the tenants in the west of England, in lieu of a heriot. In some manors of Devonshire, farleu is often distinguished to be the best goods, as heriot is the best beast, payable at the death of a tenant.

FARM, FARIN, or *Ferm*, (*Firma*), in *Law*, signifies a little country messuage or district, containing house or land, with other conveniences; hired, or taken by lease, either in writing, or parole, under a certain yearly rent. See LEASE.

This in divers parts is differently termed: in the north, it is a *tack*; in Lancashire, *fermeholt*; in Essex, a *wike*, &c.

In the corrupted Latin, *firma* signified a place inclosed or shut in: whence, in some provinces, Menage observes, Farm.

obferves, they call *cloferie*, or *clofure*, what in others they call a *farm*. Add, that we find *locare ad firmam*, to fignify to let to *farm*; probably on account of the fure hold the tenant here has in comparifon of tenants at will.

Spelman and Skinner, however, choofe to derive the word *farm* from the Saxon *fearme*, or *feorme*, that is, *victus*, "provifion;" by reafon the country people and tenants anciently paid their rents in victuals and other neceffaries, which were afterwards converted into the payment of a fum of money. Whence a *farm* was originally a place that furnifhed its landlord with provifions. And among the Normans they ftill diftinguifh between farms that pay in kind, i. e. provifions, and thofe which pay in money; calling the former fimply *fermes*, and the latter *blanche ferme*, "white ferm."

Spelman fhows, that the word *firma*, anciently fignified not only what we now call a *farm*, but alfo a feaft or entertainment, which the farmer gave the proprietor or landlord, for a certain number of days, and at a certain rate, for the lands he held of him. Thus *fearme* in the laws of King Canute is rendered by Mr Lambard, *victus*: and thus we read of *reddere firmam unius noctis*, and *reddebat unum diem de firma*; which denote provifion for a night and day, the rents about the time of the conqueft being all paid in provifions; which cuftom is faid to have been firft altered under King Henry I. We alfo fay *to farm* duties, impofts, &c.

Culture of a FARM. See AGRICULTURE.

FARM, as connected with gardening, and fufceptible of embellifhment. See GARDENING.

In fpeculation, it might have been expected that the firft effays of improvement fhould have been on a farm, to make it both advantageous and delightful; but the fact was otherwife: a fmall plot was appropriated to pleafure; the reft was referved for profit only. And this may, perhaps, have been a principal caufe of the vicious tafte which long prevailed in gardens. It was imagined that a fpot fet apart from the reft fhould not be like them: the conceit introduced deviations from nature, which were afterwards carried to fuch an excefs, that hardly any objects truly rural were left within the enclofure, and the view of thofe without was generally excluded. The firft ftep, therefore, towards a reformation, was by opening the garden to the country, and that immediately led to affimilating them; but ftill the idea of a fpot appropriated to pleafure only prevailed, and one of the lateft improvements has been to blend the ufeful with the agreeable; even the ornamental farm was prior in time to the more rural; and we have at laft returned to fimplicity by force of refinement.

Of a paftoral farm.

1. The ideas of paftoral poetry feem now to be the ftandard of that fimplicity; and a place conformable to them is deemed a farm in its utmoft purity. An allufion to them evidently enters into the defign of the Leafowes (A), where they appear fo lovely as to endear the memory of their author; and juftify the reputation of Mr Shenftone, who inhabited, made, and celebrated the place: it is a perfect picture of his mind, fimple, elegant, and amiable; and will always fuggeft a doubt, whether the fpot infpired his verfe, or whether, in the fcenes which he formed, he only realized the paftoral images which abound in his fongs. The whole is in the fame tafte, yet full of variety; and, except in two or three trifles, every part is rural and natural. It is literally a grazing farm lying round the houfe; and a walk, as unaffected and as unadorned as a common field-path, is conducted through the feveral enclofures. But for a detail of the plan and fcenery, as illuftrative of the prefent fubject, the reader is referred to the particular defcription of the Leafowes publifhed by the late Mr Dodfley. We fhall only take notice of one or two circumftances independent on the general delineation.

The art with which the divifions between the fields are diverfified is one of them. Even the hedges are diftinguifhed from each other: a common quickfet fence is in one place the feparation: in another, it is a lofty hedge-row, thick from the top to the bottom; in a third, it is a continued range of trees, with all their ftems clear, and the light appearing in the intervals between their boughs, and the bufhes beneath them; in others, thefe lines of trees are broken, a few groupes only being left at different diftances; and fometimes a wood, a grove, a coppice, or a thicket, is the apparent boundary, and by them both the fhape and the ftyle of the enclofures are varied.

The infcriptions, which abound in the place, are another ftriking peculiarity: they are well known and juftly admired; and the elegance of the poetry, and the aptnefs of the quotations, atone for their length and their number. But, in general, infcriptions pleafe no more than once: the utmoft they can pretend to, except when their allufions are emblematical, is to point out the beauties, or defcribe the effects, of the fpots they belong to; but thofe beauties and thofe effects muft be very faint, which ftand in need of the affiftance. Infcriptions, however, to commemorate a departed friend, are evidently exempt from the cenfure; the monuments would be unintelligible without them; and an urn, in a lonely grove, or in the midft of a field, is a favourite embellifhment at the Leafowes: they are indeed among the principal ornaments of the place; for the buildings are moftly mere feats, or little root-houfes; a ruin of a priory is the largeft, and that has no peculiar beauty to recommend it: but a multiplicity of objects are unneceffary in the farm; the country it commands is full of them; and every natural advantage of the place within itfelf has been difcovered, applied, contrafted, and carried to the utmoft perfection, in the pureft tafte, and with inexhauftible fancy.

Among the ideas of paftoral poetry which are here introduced, its mythology is not omitted: but the allufions are both to ancient and to modern fables; fometimes to the fairies; and fometimes to the naiads and mufes. The objects alfo are borrowed partly from the fcenes which this country exhibited fome centuries ago, and partly from thofe of Arcadia: the priory,

(A) In Shropfhire, between Birmingham and Stourbridge.

Farm.

priory, and a Gothic ſeat, ſtill more particularly characteriſed by an inſcription in obſolete language and the black letter, belong to the one; the urns, Virgil's obeliſk, and a ruſtic temple of Pan, to the other. All theſe alluſions and objects are indeed equally rural: but the images in an Engliſh and claſſical eclogue are not the ſame; each ſpecies is a diſtinct imitative character. Either is proper; either will raiſe the farm it is applied to above the ordinary level; and within the compaſs of the ſame place both may be introduced; but they ſhould be ſeparate: when they are mixed, they counteract one another; and no repreſentation is produced of the times and the countries they refer to. A certain diſtrict ſhould therefore be allotted to each, that all the fields which belong to the reſpective characters may lie together, and the correſponding ideas be preſerved for a continuance.

Of an ancient farm.

2. In ſuch an aſſortment, the more open and poliſhed ſcenes will generally be given to the Arcadian ſhepherd; and thoſe in a lower degree of cultivation, will be thought more conformable to the manners of the ancient Britiſh yeomanry. We do not conceive that the country in their time was entirely cleared, or diſtinctly divided; the fields were ſurrounded by woods, not by hedges; and if a conſiderable tract of improved land lay together, it ſtill was not ſeparated into a number of incloſures. The ſubjects, therefore, proper to receive this character, are thoſe in which cultivation ſeems to have encroached on the wild, not to have ſubdued it; as the bottom of a valley in corn, while the ſides are ſtill overgrown with wood; and the outline of that wood indented by the tillage creeping more or leſs up the hill. But a glade of graſs, thus circumſtanced, does not peculiarly belong to the ſpecies; that may occur in a park or paſtoral farm; in this, the paſtures ſhould rather border on a waſte or a common: if large, they may be broken by ſtraggling buſhes, thickets, or coppices; and the ſcattered trees ſhould be beſet with brambles and briars. All theſe are circumſtances which improve the beauty of the place; yet appear to be only remains of the wild, not intended for embelliſhment. Such interruptions muſt, however, be leſs frequent in the arable parts of the farm; but there the opening may be divided into ſeveral lands, diſtinguiſhed, as in common fields, only by different ſorts of grain. Theſe will ſufficiently break the ſameneſs of the ſpace; and the tillage does not furniſh a more pleaſing ſcene, than ſuch a ſpace ſo broken, if the extent be moderate, and the boundary beautiful.

As much wood is eſſential to the character, a ſpot may eaſily be found, where turrets riſing above the covert, or ſome arches ſeen within it, may have the reſemblance of a caſtle or an abbey. The partial concealment is almoſt neceſſary to both; for to accord with the age, the buildings muſt ſeem to be entire; the ruins of them belong to later days: the diſguiſe is, however, advantageous to them as objects; none can be imagined more pictureſque, than a tower boſomed in trees, or a cluſter appearing between the ſtems and the branches. But the ſuperſtitions of the times furniſh other objects which are more within compaſs: hermitages were then real; ſolitary chapels were common; many of the ſprings of the country being deemed holy wells, were diſtinguiſhed by little Gothic domes built over them; and every hamlet had its croſs, even this, when perfect, ſet on a little ruſtic pillar, and that raiſed upon a baſe of circular ſteps, may in ſome ſcenes be conſiderable: if a ſituation can be found for a May-pole, whence it would not obtrude itſelf on every view, that alſo might not be improper; and an ancient church, however unwelcome it may be when it breaks into the deſign of a park or a garden, in ſuch a farm as this would be a fortunate accident: nor would the old yew in the church-yard be indifferent; it would be a memorial of the times when it was uſeful.

Many other objects, ſignificant of the manners of our anceſtors, might perhaps, upon recollection, occur; but theſe are amply ſufficient for a place of conſiderable extent; and cottages muſt abound in every age and every country; they may therefore be introduced in different forms and poſitions. Large pieces of water are alſo particularly proper; and all the varieties of rills are conſiſtent with every ſpecies of farm. From the concurrence of ſo many agreeable circumſtances in this, be the force or the effect of the character what it may, a number of pleaſing ſcenes may be exhibited either in a walk or riding, to be contraſted to thoſe which in another part of the place may be formed on Arcadian ideas; or even to be ſubſtituted in their ſtead, if they are omitted.

Of a ſimple farm.

3. A part may alſo be free from either of theſe imitative characters, and laid out in a common ſimple farm. Some of the greateſt beauties of nature are to be found in the fields, and attend an ordinary ſtate of cultivation: wood and water may there be exhibited in ſeveral forms and diſpoſitions; we may enlarge or divide the incloſures; and give them ſuch ſhapes and boundaries as we pleaſe; every one may be an agreeable ſpot; together, they may compoſe beautiful views; the arable, the paſture, and the mead, may ſucceed one another; and now and then a little wild may be intermixed without impropriety; every beauty, in ſhort, which is not unuſual in an incloſed country, whether it ariſes from neglect or improvement, is here in its place.

The buildings, alſo, which are frequent in ſuch a country, are often beautiful objects; the church and the manſion are conſiderable: the farm-yard itſelf, if an advantageous ſituation be choſen for it; if the ricks, and the barns, and the out-houſes, are ranged with any deſign to form them into groups, and if they are properly blended with trees; may be made a pictureſque compoſition. Many of them may be detached from the group, and diſperſed about the grounds: the dove-cote, or the dairy, may be ſeparated from the reſt; they may be elegant in their forms, and placed wherever they will have the beſt effect. A common barn, accompanied by a clump, is ſometimes pleaſing at a diſtance; a Dutch barn is ſo when near; and a hay-ſtack is generally an agreeable circumſtance in any poſition. Each of theſe may be ſingle; and beſides theſe, all kinds of cottages are proper. Among ſo many buildings, ſome may be converted to other purpoſes than their conſtruction denotes; and, whatever be their exterior, may within be made agreeable retreats, for refreſhment, indulgence, or ſhelter.

With ſuch opportunities of improvements, even to decoration within itſelf, and with advantages of proſpect into the country about it, a ſimple farm may undoubtedly be delightful. It will be particularly acceptable

Farm. ceptable to the owner, if it be cloſe to his park or his garden: the objects which conſtantly remind him of his rank, impoſe a kind of conſtraint; and he feels himſelf relieved, by retiring ſometimes from the ſplendor of a ſeat into the ſimplicity of a farm: it is more than a variety of ſcene; it is a temporary change of ſituation in life, which has all the charms of novelty, eaſe, and tranquillity, to recommend it. A place, therefore, can hardly be deemed perfect, which is not provided with ſuch a retreat. But if it be the whole of the place, it ſeems inadequate to the manſion: a viſitor is diſappointed; the maſter is diſſatisfied; he is not ſufficiently diſtinguiſhed from his tenants; he miſſes the appendages incidental to his ſeat and his fortune; and is hurt at the ſimilarity of his grounds with the country about them. A paſtoral or an ancient farm is a little above the common level; but even theſe, if brought cloſe up to the door, ſet the houſe in a field, where it always appears to be neglected and naked. Some degree of poliſh and ornament is expected in its immediate environs; and a garden, though it be but a ſmall one, ſhould be interpoſed between the manſion and any ſpecies of farm.

Of an ornamented farm. 4. A ſenſe of the propriety of ſuch improvements about a ſeat, joined to a taſte for the more ſimple delights of the country, probably ſuggeſted the idea of an *ornamental farm*, as the means of bringing every rural circumſtance within the verge of a garden. This idea has been partially executed very often; but nowhere, perhaps, ſo completely, and to ſuch an extent, as at Woburn farm, (near Weybridge in Surry.) The place contains 150 acres: of which near 35 are adorned to the higheſt degree; of the reſt, about two thirds are in paſture, and the remainder is in tillage. The decorations are, however, communicated to every part: for they are diſpoſed along the ſides of a walk, which, with its appendages, forms a broad belt round the grazing-grounds; and is continued, though on a more contracted ſcale, through the arable. This walk is properly garden; all within it is farm; the whole lies on the two ſides of a hill, and on a flat at the foot of it: the flat is divided into corn-fields; the paſtures occupy the hill; they are ſurrounded by the walk, and croſſed by a communication carried along the brow, which is alſo richly dreſſed, and which divides them into two lawns, each completely encompaſſed with garden.

Theſe are in themſelves delightful; the ground in both lies beautifully: they are diverſified with clumps and ſingle trees; and the buildings in the walk ſeem to belong to them. On the top of the hill is a large octagon ſtructure; and, not far from it, the ruin of a chapel. To one of the lawns the ruin appears, on the brow of a gentle aſcent, backed and grouped with wood; from the other is ſeen the octagon, upon the edge of a ſteep fall, and by the ſide of a pretty grove, which hangs down the declivity. This lawn is further embelliſhed by a neat Gothic building; the former by the houſe, and the lodge at the entrance; and in both, other objects of leſs conſequence, little ſeats, alcoves, and bridges, continually occur.

The buildings are not, however, the only ornaments of the walk; it is ſhut out from the country, for a conſiderable length of the way, by a thick and lofty hedge-row, which is enriched with woodbine, jeſſamine, and every odoriferous plant whoſe tendrils will entwine with the thicket. A path, generally of ſand or gravel, is conducted in a waving line, ſometimes cloſe under the hedge, ſometimes at a little diſtance from it; and the turf on either hand is diverſified with little groups of ſhrubs, of firs, or the ſmalleſt trees, and often with beds of flowers: theſe are rather too profuſely ſtrewed, and hurt the eye by their littleneſſes; but then they repleniſh the air with their perfumes, and every gale is full of fragrancy. In ſome parts, however, the decoration is more chaſte; and the walk is carried between larger clumps of evergreens, thickets of deciduous ſhrubs, or ſtill more conſiderably open plantations. In one place it is entirely ſimple, without any appendages, any gravel, or any ſunk fence to ſeparate it from the lawn; and is diſtinguiſhed only by the richneſs of its verdure, and the nicety of its preſervation. In the arable part it is alſo of green ſward, following the direction of the hedges about the ſeveral incloſures: theſe hedges are ſometimes thickened with flowering ſhrubs; and in every corner or vacant ſpace, is a roſary, a cloſe or an open clump, or a bed of flowers: but if the parterre has been rifled for the embelliſhment of the fields, the country has on the other hand been ſearched for plants new in a garden; and the ſhrubs and the flowers which uſed to be deemed peculiar to the one, have been liberally transferred to the other; while their number ſeems multiplied by their arrangement in ſo many and ſuch different diſpoſitions. A more moderate uſe of them would, however, have been better; and the variety more pleaſing, had it been leſs licentious.

But the exceſs is only in the borders of the walk; the ſcenes through which it leads are truly elegant, everywhere rich, and always agreeable. A peculiar cheerfulneſs overſpreads both the lawns, ariſing from the number and the ſplendor of the objects with which they abound, the lightneſs of the buildings, the inequalities of the ground, and the varieties of the plantations. The clumps and the groves, though ſeparately ſmall, are often maſſed by the perſpective, and gathered into conſiderable groups, which are beautiful in their forms, their tints, and their poſitions. The brow of the hill commands two lovely proſpects: the one gay and extenſive, over a fertile plain, watered by the Thames, and broken by St Anne's Hill and Windſor Caſtle; a large mead, of the moſt luxuriant verdure, lies juſt below the eye, ſpreading to the banks of the river; and beyond it the country is full of farms, villas, and villages, and every mark of opulence and cultivation. The other view is more wooded: the ſteeple of a church, or the turrets of a ſeat, ſometimes riſe above the trees; and the bold arch of Walton bridge is there a conſpicuous object, equally ſingular and noble. The incloſures on the flat are more retired and quiet; each is confined within itſelf; and all together they form an agreeable contraſt to the open expoſure above them.

With the beauties which enliven a garden are everywhere intermixed many properties of a farm: both the lawns are paſtured; and the lowings of the herds, the bleating of the ſheep, and the tinklings of the bell-wedder, reſound through all the plantations: even the clucking of poultry is not omitted; for a menagerie of a very ſimple deſign is placed near the Gothic building; a

Farmer.

a small serpentine river is provided for the water-fowl; while the others stray among the flowering shrubs on the banks, or straggle about the neighbouring lawn: and the corn fields are the subjects of every rural employment which arable land from seed-time to harvest can furnish. But though so many of the circumstances occur, the simplicity of a farm is wanting; that idea is lost in such a profusion of ornament; a rusticity of character cannot be preserved amidst all the elegant decorations which may be lavished on a garden.

FARMER, he that tenants a farm, or is lessee thereof. Also generally every lessee for life, years, or at will, is called *farmer*. As this word implies no mystery, except it be that of husbandry, husbandman is the proper addition for a farmer.

FARMER, *Hugh*, an English clergyman and a man of literature, belonging to the protestant nonconformists, was descended from people of respectability in North Wales, and drew his first breath at Shrewsbury, in the year 1714. Dr Charles Owen was for some time his tutor, and prior to that period he was educated at a school in Llanegrin. His parents from the first having designed him for the ministry, he was sent to prosecute his studies under the justly celebrated Dr Doddridge at Northampton, in 1730. Here, by the rectitude of his conduct and wonderful proficiency, he gained the esteem of that great man, who always spoke of him in the most respectful terms. Having completed his academical studies, Mr Farmer became the chaplain of William Coward, Esq. of Walthamstow, in the county of Essex, and was at the same time chosen minister to a dissenting congregation in that village. Notwithstanding the gratitude with which Mr Coward ought to be remembered by many for his charitable institutions, he had certain peculiarities of temper which rendered him a very disagreeable domestic. His doors were shut at an uncommonly early hour of the night, and neither visitor nor constant resident could afterwards obtain admission. Mr Farmer having one evening been detained a little beyond that hour, found the doors shut against him, and was under the necessity of applying to a William Snell, Esq. solicitor, a man of eminence, and possessed of many excellent qualifications, in whose family he remained for 30 years, living in the greatest friendship and intimacy. In this gentleman's house he gradually prepared those valuable treatises and dissertations which were afterwards given to the public, and acquired him so much celebrity as a man of letters. He also continued to discharge the duties of his ministerial function to the people of Walthamstow.

When a day of thanksgiving was appointed for the fortunate suppression of the rebellion in 1745, Mr Farmer preached a sermon on that occasion which was published the following year. His next work was of considerably greater importance, and was entitled, "An Inquiry into the Nature and Design of our Lord's temptation in the wilderness." 8vo. In this work it was the design of Mr Farmer to prove that the whole was transacted in vision, the different stages of which were intended to point out to him the difficulties and duties of his subsequent ministry. The originality of thought and profound erudition which this work displayed, soon gave it a very extensive circulation, and called forth the exertions of those who were of an opposite opinion. It received one reply under the title of "Christ's temptations real facts," which possessed considerable merit, but much inferior to Mr Farmer's for energy of expression, depth of thinking, and force of argument. But the most masterly, perhaps, of all Mr Farmer's literary productions, was his "Dissertation on Miracles, designed to shew that they are arguments of a divine interposition, and absolute proofs of the mission and doctrine of a prophet." Some have believed, and perhaps not without reason, that this work has no proper rival, notwithstanding the many able treatises upon that subject which have made their appearance in different ages. It was first published in the year 1771. But as great talents are frequently envied, and as this infernal principle is the prolific source of calumny and detraction, so this supereminent work of Mr Farmer was declared to have been chiefly borrowed from Mr le Moine on the same subject;—a slander which Mr Farmer refuted in a very able and satisfactory manner. In the year 1775, he published his celebrated "Essay on the Demoniacs of the New Testament," which may be considered as a masterly completion of the design he had in view by his dissertation on miracles. The hypothesis he adopted had been formerly defended with great ability by Mede, Sykes, Lardner, and others; but it was reserved for the critical acumen of Mr Farmer to free it completely from those difficulties which still hung around it. His essay on demoniacs was successively attacked by Dr Worthington and Mr Fell, both of them men of considerable erudition, but much inferior to their able antagonist.

Farmer.

Mr Farmer having continued for several years the sole pastor of the congregation at Walthamstow, an able colleague was appointed him in 1761, in consequence of which he became the afternoon preacher to the congregation of Salter's-hall, in the city of London, and soon after the Tuesday lecturer at the same place. He resigned his ministerial employments as he advanced in years, which the people commited to his charge very much regretted. In the year 1785 his eyes gave him very much trouble, of the sight of which he was nearly deprived, but by means of a surgical operation, he was for some time enabled to resume his studies. But mortality is the inevitable lot of all men, and the growing infirmities of Mr Farmer brought him to the grave in 1787, in the 73d year of his age.

By his last will he had ordered all his manuscripts to be burnt after his death, a circumstance which men of letters have just reason to lament. It is no doubt the duty of executors to pay attention to the will of the deceased; yet for the benefit of the Christian world they would have been justified in taking a certain latitude in the explanation of his meaning; as it does by no means appear probable that he meant to consign to the flames his manuscript entitled, "A Dissertation on the story of Balaam," which appeared written in a fair hand, as if manifestly intended for the press. When we say that Mr Farmer was a consummate scholar, we trust that his numerous and able works will fully justify the assertion; and his talents as a preacher were equally conspicuous. His voice was remarkable for its clearness and harmony, and his whole manner was peculiarly impressive. His piety was not morose, his conversation was lively, and his whole deportment was a beautiful transcript of his moral injunctions.

FARMER, *Richard*, D. D. a scholar and critic of considerable

Farmer. considerable eminence, was the son of a hosier at Leicester, at which place he was born in the year 1735. Here he received the rudiments of his education, and was afterwards a student at Cambridge, and pensioner of Emanuel college. He was considered as a young man well acquainted with books, was much esteemed among his friends, and looked upon as possessed of lively parts, even before he acquired any extraordinary reputation as a scholar. He was made B. A. in 1757, and M. A. in 1760. Seven years after this period, having been for some time a curate, he took the degree of B. D. and became a preacher at Whitehall. Besides the attention he paid to the Grecian and Roman authors, he prosecuted the study of books in his own language, printed on black-letter, which laid the foundation of a work that added more to his literary reputation than any other performance. This was "An Essay on the learning of Shakespeare," which he published in 1766 Men of letters had long turned their attention to the learning of Shakespeare, in order to ascertain its real extent. It could not be questioned that he was acquainted with the history and mythology of the ancients, but it was still a matter of dispute from what sources that acquaintance was derived. To obviate this difficulty, Mr Farmer's knowledge of books enabled him to demonstrate, that translations of the far greater part of classical authors were to be met with in the time of the celebrated dramatist; and as he proved that Shakespeare had even copied the blunders and errors of such translations, he made it manifest beyond the possibility of a rational doubt, that he was wholly incapable of consulting the originals. This essay passed through three editions in a very short time; was much admired for the sprightliness of its composition, and the generality were persuaded that he had fully established his point.

This performance brought him so much into notice, as to become extremely favourable to his professional advancement. By the influence of Bishop Hurd, he procured the chancellorship and a prebend in the cathedral of Lichfield, and in 1755 he was elected master of Emanuel college, and took the degree of D. D. He was soon after constituted principal librarian to the university, and served in turn the office of vice-chancellor. He was made prebendary of Canterbury by Lord North, at that time prime minister, and Mr Pitt made him twice an offer of a bishopric; but the constraints and solemnity of the episcopal character were not congenial to his natural temper, on which account he declined the offer, and having resigned his office as prebendary, he accepted of a residentiaryship of St Paul's. This obliged him to reside three months annually in London, which he spent with pleasure and advantage in the company of literary characters. From nature he inherited a fund of good humour, and was of such an obliging turn, that he buried party spirit in the satisfaction which he found in the performance of beneficent actions. Though in general an enemy to reforms of any kind, and anxious to preserve *things as they were*, both in church and state, he was instrumental in amending the police of Cambridge, especially as it related to the paving and lighting of the streets. At his instigation also, monumental sculpture was admitted into the cathedral of St Paul's, which will continue to exhibit a striking proof of national gratitude, and serve to cover the nakedness of the walls.

It was at one time the intention of Dr Farmer to publish a history of the town and antiquities of Leicester, the expences to be defrayed by subscription; but either his independent circumstances, or a degree of native indolence, made him relinquish the design, and the few materials he had collected were given to Mr John Nichols, at that time engaged in an elaborate work on the same subject. After a painful illness of some length, Dr Farmer died at Emanuel college in the month of September, 1797, in the 62d year of his age. Dr Parr wrote an epitaph for his tombstone, in which we find the following testimony to his worth. "Vir facetus et dulcis, festique sermonis, Græcè et Latinè doctus, in explicanda veterum Anglorum poësi subtilis et elegans." He had a considerable library, in which were a vast number of books purchased at the stalls of London, and afterwards disposed of for much more than they cost.

Farmer || Farnabie.

FARMER, in mining, is the lord of the field, or one that farms the lot and cope of the king.

FARN ISLANDS, two groups of little islands and rocks, 17 in number, lying opposite to Bamborough castle in Northumberland. At low water the points of several others are visible besides the 17 just mentioned. The nearest island to the shore is called the *House-island*, and lies exactly one mile and 68 chains from the coast. The most distant is about seven or eight miles. Their produce is kelp, feathers, and a few seals, which the tenant watches and shoots for the sake of the oil and skins. Some of them yield a little grass that may serve to feed a cow or two; which the people transport over in their little boats. The largest or House-island is about one mile in compass, and has a fort and a lighthouse. It contains about six or seven acres of rich pasture; and the shore abounds with good coals which are dug at the ebb of tide. St Cuthbert is said to have passed the two last years of his life on this island. A priory of Benedictines was afterwards established here, for six or eight monks, subordinate to Durham. A square tower, the remains of a church, and some other buildings, are still to be seen on this island; and a stone coffin, which is pretended to be that of St Cuthbert. At the north end of the isle is a deep chasm, from the top to the bottom of the rock, communicating with the sea; through which, in tempestuous weather, the water is forced with great violence and noise, and forms a fine jet d'eau of 60 feet high. It is called by the inhabitants of the opposite coast, the *Churn*. One of the islands in the most distant group is called the *Pinnacles*, from some vast columnar rocks at the south end, even at their sides, flat at the tops, and entirely covered with guillemots and shags. The fowlers pass from one to the other of these columns by means of a board, which they place from top to top, forming a narrow bridge over such a dreadful gap that the very sight of it strikes one with horror.

FARNABIE, THOMAS, son of a carpenter at London, born in 1575, staid a short while at Oxford; where being enticed to abandon his religion, he went to Spain, and was there educated in a college belonging to the Jesuits. Being weary of their severe discipline, he went with Sir John Hawkins and Sir Francis Drake in their last voyage in 1595. He was afterwards a soldier in the Low Countries: but being reduced

Farnham, Farnovians.

ded to great want, returned to England, where wandering about for some time under the name of *Thomas Bainrafe*, the anagram of his name, he settled at Mattock in Somersetshire, and taught a grammar-school with good reputation. He removed to London, and opened a school with large accommodations for young gentlemen. While he taught this school, he was made master of arts at Cambridge, and incorporated into the university of Oxford. Thence he removed, in 1636, to Seven-oaks in Kent; and taught the sons of several noblemen and gentlemen, who boarded with him, with great success, and grew rich. His works gained him reputation. Upon the breaking out of the civil commotions in 1641, he was cast into prison. It was debated in the house of commons, whether he should be sent to America; but this motion being rejected, he was removed to Ely-house in Holborn, and there he died in 1647. Mr Farnabie was a very eminent grammarian; and many writers have spoken with great approbation of his labours. M. Bayle in particular says, "His notes upon most of the ancient Latin poets have been of very great use to young beginners; being short, learned, and designed chiefly to clear up the text."

FARNHAM, or FERNHAM; a town of Surry, and capital of the hamlet of its own name, 41 miles from London on the Winchester road. It is a large populous place, situated on the river Wey, and supposed to have its name from the fern which abounded here. It was given by the West Saxon king Ethelbald to the see of Winchester; the bishops of which have generally resided in the castle here, in the summer time, ever since the reign of King Stephen, whose brother, its then bishop, first built it It was a magnificent structure, with deep moats, strong walls and towers at proper distances, and a fine park; but it is much decayed. The town, which has many handsome houses, and well paved streets, is governed by 12 masters or burgesses, of whom two are bailiffs, (chosen annually). They have the profit of the fairs and markets, and the assize of bread and beer; and hold a court every three weeks, which has power of trying and determining all actions under 40s. From Michaelmas to Christmas here is a good market for oats; and one of the greatest wheat markets in England, especially between All-Saints day and mid-summer. The toll-dish here was once reckoned worth 200l. a-year; but it is much diminished, since the people about Chichester and Southampton began to send their meal to London by sea. But this loss is amply made up by the vast growth of hops here, of which there are 300 or 400 acres of plantations about this town, and they are said to outdo the Kentish hop-yards both in quantity and quality. This town sent members to parliament in the reign of Edward II. but never since. The magistrates have their privileges from the bishop of Winchester, to whom they pay an acknowledgment of 12d. a-year. The market is on Thursday: fairs, Holy Thursday, June 24 and November 2. Here are a free school, and a great market for Welsh hose.

FARNOVIANS, in ecclesiastical history, a sect of Socinians, so called from Stanislaus Farnovius, who separated from the other Unitarians in the year 1568, and was followed by several persons eminent for their learning. This sect did not last long; for having lost their chief, who died in 1615, it was scattered abroad and reduced to nothing. Farnovius was engaged by Gonesius to prefer the Arian system to that of the Socinians, and consequently asserted, that Christ had been produced out of nothing by the Supreme Being before the creation of this terrestrial globe. His sentiments concerning the Holy Ghost are not certainly known; however, it appears that he warned his disciples against paying the tribute of religious worship to the Divine Spirit.

Farquhar.

FARQUHAR, GEORGE, an ingenious poet and dramatic writer, the son of a clergyman in Ireland, was born at Londonderry in 1678. He was sent to Trinity College, Dublin; but his volatile disposition not relishing a college life, he betook himself to the stage; where, having dangerously wounded a brother-actor in a tragic scene, by forgetting to change his sword for a foil, it shocked him so much that he left the Dublin theatre and went to London. Here he procured a lieutenant's commission by the interest of the earl of Orrery; which he held several years, and gave many proofs both of courage and conduct. In 1698, he wrote his first comedy called Love and a Bottle; which, for its sprightly dialogue and busy scenes, was well received. In the beginning of the year 1700, which was the jubilee year at Rome, he brought out his Constant Couple, or a Trip to the Jubilee: and suited Mr Wilks's talents so well in the character of Sir Harry Wildair, that the player gained almost as much reputation as the poet. This tempted him to continue it in another comedy called Sir Harry Wildair, or The sequel of the Trip to the Jubilee; in which Mrs Oldfield acquired great applause. In 1702, he published his Miscellanies, which contain a variety of humorous sallies of fancy. In 1703, appeared the Inconstant, or the Way to Win him: in 1704, a farce called the Stage-coach; in 1705, The Twin Rivals; and in 1706, the Recruiting Officer, founded on his own observations while on a recruiting party at Shrewsbury. His last comedy was the Beaux Stratagem, of which he did not live to enjoy the full success. Mr Farquhar married in 1703. Before that time his manner of life had been rather dissipated. The lady, therefore, who afterwards became his wife, having fallen violently in love with him, but judging that a gentleman of his humour would not easily be drawn into the trammels of matrimony, contrived to have it given out that she was possessed of a large fortune; and finding means afterwards to let Mr Farquhar know her attachment to him, interest and vanity got the better of his passion for liberty, and the lady and he were united in the hymeneal bands. But how great was his disappointment, when he found all his prospects overclouded so early in life (for he was then no more than 24), by a marriage from which he had nothing to expect but an annual increase of family, and an enlargement of expence in consequence of it far beyond what his income would support. Yet, to his honour be it told, though he found himself thus deceived in a most essential particular, he never was known once to upbraid his wife with it; but generously forgave an imposition which love for him alone had urged her to, and even behaved to her with all the tenderness and delicacy of the most indulgent husband. Mrs Farquhar, however, did not very long enjoy the happiness she had purchased by this stratagem; for the circumstances that attended this union were in some respect perhaps the means

Farquhar. means of ſhortening the period of the captain's life. For, finding himſelf conſiderably involved in debt in conſequence of their increaſing family, he was induced to make application to a certain noble courtier, who had frequently profeſſed the greateſt friendſhip for him, and given him the ſtrongeſt aſſurances of his intended ſervices. This pretended patron repeated his former declarations; but, expreſſing much concern that he had nothing at preſent immediately in his power, adviſed him to convert his commiſſion into money to anſwer his preſent occaſions, and aſſured him that in a ſhort time he would procure another for him. Farquhar, who could not bear the thoughts of his wife and family being in diſtreſs, followed this advice, and ſold his commiſſion; but, to his great mortification and diſappointment, found, on a renewal of his application to this inhuman nobleman, that he had either entirely forgotten, or had never intended to perform, the promiſe he had made him. This diſtracting fruſtration of all his hopes fixed itſelf ſo ſtrongly on our author's mind, that it ſoon brought on him a ſure, though not a very ſudden, declenſion of nature, which at length carried him off the ſtage of life in 1707, before he arrived at 30 years of age.—His comedies are ſo diverting, and the characters ſo natural, that his plays ſtill continue to be repreſented to full houſes.

Farrier. FARRIER, one whoſe employment is to ſhoe horſes, and cure them when diſeaſed or lame.

FARRIERY.

INTRODUCTION.

1 Origin of the term farriery.

THE term *farrier* is probably a corruption of *ferrier*, Fr. *ferrans*, from the verb *ferrer*, *to ſhoe a horſe*; all theſe words being derived from the Latin *ferrum*, "*iron*." There is no doubt that the word *farrier* was at firſt uſed to denote a perſon who ſhod horſes, but as theſe perſons were for a long period the only *horſe-doctors*, the term was ſoon uſed in the more extenſive ſenſe of *horſe-doctor* or *horſe-leech*; and hence *farriery* came to ſignify the *art of curing the diſeaſes of horſes*.

There can be little doubt that the word *farrier* was originally ſpelt *ferrier* or *ferrer*; as we meet with this latter orthography in ſome of our older writers. Thus Blundeville, who wrote in the time of Queen Elizabeth, in his "Addreſs to the Gentlemen of England," book iv. has the following ſentence.

"All horſes, for the moſt part, do come into their decay, ſooner than they ſhould do, by one of theſe four waies; that is to ſay, either for lacke of being well bred, or through the raſhneſs of the rider, the negligence of the keeper, or elſe through the unſkilfulneſſe of the *ferrer*."

Again, the ſame author mentions, "Martin Ghelly of Aſton, called Martin Alman, chiefe *ferrer* to the queen's magiſtie."

2 Veterinary art.

Farriery, in the uſual acceptation of the word, forms only a part of that more general art, which has been commonly called the *veterinary art*; by which is underſtood the art of medicine as applied to the inferior animals, which has been long called by the French *l' art veterinaire*, or *medicine veterinaire*. This word *veterinary* is of very ancient date, being derived from the Latin *veterinarius*, which is uſed by Columella to denote a *horſe-doctor*, or *cattle-doctor*. The term *veterinary*, being derived from *veterinus*, qu. *veheterinus*, à *vehendo*, *carrying*, is properly applicable only to beaſts of burden; but *veterinary medicine* is now commonly employed in a more comprehenſive ſenſe, to denote the art of curing the diſeaſes of *domeſtic animals* in general.

3 Term extended.

The French, who appear to have firſt uſed the term in this general ſenſe, uſually diſtinguiſh that part of the art which we call *farriery* by the appellation of *Hippiatrique*, from ἱππος, *a horſe*, and ιατρος, *phyſician*. Thus, they have a *Cours d'Hippiatrique*, a *Dictionaire d'Hippiatrique*, &c.

As there are conſiderable advantages attending the conſideration of the diſeaſes of the ſeveral domeſtic animals in the ſame treatiſe, we propoſe, in the preſent article, not to confine ourſelves to the medical treatment of the horſe, but to extend our views to the diſeaſes of ſuch other of the domeſtic animals, as are of moſt importance to man, particularly the ox, ſheep, and dog.

The diſeaſes of the horſe, as they are better known, and more intereſting, than thoſe of the other domeſtic animals, will of courſe occupy the greateſt ſhare of our attention. The diſeaſes of the dog have been as yet too little inveſtigated for us to give a very ſatisfactory account of them; but as the ſubject of veterinary medicine has of late been much cultivated, it is probable that theſe, as well as ſome other obſcure diſeaſes of animals, may ere long receive ſome elucidation. If any conſiderable improvements or diſcoveries ſhall be made before the completion of our work, we ſhall notice them under VETERINARY medicine.

4 Objections answered.

It may be thought, that, conſidering veterinary medicine in this extenſive point of view, it would have been more correct to defer the ſubject to the article VETERINARY; but moſt of our readers who have been accuſtomed to ſee in our dictionary the article FARRIERY, will expect an account of, at leaſt, the diſeaſes of the HORSE, under this article, and would probably not be pleaſed to have this delayed till nearly the end of the work; beſides, it is of little importance under which article the diſeaſes of animals are treated of, as, when we have once defined our terms, we cannot be miſunderſtood, provided we always employ them in the ſenſe of the definition. Again, as the term *veterinary* has departed from its original ſignification, there can be no objection to our employing the word *farriery*, a term that is more familiar, in the ſame general ſenſe. In fact, it has been ſo employed by a late writer on the ſubject, Mr Feron, who has entitled his work, "A new Syſtem of Farriery," though he profeſſes to treat in it of the horſe, ox, and ſheep.

In this article, then, we ſhall uſe *farriery* as ſynonymous with *veterinary art*, and ſhall conſider both as

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the art of preſerving the health and curing the diſeaſes of domeſtic animals.

5 Importance of the ſubject

The ſtudy of veterinary medicine muſt be an intereſting object to every perſon, whoſe profeſſion, or ſituation in ſociety, requires him to attend to the comforts and diſeaſes of domeſtic animals.

6 To the veterinary practitioner.

To the *veterinary practitioner*, the ſtudy of the principles of his art, the hiſtory of the diſeaſes which he is called on to relieve, and the methods of treating them that have been found moſt ſucceſsful, are as eſſential, as the ſtudy of the human economy, and the diſeaſes to which it is expoſed, are to the medical practitioner. A farrier who has ſtudied his art ſcientifically, is as much ſuperior to the ignorant empiric, to whoſe mercy the lives and limbs of horſes and cattle are uſually intruſted; as the regular phyſician to the illiterate quack, who puffs off his pernicious noſtrums in every newſpaper, and enriches himſelf, by impoſing on the credulity and folly of the public. The neceſſity of a regular education to the farrier, as well as to the ſurgeon or phyſician, which had long been ſeen, has led to the inſtitution of veterinary ſchools; at firſt in France, and within theſe few years in England. Of theſe we ſhall preſently give an account.

7 To the farmer and country gentleman.

To the *farmer* and *country gentleman* this ſubject muſt be highly intereſting. They will find their account in being able *themſelves* to ſuperintend the management of their horſes, dogs, ſheep, and cattle, ſo as beſt to preſerve their health, and relieve their diſeaſes, without relying implicitly on their grooms, huntſmen, and farriers, herdſmen and cattle-doctors, who are probably either notoriouſly ignorant, or are induced from intereſted views, or a fellow-feeling, to prolong the cure, and pick the pockets of their maſters (A). Theſe gentlemen therefore cannot employ a part of their leiſure time to greater advantage than in acquiring a knowledge of the diſeaſes of domeſtic animals.

8 To the medical practitioner.

The *medical* practitioner who wiſhes to derive an advantage from analogy in ſome of the obſcure diſeaſes to which the human frame is ſubject, and which would probably receive conſiderable elucidation from a compariſon with ſimilar diſeaſes that affect the inferior animals, muſt engage with peculiar intereſt, in a reſearch that promiſes ſo well to repay his labour. "It is not a little remarkable, (ſay the editors of a well-conducted medical journal), that the diſeaſes of horſes, cattle, and ſheep, which occur ſo frequently, and are ſo ſeriouſly lamented, ſhould be ſo imperfectly underſtood. No greater benefit could be conferred on phyſical ſcience than a complete hiſtory of the diſeaſes of our domeſtic animals, eſpecially if given by any one endowed by nature with ſuperior acuteneſs, and a talent for obſervation, improved by habit and experience; who could deſcribe the ſymptoms and appearances of the different diſorders, point out the analogies with thoſe incident to the human body, detect thoſe minute circumſtances which ſerve to diſtinguiſh them, claſs them under their proper heads, and correct all the confuſion in which they now lie involved. Veterinary medicine has lately occupied ſome ſhare of attention, chiefly as relating to horſes, and as a diſtinct purſuit from the general ſtudy of all the diſeaſes of animals, but conſidered apart from any relation or inquiry concerning the treatment of the morbid ſtates of the human ſyſtem. It is in this laſt point of view, that comparative pathology ſeems to offer ſo many ſubjects worthy inveſtigation; and, when looked upon in this light, it ſtrikes us as one of thoſe ſtudies *quæ ad nos pertinent, et quæ neſcire malum eſt* *.

* *Edin. Med. and Sur. Journ.* vol. i. p. 440.

9 Farriery much indebted to medical men.

We ſhall ſee, from the hiſtorical ſketch of farriery, which will immediately be given, that the art never made any conſiderable progreſs, or aſſumed any thing like a ſcientific form, till it attracted the attention of men who had made the *human* economy their ſtudy. Almoſt the only rational improvements, that have been made in the art, were either ſuggeſted or carried into effect by medical men; and nothing will contribute ſo much to its perfection as the intereſt which the profeſſion has lately ſhewed to it, and the attention that has of late been paid to the ſtudy of comparative anatomy and pathology.

10 Analogy between the diſeaſes of man and of animals.

The healing art in general muſt profit by this. There is not only an intimate connection between the ſtructure of man and that of the inferior animals; but, eſpecially in thoſe that have been domeſticated, the diſeaſes of both are nearly allied.

The murrains, that in the early part of the laſt century ſo frequently attacked the horned cattle throughout almoſt all Europe, nearly depopulating moſt of the farms, are very analogous to ſome of the epidemic diſeaſes of man; and peſtilential diſeaſes among cattle, have not unfrequently been the forerunners of ſimilar epidemics among the human race. Homer, in deſcribing the plague that haraſſed the Grecian camp, in conſequence of the affront given by Agamemnon to the prieſt of Apollo, ſays that the domeſtic animals were firſt affected.

> *Οὐρῆας μεν πρῶτον ἐπώχετο. και κυνας ἀργὺς,*
> *Αὐτὰρ ἐπειτ' αὐτοισι βέλος ἐχεπευκὲς ἐφιεὶς,*
> *Βαλλ'*—— *Il.* i. 50.

> "On mules and dogs th' infection firſt began,
> "And laſt the vengeful arrows fix'd in man."
> POPE.

The plague of boils that raged among the Egyptians (Exod. ix. 10.) affected both man and beaſt. Similar inſtances are related both by ſacred and profane hiſtorians.

Almoſt the whole tribe of inflammations, even the gout (according to Van Swieten), are found to affect the domeſtic animals, are produced by the ſame cauſes, and

(A) It may be thought by ſome, that we have gone too far in accuſing the farriers and grooms, &c. of having a fellow-feeling; but, when it is known, that "a part of every ſhilling paid to common farriers, is in ſome ſhape returned to the groom, as a fee or perquiſite;" that "the ſervant receives at leaſt five per cent. from the farrier on every bill paid by his maſter;" and that "if a horſe dies under the care of a farrier, he generally becomes the property of the groom;" (See Veterinary Tranſactions, N° 1. Introduction); it will be allowed that there is ſome ground for the ſurmiſe.

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and yield to the fame treatment as in the human fyftem.

Domeftic animals are fubject to eruptive difeafes, both chronic, and fuch as are attended with fever; and both are very fimilar to thofe by which man is affected. It is pretty certain that the fmallpox fometimes rages among fheep, as we fhall fee hereafter; and a complaint very like the meafles often attacks fwine. Some of them are transferable to man; and to this transference in the cafe of the cowpox, a bleffing which will render immortal the name of JENNER, we owe the probable annihilation of one of the moft dreadful pefts that ever affected the human race.

Scrofula and confumption attack monkeys. Apoplexy, epilepfy, and many others of what are called *nervous* difeafes, indigeftion, and even mental derangement, are not uncommon among domeftic animals; fpafmodic affections are very frequent among them, and it is faid, that for one cafe of *tetanus* or *locked jaw* among the human fpecies in thefe climates, there are ten or twenty among horfes.

The analogy might be purfued much farther; but what has been ftated is fufficient to fhew the advantages that medical men may derive from the ftudy of veterinary medicine. Many obfcure and dangerous difeafes may thus in time be illuftrated or mitigated; and the effect of doubtful remedies may be afcertained by experiments on the inferior animals. For, though there are a few inftances of different effects following the exhibition of the fame medicines in man and animals; yet, on the whole, the analogy is nearly as complete with refpect to remedies as difeafes (B).

11
A farrier fhould be acquainted with medicine.

It will appear, from what has been faid, that the reafoning, and much of the treatment, in the difeafes of animals muft be nearly the fame as in man, and, of courfe, that the veterinary practitioner will gain much by acquiring a knowledge of human medicine. Were the practitioners in farriery generally inftructed in the principles of medicine, little more would be required, in a treatife on farriery, than to point out the difference in the ftructure and functions of domeftic animals, to defcribe the difeafes peculiar to thefe, and to mark the varieties that it is neceffary to obferve in the treatment of difeafe and the adminiftration of remedies. But, as many of thefe gentlemen have not the opportunity of attending medical lectures, and moft of them have not received an education that would enable them to underftand the language in which medical writings are ufually compofed; it becomes neceffary in a treatife of this kind to accommodate the language to the tafte and capacity of general readers, and to introduce much that will be found in other articles on fubjects connected with medicine. To prevent repetition, as much as poffible, and to avoid fwelling this article to a greater length than is neceffary, we fhall, however, where the fimilarity of the fubject will admit of it, occafionally refer to fome of the medical articles in this dictionary.

12
Knowledge requifite for the veterinary practitioner.

The fuccefsful practice of farriery, like that of medicine in general, requires that the practitioner fhould poffefs a confiderable fhare of knowledge. It is not fufficient to have been long in the habit of managing horfes and cattle; this indeed, to a perfon of a ftrong mind, and attentive obfervation, will furnifh a confiderable number of facts, with refpect to the fymptoms and progrefs of the difeafes to which domeftic animals are fubject. But, to mark the minute differences between fuch as refemble each other, to inveftigate their caufes, and to contrive a rational mode of treatment, requires a much greater fhare of abilities, and much more extenfive information, than we can expect to find among grooms and fhepherds, or falls to the lot of moft of thofe, who call themfelves farriers and cattle-doctors.

13
Anatomy and phyfiology.

It muft be obvious to every thinking mind, that no practice either in medicine or farriery can be rational, but fuch as is founded on a comprehenfive knowledge of the ftructure and functions of thofe animals, the treatment of whofe difeafes is the object of that practice. The firft thing, therefore, neceffary to the veterinary practitioner is, to acquire fome idea of the anatomical ftructure of the domeftic animals. We have already, in the fecond part of the article ANATOMY, given a general account of the ftructure of quadrupeds; and in exemplifying this, in the chapter on *the anatomy of a dog*, we pointed out the moft ftriking peculiarities that are to be found in this animal; as we have done with refpect to ruminating animals, viz. the cow and fheep, in the fucceeding chapter of that part. To that article we muft refer our readers for the anatomical part of our fubject, as far as relates to the ox, the fheep, and the dog. It will naturally be expected, that a defcription of the ftructure of the horfe fhould be given in this article; but this defcription muft, in general, be concife, as the nature of our plan prevents us from enlarging on the fubject, excepting in thofe parts where a pretty minute knowledge appears to be neceffary.

Thofe who wifh to ftudy the anatomy of the horfe minutely, may confult Vitet's Medicine Veterinaire, tom. I.; Blaine's Outlines, and Stubb's elegant work on the anatomy of the horfe.

The practitioner fhould take every opportunity of infpecting the bodies of thofe animals that die of difeafes, which are very important, or which are not very well underftood. Morbid diffections often throw confiderable light on the nature and treatment of difeafes; and it fortunately happens, that with refpect to domeftic animals, thefe diffections are very eafy, and are not obftructed by thofe abfurd prejudices, which, efpecially in this country, are oppofed to the diffection of human bodies. In treating of the difeafes of domeftic animals, in a

(B) One of the moft remarkable cafes of anomaly in the effect of remedies is that of arfenic, which, in the quantity of a few grains will prove a deadly poifon to man and moft animals, but may be given with impunity to horfes to the amount of two drams or more. The ftory of the different effects of *antimony*, on hogs and *monks*, is well known. See ANTIMONY. As to the example of *white vitriol*, (fulphate of zinc), which proves emetic in the human fubject, but produces no fuch effect in the horfe; it is owing to the different ftructure of the ftomach in this animal, by which he is incapable of vomiting. Colocynthis, or *bitter apple*, is well known to be a moft violent purgative to *man*, but in the *horfe* it has produced no effect, in the enormous dofe of *four ounces*.

Introduction. a future part of this article, we ſhall give a conciſe view of the appearances on diſſection, as far as they have been aſcertained, whenever they tend to illuſtrate the nature, cauſes, or treatment of the diſeaſe under conſideration.

The ſtudy of the functions of domeſtic animals ought to go hand in hand with that of their ſtructure; and the ſtudent will find it of conſiderable advantage, to compare the functions of theſe animals with thoſe of man. This comparative view will be given in ſome future article. In the preſent treatiſe, we can only ſpeak of the functions of domeſtic animals, as far as it is neceſſary to illuſtrate the nature or the treatment of their diſeaſes.

14 Natural hiſtory. The natural hiſtory of theſe animals ought to form a part of the ſtudies of the veterinary practitioner. It is a ſubject that is not only highly curious and intereſting, but extremely uſeful. We find, that theſe animals, in their native fields, enjoy a ſtate of health and vigour, which is interrupted only by thoſe accidents to which a life of liberty and wildneſs may expoſe them. It is only when they are received under the protection of man, that they become ſubject to diſeaſe. It is therefore an intereſting inquiry, to examine into their native habits; as, in our endeavours to preſerve their health, we ſhould, as nearly as is compatible with convenience and economy, imitate the habits that are found to prevail amongſt theſe animals in a ſtate of nature. It is the province of the naturaliſt to deſcribe the external conformation of theſe animals, and the advantages, and defects dependant on it, that fit or diſqualify them for the various purpoſes, for which they are deſtined under the ſervice of man; it is his buſineſs to deſcribe the methods of breeding theſe animals in a ſtate of nature, and how far this may be improved for the purpoſes of domeſtication, and to detail the method of training and managing them. Many of theſe circumſtances are treated of by ſome of the writers on the veterinary art, in a complete ſyſtem of which they ought not properly to be omitted. We ſhall, however, not treat of them in this article, as, according to the plan of our work, they more properly fall to be conſidered under the article MAMMALIA, in which will be given the natural hiſtory of all quadrupeds.

15 Chemiſtry. Chemiſtry muſt form a neceſſary part of the ſtudies of every man who engages in the practice of medicine, whether human or veterinary, as, without a knowledge of its principles, neither the functions of the animal economy, the intimate ſtructure of its component parts, nor the action of many remedies, can be properly underſtood. In the article CHEMISTRY, we have prepared abundant matter for the reader to make himſelf acquainted with the elements of that admirable ſcience.

16 Surgery. The practitioner, whether of human or veterinary medicine, who is a proficient in anatomy, wants but a little manual dexterity, and ſome practical experience, to make him a tolerable ſurgeon. The operations to be performed on brutes are few, and theſe are in general very clumſily executed. Humanity, however, as well as prudence, will readily point out to the farrier the neceſſity of learning the beſt methods of performing theſe operations with dexterity and deſpatch, ſo as to give the leaſt pain to the unfortunate animals that are placed under his care. We ſhall deſcribe the uſual operations immediately after treating of the anatomy of the horſe.

17 Hygeiology. It is of conſiderable conſequence, that the perſon who undertakes the management of domeſtic animals, ſhould make himſelf acquainted with thoſe circumſtances which experience has ſhewn to be moſt favourable to the preſervation of their health, and the prevention of their diſeaſes. This ſubject forms what may be called *veterinary hygeiology*; and will be conſidered at ſome length in the fourth part of this article.

18 Materia medica. Before the practitioner can attempt to remove or alleviate the diſeaſes to which domeſtic animals are ſubject, he muſt acquire a competent knowledge of the remedies employed for that purpoſe, their nature, uſes, and doſes, as adapted to the different animals, in various ſituations, and various diſeaſes; with the methods of preparing and compounding them into the ſeveral forms that are uſually employed; and with the beſt means of adminiſtering them. This comprehends what is called the *veterinary materia medica*, and will form the ſubject of our fifth part.

19 Practice. With this previous knowledge, the veterinary ſtudent is prepared to enter on the conſideration of the diſeaſes, which will be treated of in the ſixth part of our article. He muſt be particularly attentive to the ſymptoms of each diſeaſe, as, on an accurate knowledge of theſe, will depend the means of diſtinguiſhing thoſe complaints, which upon a ſuperficial view bear conſiderable reſemblance to each other, but which require a very different, and perhaps oppoſite mode of treatment. He muſt attend to the greater or leſs violence of theſe ſymptoms, to the nature of the part which they attack, and to the greater or leſs rapidity of their progreſs; as theſe circumſtances muſt conſiderably influence the judgment he is to form of the danger, and probable termination, of the diſeaſe. He muſt, as far as poſſible, inveſtigate the cauſes, that appear to have produced the diſeaſe in queſtion, or which ſeem to aggravate or keep up the morbid ſymptoms; as on the removal or mitigation of theſe cauſes, muſt depend the only rational and ſcientific method of cure. Laſtly, he muſt make himſelf acquainted with the treatment that experience has found moſt ſucceſsful in the cure of each particular diſeaſe, as well as with that which has been found to be attended with little or no advantage.

As the proper means of attaining the beſt information is of the greateſt importance, we ſhall here give Mr Blaine's inſtructions on this point.

"The mode in which any art is attained, muſt be in a great meaſure directed by the future views of the learners. It appears to me that there are three diſtinct claſſes of perſons, who are likely to ſtudy this branch of uſeful knowledge. The firſt are perſons of enlarged minds, and extended fortunes. The ſecond are ſurgeons, whoſe ſituation in country villages may render their ſervices in this art highly uſeful, upon occaſions when no farrier is at hand, or, in the end, in caſes in which farriers of the common claſs are unable to judge. The third are farriers themſelves, or perſons intending to profeſs veterinary medicine.

"Gentlemen and amateurs, who wiſh to accumulate information on this curious and intereſting ſubject, within the reach of the veterinary college, will find their account in attending a courſe of lectures there; if not,

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not, they should apply themselves to the study of the more general parts of the body, both of the human and animal; the latter, I hope, they may attain by the following sheets. They may direct the collar-maker, huntsman, or tanner, to cut up their dead horses in their presence. They may study physiology in a pleasant and interesting manner, from the ingenious work on this subject by Mr Saumarez. The lighter parts of the veterinary art may be acquired with pleasure, from the elegant publication of Mr Richard Lawrence of Birmingham, and a course of chemistry will amply reward them for their pains in acquiring it.

"A good surgeon has travelled three-fourths of the road towards making a good veterinarian, but he must diligently travel the remainder to arrive at excellence. He must by no means sit down contented with the analogy between the human and brute; which, if he does, will lead him into very great error; for though this analogy is in most cases very striking, yet there are others in which the similarity fails, and he is left to act upon other principles. Hence in those diseases that are conquered or mitigated by vomiting in the human; in the horse he must pursue another mode of treatment. In acute diseases removed by purging in the human, his attempts on the horse would probably fail; as before the effects were produced, the animal might be past relief. It must be remembered that the operations of medicines are very different in the one, and the other. It is not sufficient that a surgeon has an intimate acquaintance with the human frame; he must be equally conversant with the animal he treats, or he will treat in vain; particularly those diseases originating in a peculiarity of form from the human, as all the diseases of the feet. He should make himself particularly conversant with the specific diseases of the horse, which bear no analogy to any thing in the human body; as farcy, glanders, strangles, grease, &c. From the great strength of the arterial system, he must ever be aware how prone the diseases of the horse are to a rapid termination, and hence that his treatment must be decisive and energetic; therefore, in all cases, he must be very attentive to diagnostics. But what will much embarrass a surgeon in practising the veterinary art, will be a want of knowledge of the general usages, nomenclature, and idiom, if I may so express it, among grooms and farriers; without an acquaintance with which, these people at once detect and despise the practitioner. It should be the business therefore of the surgeon, with his other acquisitions, to learn their manners, and to make himself acquainted with their terms. The third class of persons, either farriers already practising, or persons intending to practise, will easily gain that. When it is in their power, I would advise their taking the advantage of the veterinary college; but when they cannot, I would recommend the prosecution of their studies in a regular manner. Begin by first reading some general description of the human body, such as Symond's Anatomy, or the anatomical part of the present work, carefully; let them pay attention to the functions and uses of the parts, particularly where the same uses are brought about by a variation in structure; this enlarges the mind, and prepares it to receive the benefits of dissection, which should now be proceeded to. Any small animal may be first dissected, to enable the learner to use his instruments properly. He may then proceed to dissect the horse with some authorities by him, which will assist him at first to make out parts, but too scrupulous an attention to numerous descriptions will only bewilder. The necessary instructions for dissection, and the preservation of parts, may be gained, by a recourse to Poole's Anatomical Instructor, which is professedly written to instruct the pupil in these particulars. When he is well acquainted with the appearance of the animal in health, he should take every opportunity of examining diseased appearances, which are seldom wanting at the tan-yard or the kennel. He should now make himself acquainted more intimately with physiology, for which purpose he may read Haller's works; there is at present a translation of Cuvier's Treatise on Comparative Anatomy, which he may likewise avail himself of. When he has become acquainted with pathology, as at present received, he may peruse the older authors on farriery; to this should succeed a knowledge in chemistry, preceded by an acquaintance with the materia medica; the proper works for which he may see by a reference to that article, and nothing will now be wanting, but experience and practice to perfect him *."

* *Blaine's Outlines*, vol. i.

20 Means of promoting a knowledge of farriery.

Since the establishment of a veterinary school in Britain, little is wanting to promote the progress and improvement of the veterinary art, as far as relates to the diseases of horses. But the art, with respect to the medical treatment of other animals, is still in the most deplorable state of imperfection. Proposals have been made for improving cattle medicine; and among these, we think the following of Mr John Lawrence, entitled to attention; though, probably the proposer's list of works may be much improved and enlarged, by referring to the account of authors which will be immediately given.

21 Mr Lawrence's proposal.

Mr Lawrence's proposal is simply, "that the affair of providing the country with regular-bred surgeons, for the practice of cattle medicine, be immediately undertaken by the agricultural societies; at least, that the experiment be made by some of the most considerable, each society engaging a gentleman of that description, at a sufficient and respectable annual stipend. The contract may run in such form, that should the surgeon's annual emolument from practice come short of the stipulated sum, the deficiency should annually be made up by his patrons the society. No person to be engaged on any pretence, but who shall have received the usual education of a surgeon, and have attended the hospitals the usual length of time. A selection of *Veterinary text-books* to be made, and the books purchased for the use of the surgeon, but to remain the property of the society. This may consist of Gibson's last edition, two vols. Bracken, Bartlett, Osmer, Layard, with our late writers; and Lafosse and Bourgelat from the French, with whatever may have been published since their time, by authority of the French veterinary schools. All the members of the society and their connections, as far as their influence may extend, to entrust the care of their diseased animals to the surgeon appointed, at a fair and liberal charge for his attendance and medicines. The surgeon to keep a regular history of all the cases which shall come under his inspection, including the presumed causes and symptoms of the disease, with the probable methods of prevention, his mode of treatment, a particular detail of the medicines prescribed, their operation, with every relative and useful remark which may occur.

A clear written copy of ſuch veterinary tranſactions, to be delivered annually, and on a certain day, to the ſociety, to remain at their diſpoſal *."

* *Lawrence on Cattle.*

21 Importance of being acquainted with the hiſtory.

It is of conſiderable conſequence for the practitioner to be informed of the riſe and progreſs of the art which he profeſſes, and to be acquainted with the principal authors that have written on the ſubject. We ſhall here, therefore, give a brief ſketch of the hiſtory of Farriery, with a conciſe view of the writings that have appeared from the earlieſt authentic records to the preſent time (1806.)

Though we ſhall enumerate all the authors that have written profeſſedly on this ſubject, who appear deſerving of notice, we ſhall here characterize only the general treatiſes, reſerving our remarks on ſuch works as have appeared on individual diſeaſes, &c. to that part of our treatiſe, in which we ſhall conſider theſe ſubjects.

PART I. HISTORY.

23 Early hiſtory of the art very obſcure.

THE early hiſtory of farriery, as of every other art and ſcience, is involved in great obſcurity. We ſhall not attempt to penetrate the cloud that hangs over the ancient ſtate of the art, or to ſupply the want of facts, by conjectures, which, however rational, can lead to no certain or uſeful concluſions.

There ſeems no doubt that in the time of Hippocrates, and probably long before, the medical practitioner exerciſed his office in favour of the domeſtic animals, as well as of man; and Galen ſeems to have been well ſkilled in the knowledge and treatment of ſome of the diſeaſes of animals.

24 Columella.

Perhaps the earlieſt authentic writings on the ſubject of the veterinary art, now extant, are to be found in the works of Columella, the celebrated Roman author on huſbandry, who, in his work *De Re Ruſtica*, has given many ſenſible directions for the management of horſes and cattle. Columella lived about the ſecond century, under the reign of the Roman emperor Tiberius, or, as ſome ſay, of Claudius Cæſar.

25 Celſus.

It is underſtood that Celſus, the elegant imitator of Hippocrates, who lived ſome time before Columella, wrote much on the diſeaſes of animals; but none of his writings on this ſubject have ſurvived the general wreck of ſcience and literature that accompanied the fall of the Roman empire.

26 Vegetius.

We have no certain accounts of any author who wrote expreſsly on this ſubject earlier than Vegetius, who flouriſhed, as is ſuppoſed, ſometime in the fourth century, and probably during the reign of the emperor Valentinian the third. The work of Vegetius, *De Arte Veterinaria*, is ſtill conſidered as extremely valuable, as it has handed down to us the only certain account of the opinions and practice of the early practitioners in this art. The body of the work appears to have been compiled from the moſt celebrated Greek writers on the ſubject. It is divided into four books; the prefaces or introductory chapters to which are written in very elegant language.

An edition of Vegetius was publiſhed at Baſil, in 1574; and the work has been tranſlated into ſeveral modern languages. Such of our readers as wiſh for a particular account of the contents of Vegetius's treatiſe, will find a copious analyſis of it, in the third volume of M. Vitet's *Medicine Veterinaire*.

27 Ruelli's collection.

A collection of fragments of ancient writers on the veterinary art, was made by Ruellius, phyſician to Francis I. king of France. It was firſt publiſhed in Latin, in the year 1530; and afterwards, in 1637, the original Greek was publiſhed. The writers who contributed to this collection were chiefly Abſyrtus, Eumelus, Hierocles, Petagonius, and Theomeſtus. Some part of this collection is tolerably good; but, on the whole, it appears to be a ſtrange jumble of good, bad, and indifferent, collected without judgment, and arranged without taſte.

28 Xenophon.

It is ſaid that Xenophon, who lived three or four hundred years before the Chriſtian era, wrote a ſmall treatiſe in twelve chapters, on the training, management, and external figure of horſes; but, as he ſays little or nothing with reſpect to their diſeaſes, he cannot properly be ranked among the writers on veterinary medicine.

29 Dark ages.

A blank of more than a thouſand years now occurs in the hiſtory of farriery. During this long period of darkneſs, ignorance, and barbarity, the veterinary art, like moſt others, rather went back than advanced. During ſome part of this gloom, however, the art of ſhoeing horſes with iron appears to have been invented; an art which ſeems to have contributed not a little to throw the management of this noble animal into the hands of a ſet of errant blockheads, who were now firſt called farriers. We cannot here enter on a diſcuſſion of the medical pretenſions of theſe guardians of the health of horſes. They have been amply commented on, by ſome of the beſt writers on the ſubject of farriery, as Gibſon, Bracken, Lafoſſe, and particularly Mr John Lawrence, to whoſe uſeful and humane treatiſe on horſes we refer our readers for ſome very ſpirited remarks on the ſubject.

30 Ruini.

The firſt modern writer on farriery, whom we can mention, is Carlo Ruini, an Italian, who, in 1618, publiſhed at Venice his Anatomia del Cavallo. This work, of which very few copies are now to be found, is embelliſhed with many copperplates, which, for the time when they were engraved, are very elegant. It is ſaid that many ſucceeding writers on the anatomy of the horſe have been indebted to them for moſt of their figures.

31 Progreſs of farriery in France.

We now come to a period at which the veterinary art began to aſſume ſomething of a ſcientific form. Many writers of eminence began to appear both in France and England, countries which have been the moſt diſtinguiſhed for their attention to the management and diſeaſes of domeſtic animals. As the French writers were the firſt, who did any thing conſiderable towards the improvement of farriery, we ſhall trace the progreſs of the art in that country, before we examine the improvements it has received in England.

32 Solleyſel.

In 1698 Solleyſel publiſhed his grand work, "*Le parfait*

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parfait Marechal," the complete Horseman, a work, which gained its author a high reputation, and was long the only guide, as well in farriery as in the manege.

M. Solleysel was principal riding-master in France, and this situation led him to pay much attention to the diseases of horses; and being a man of considerable abilities, and enlightened understanding, he saw the errors that prevailed in his time; and his genius and experience led him to expose and to correct them. His practical observations and remarks, which it would be out of place to particularize in this early part of our article, in general merit considerable attention. His observations on the external figure of the horse, and of his blemishes and defects, are also very valuable. It is much to be regretted that this ingenious author had not studied the anatomy of the horse, as he would then have avoided many errors and much false reasoning, into which his ignorance of anatomy betrayed him. Solleysel's work passed through many editions, and was translated into most of the modern languages. A version of it into English was executed by Sir William Hope, one of his pupils, early in the 18th century.

33 Appearance of the murrain in Europe.

The dreadful havock committed by the murrains or epidemic diseases among horned cattle, that ravaged Europe during the first half of the 18th century, attracted the attention of medical men, and thus led the way to a greater improvement in the veterinary art, than it had ever before experienced. These epidemics were first described by two Italian physicians, Ramazzini, in a treatise *De Contagione Epidemica;* and Lancisi, physician to the pope, in a treatise *De Bovina Peste.* But the most celebrated works on the prevailing epidemic seem to have been written by the faculty in France. Among the first appeared a memoir by M. Hermant, physician to the king.

34 Sauvages.

In 1746 was published a memoir *Sur la Maladie Epidemique des Boeufs du Vivarais*, by the celebrated nosologist Sauvages.

35 Establishment of veterinary schools.

About the middle of this century, the first steps were taken towards the establishment of schools for the public instruction of practitioners in farriery. One of the most celebrated of these was the veterinary college of Lyons.

36 Bourgelat.

Over this institution presided the famous Bourgelat, a name that will be ever respectable in the history of farriery. Besides his office of professor at Lyons, he was inspector general of the veterinary schools in France; commissary general to the royal stables; honorary member of the Royal Academy of Paris, and member of the Royal Academy of Berlin. M. Bourgelat was a voluminous writer, and most of his works are still in much repute. In 1752, he published *Elemens d'Hippiatrique*, "Elements of Farriery," in 3 vols. The first volume is divided into eight chapters, comprehending the knowledge of the horse, as far as regards his external form. The first chapter treats of the denomination and division of the parts that compose the body of this animal; the second treats of the beauties and defects of the fore part of the horse, or what the French writers call *l'Avant Main*; the third treats of the beauties and defects of the several parts of the body; the fourth, of the beauties and defects of the hind part of the horse, or *l'Arriere Main;* the fifth, of the different marks of horses; the sixth, of the means of ascertaining the age of horses; the seventh, of the geometrical proportions of the horse; and the eighth, of shoeing.

The second volume describes the anatomy of the horse, as far as relates to the bones, the integuments, the muscles, and blood-vessels; and the third volume concludes the anatomy with a description of the parts that compose the head and chest.

In 1765, M. Bourgelat's materia medica, for the use of the veterinary pupils, came out. Soon after was published his Elementary Treatise on the Anatomy of the Horse, which is the most complete work of the kind that has ever yet appeared. In 1766 he published his Elementary Botanical Demonstrations, for the use of the pupils of the veterinary college. He likewise gave to the world a treatise on bandages applicable to the horse.

M. Bourgelat also furnished many of the best articles on farriery for the French ENCYCLOPEDIE.

37 Buffon and Daubenton.

About this time appeared a number of works on the manege, and on natural history, particularly a work by M. de la Guerincere, entitled *Ecole de Cavalerie*, and the celebrated natural history by M. de Buffon and Daubenton; but as these works have little connection with the diseases of animals, which they mention only incidentally, we shall not here particularize their contents.

38 Lafosse the Elder.

Contemporary with Bourgelat, and equal to him in celebrity, flourished Lafosse the Elder, a member of Royal Academy of Sciences at Paris, and farrier to the king of France. He made many discoveries, and introduced several valuable improvements in the art of farriery, particularly an improved method of shoeing, and a treatise on the glanders. These were at first communicated in the form of memoirs to the French academy, and published in their annals. They were afterwards collected in 1754 into one volume, under the title of *Observations et Decouvertes Faites sur des Chevaux;* "Observations and Discoveries on Horses." We shall have occasion, in future parts of our article, to consider the merits of these memoirs, which were well received, and have contributed much to the advancement of farriery.

The elder Lafosse also wrote some of the articles on farriery in the ENCYCLOPEDIE.

39 Lafosse the Younger

He was soon followed by his son Lafosse the Younger, who occupied the same post as his father, and has acquired much reputation, by following his steps, and extending his improvements. He published, in 1766, his *Guide de Marechal*; or "Farrier's Guide;" a work well known in this country, though it has never, we believe, appeared in an English dress. It is divided into five parts, treating, 1st, Of the means of ascertaining the age of horses, and a succinct enumeration of the several parts; 2d, Of the blunders and tricks of farriers; 3d, Of the internal diseases of the horse; 4th, Of the external diseases, and the most important operations; and, 5th, Of shoeing. This work is characterized by M. Vitet, as one of the most accurate, simplest, and most *precise*, that had ever appeared. The anatomical part of the work is short, but comprehensive, and is illustrated by some tolerably good plates. It appears to have been a sort of text-book to a course of lectures on farriery, which were afterwards, in 1772, published in a superb form, with 65 coloured plates, under the title of *Cours de Hippiatrique;* or "Course of

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of Farriery." This work is extremely scarce in Britain, where, according to Mr Blaine, there are only three copies of it; one of which belongs to the Medical Society of Woolwich; another is in the hands of a Mr Mathaisa, ci-devant pupil of the Veterinary College; and he believes Mr Morecroft has a third.

But the principal work of the younger Lafosse is his *Dictionaire d' Hippiatrique*, in four volumes, which is little known in this country, and which we have not seen. Mr Blaine calls it "the best practical system of farriery that had ever appeared."

In 1803 was published an abridgement of M. Lafosse's Guide, of which an English translation has lately appeared under the title of The Veterinarian's Pocket Manual. It is a useful little book, but it is a pity that the author or translator had not observed a more methodical arrangement.

Though, for the sake of uniformity, we have mentioned the younger Lafosse immediately after his father; there were many works published in France between the Memoirs and the Guide.

40 Garfault. In 1755, M. Garfault published his *Nouveau parfait Marechal*, an improvement on the *Parfait Marechal* of Solleysel. It is divided into seven treatises; on the Conformation of the Horse; on Haras, or on the Method of Breeding; on Stables; on the Diseases of Horses; on Operations; on Shoeing; and on Horse Medicines. This work is not without defects, but, for the most part, it is very good, and by no means deserves the brief character given of it by Mr Blaine in his History of the Veterinary Art, that it "does not seem to merit any distinction in this place."

41 Ronden. The articles on farriery in the Encyclopedie that had been written by Bourgelat and Genson, called forth a work from M. Ronden, senior, farrier to the larger stables of the king; who, in 1759, published *Observations sur les Articles de l' Encyclopedie concernant la Marechallerie*. They appear to be ingenious, and contain much practical information.

42 La maison rustique. In 1763 there appeared at Paris a work on agriculture in two volumes 4to, entitled, *La Nouvelle Maison Rustique*, which contains much useful matter respecting the breeding, management, and diseases of domestic animals, as well fowls as quadrupeds.

The contagious epidemics among horned cattle still appeared occasionally in France and other parts of Europe; and many essays were written on them by various physicians, particularly by M. Bovand of Besançon, in 1766; by M. Leclerc and M. Barbaret, of Paris, in the same year.

In 1768 Daubenton, the celebrated naturalist, already mentioned, published a memoir on the mechanism of rumination in sheep; and in 1769, appeared a small volume entitled *La Medicine des Bêtes a Laine*; "the Medical Treatment of Sheep."

43 Vitet. Between 1776 and 1782, M. Vitet, a physician at Lyons, published his *Medecine Veterinaire*, in 3 vols 8vo. of which the first contains a pretty full account of the anatomy of the horse and ox, with some judicious remarks on the beauties and defects of both, and on some of the more important operations to which they are exposed; the second treats of the diseases of horses, sheep, and cattle; and the third gives an account of the remedies employed in veterinary medicine; and ends with a copious analysis of most of the continental writings, and a few English, that had appeared on the subject, from Vegetius to 1770.

M. Vitet's work is, for the most part, a compilation from the best writers who have gone before him; but as he had read much, and appears to have selected with judgment, his book is one of those which may be consulted with advantage. We know that it bears a high character in France, and is often quoted with respect. We are therefore disposed to rate it at a higher value than a late writer has done; and are inclined to suspect that some of those who affect to think lightly of it are indebted to it for much more than the "names of many of those who have written on this subject."

Much about this time, but in what precise year we cannot say, the abbé Rozier, well known as the editor of the early volumes of the *Journal de Physique*, published his *Cours d'Agriculture et de Medicine Veterinaire*; a work of much reputation in France, but, we believe little known on this side the water. 44 Rozier.

Another work appeared about this time on the epidemics among cattle, entitled *Recherches Historiques et Physiques sur les Maladies Epizootiques*; "Historical and Philosophical Researches respecting Epizootic Diseases," by M. Paulet. It contains an abridgement of almost all that had been written on the subject, and is particularly valuable for the account of the morbid appearances that were discovered on dissection. 45 Paulet.

We shall finish our account of French writers in the words of Mr Blaine.

"After the death of Bourgelat and Lafosse, we hear of no character of any great eminence for some years; but it appears, that since the revolution, the subject has again been more diligently studied, and the names of Chabert and Huzard stand forward. Soon after, or about the time above alluded to, there appeared a considerable work, called, The Rational Dictionary of Medicine, Surgery, and Farriery, in six volumes; and very soon after, a Veterinary Dictionary, by Buchon; but it has no merit superior to that of Lafosse. In 1787, M. Chabert published a Treatise on the Mange of Horses; since which he has likewise published upon the peripneumonia of black cattle. There has also appeared an Essay on the Grease of Horses, which gained the prize medal of the society for the promoting the health of animals; to which is joined a report on thick wind and on broken wind; but we are not aware who is the author. In 1788, there came out a treatise on the *haras*, with the method of shoeing, cutting, and all the lesser operations, translated from the Spanish of Hartmann, by Huzard. Likewise "Instructions and Observations on Domestic Animals, with remarks on the breeding, rearing, buying and selling; with an analysis of previous authors, by Chabert, Handrin, and Huzard. The above authors have also published, conjointly, a Veterinary Almanack, containing the history and progress of animal medicine, since the establishment of the veterinary schools. In 1791, M. Lampagieu Lapole, veterinary surgeon, published observations on the health of the animals of St Domingo, dedicated to the veterinary college at Alfort. In 1797, M. Chabert and M. Huzard published, by order of government, a treatise on ascertaining the existence of the glanders, the means of preventing it, and destroying the infection." * 46 Huzard and Chabert.

Before we detail what has been done in Britain for the advancement of the art, we must take a cursory 47 Progress of farriery on the continent.

* Blaine's Outlines, vol. i.

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view of the principal writings that appeared during the 18th century in the rest of Europe.

48 Goelicke.

In 1730, Goelicke, a German, published a treatise in 4to, *De Lue Contagiosa Bovium;* "On the Contagious Disease of Cattle;" in which the symptoms of the murrain that raged in Flanders about that time are well described; and there are added the appearances on dissection.

49 Saunier.

In 1734, appeared at the Hague a work entitled *La parfaite Connoissance des Chevaux;* "The Complete Knowledge of Horses;" by John Saunier, and Gaspard his son. The latter boasts of this work, that it was drawn up from the lectures of his father, an experienced man; and that it contains the result of numerous experiments on subjects of every description, and diseases of every species; that it is the labour of the life of two men, the offspring of their continual application and study. After all their boasting, however, the work of Mynheers Saunier is little worth.

In 1745 and 1746, appeared two other treatises on the epidemic of cattle by Mauchard and Ens.

50 Linnæus.

In 1749, the illustrious and indefatigable Linné published at Upsal his *Pan Suecicus*, in which there is little that relates to our subject, if we except a table of such plants as are eaten or refused by the domestic animals, which is curious and useful.

51 Hastfer.

Some time before 1756, Frederic Hastfer, a Swede, published Instructions for Improving the Breed of Sheep, which was in much repute, and was translated into French.

52 Reynier.

In 1762, M. Reynier of Lausanne published a treatise on a contagious inflammatory disorder that raged among horses and cattle, and which the Genevese called *la louvet*. This will be considered hereafter.

In the same year there appeared at Vienna a work on the epidemic of cattle by Dr Pleneiz; and in 1765 Mich. Sagard of the same city published a work on a contagious distemper that the year before attacked the cattle in the circle of Iglaw in Moravia; and was attended with an appearance of aphthous crusts in the mouth.

53 Hartmann.

Of late veterinary medicine has been much cultivated in Spain, where the works of Hartmann are held in much esteem. In that country, it is said, a work on farriery in nine volumes has been lately published; but of this we know nothing.

54 Camper.

We must not close our account of continental writers without mentioning the name of the illustrious Camper, whose works were lately collected and published at Paris. Besides a long description of the structure of the oran-outang, and some lesser essays on comparative anatomy, these volumes contain an elaborate history of the epizootic disease that raged among the cattle on the continent in the middle of last century, in the form of lectures. We shall speak of this work hereafter.

We have thus brought the history of this art on the continent in a concise manner, down to the present time; and from it may be learned what improvements have originated there, and at what periods. It would appear, that when the science began to command attention, from the exertions of Francis the first, and Vegetius became studied, had it progressively improved in the degree it might be supposed to be placed by a converſance with this author, it would ere this have been more approximating to perfection: but instead of proceeding on the rational system of Vegetius, it dwindled again into ignorance of barbarity; and the recipes of manege-masters, and the operations of blacksmiths, were the only ostensible marks of its assistance. From this state the practitioner became in some degree roused by the improved system of Solleysel; but he could only combat present errors, he could not point the way to future improvement, for he was ignorant of the groundwork whereon to build it, i. e. the anatomy of the animal. This defect was only in a small degree supplied by the labours of Ruini, and in some measure farther assisted by the demonstrations of Bourgelat. Many of the remaining errors were combated by Lafosse with great advantage; and his experiments and discoveries on glanders, the rationality and improvements of his mode of shoeing, entitle him to great merit. Yet, though by these exertions, and by the establishment of veterinary seminaries, the art assumed a more regular and scientific form, its attainments were by no means adequate to its opportunities; which was almost wholly owing to an obstinate adherence to the humoral pathology, by which the treatment of internal and acute diseases continued inert and unsuccessful. Their prescriptions were filled with decoctions of simples, and they were utterly unacquainted with the medicinal virtues of the more active remedies in use among us. Under an opinion that the blood and humours were the constant seat of disease, they were continually washing them sweet with correctors; entirely ignorant or unmindful of the derangements of the solids, and of the connections between living blood and living vessels. Nor did this influence only their treatment of internal and acute diseases; but even of local and chronic affections: hence their mode of treating farcy, grease, and other complaints of a similar nature, were equally inert, and all evinced an erroneous pathology. Upon a careful and unprejudiced review of the state of farriery among ourselves, and on the continent of Europe, we are not inclined to think it had any advantages of moment at the beginning of the war in their favour; though it must be allowed, we are indebted to them for many improvements, and for the first hints towards the establishment of a regular school of the art among us. Since the war, our means of communication are so few, that we are not aware of what is doing among our neighbours. But though farriery, as a branch of veterinary medicine here, has kept nearly equal pace with its continental improvements, I do not think (says Mr Blaine,) the treatment of other animals, particularly of *oxen*, *cows*, and *sheep*, has been equally attended to; and, in this particular, I am disposed to think we are behind hand with them. Their severe visitations of the epizootic distemper have made them more attentive to this branch of the art." *

* *Blaine's Outlines.*

55 Progress of farriery in Britain.

In taking a view of the history of farriery, or veterinary medicine in general, in our own country, it will be seen, that we were much longer in improving the art, and reducing it under a rational and scientific form, than our neighbours on the continent. Our earliest writers on the diseases of horses and cattle, were deplorably ignorant, not only of all principles of general medicine and sound practice, but even frequently of the common appearances of the diseases, which they professed to cure.

56 Blundeville.

Our first writers on the treatment of the diseases of horses, History. horſes, were, as in France, chiefly riding-maſters; and of theſe, the firſt that ſeems worthy of notice is Blundeville, who lived, as we have already obſerved, in the reign of Queen Elizabeth. His work appears to have been principally compiled from the writings of Vegetius, and other ancient writers; and it contains little that can entitle it to any diſtinction, as a work of utility. It may, however, be peruſed as a literary curioſity.

57 The names of many writers, after Blundeville, are mentioned by thoſe who have written on the hiſtory of farriery; but they are all ſtill inferior to Blundeville, except perhaps Burdon, on whoſe work, notes were written by Dr Bracken.

58 Markham. About the end of the 17th century, lived Gervaſe Markham, a name in high repute amongſt grooms and farriers, even to this day. He publiſhed a work on Farriery, which he called his *Maiſter Peece*, and which is one of the ſtrangeſt compounds of nonſenſe and abſurdity that has ever appeared on the ſubject.

In the opinion of Mr Lawrence, Markham was nothing more than a mere vulgar and illiterate compiler; and his works, ſome few things excepted, are ſtuffed with all the execrable traſh that had ever been invented by any writer, or practiſed by any farrier, ancient or modern, on the ſubject of horſes. It is neceſſary, however, that we do juſtice to the character of Gervaſe Markham; he certainly poſſeſſed a ſpecies of merit which has not deſcended to all his ſucceſſors, the copyiſts and plagiariſts; he very honeſtly gives the names of thoſe authors from whom he derives his knowledge.

59 Baret. Some years after Markham, Michael Baret publiſhed a book, which he called the *Vineyarde of Horſemanſhip*. This we have never ſeen, but it appears to be of

60 Duke of Newcaſtle. ſome repute. The next writer on this ſubject, is the duke of Newcaſtle, who gave to the world a moſt ſuperb work on an improved method of breeding and managing horſes. This work bears a very high character, not only from the name of the illuſtrious perſon by whom it was compoſed, but from its own intrinſic merit. The duke is quoted with reſpect by moſt ſucceeding writers; and his work has been tranſlated into French, German, Dutch, and Italian. It chiefly relates to horſemanſhip, but as it contains ſome excellent obſervations and maxims on the breeding of horſes, it naturally comes to be conſidered here.

61 Snape. In the latter end of the 17th century, Andrew Snape, who was farrier to Charles II. publiſhed a large work on the anatomy of the horſe, illuſtrated with many copperplates. Theſe plates appear not to have been taken from his own diſſection, but are moſtly copied from preceding authors, eſpecially from Ruini. Mr Blaine, however, is miſtaken in aſſerting that ſome of them are copied from Saunier, as Snape's work was publiſhed in 1683, whereas Saunier's did not appear, (according to Vitet) before 1734. It is ſaid that Snape had projected a larger work on the diſeaſes of horſes, but this he did not live to execute.

62 Gibſon. Early in the 18th century, farriery experienced a conſiderable improvement from the writings of Mr William Gibſon. This gentleman had been a ſurgeon in the army, but relinquiſhed that ſituation for the practice of farriery, which he probably expected to find more profitable. Mr Blaine places this writer in the middle of the laſt century; but his firſt work entitled "The Farrier's New Guide," was certainly publiſhed previous to the year 1721, as we have ſeen a ſecond edition of it advertiſed in that year. This was the moſt ſcientific work on the diſeaſes of horſes, that had then appeared in the Engliſh, or perhaps any language. The detail of ſymptoms is in general juſt, accurate, and the plan of treatment adviſed is for the moſt part very judicious. The anatomical part of Mr Gibſon's work is not ſo valuable, being frequently incorrect, and evidently not the reſult of his own obſervation. The Farriers Guide was ſoon followed by The Farriers Diſpenſatory, containing an account of the remedies employed in farriery, and the means of preparing and exhibiting them. This work is far inferior to the former, and is now of little uſe. In 1721, Mr Gibſon publiſhed a ſmall work on The True Method of Dieting Horſes, which contains ſome judicious remarks on the means of preſerving the health of this uſeful animal; as alſo on the breeding of horſes: with ſome obſervations on their external form, their ſagacity, and habits. This book muſt have been very valuable at the time of its publication, but is now in a great meaſure ſuperſeded by Clark and other later writers.

About 1750, Mr Gibſon publiſhed a larger work, On the Diſeaſes of Horſes, in which he has brought together the ſubſtance of his former works on farriery, with ſome improvements. There is, we believe, a later edition of it in two vols. Mr Gibſon muſt be conſidered as one of thoſe to whom farriery is moſt indebted for its improvements. He was almoſt the firſt, at leaſt in this country, to reſcue the art from the hands of the illiterate empirics, to point out their blunders, and correct their errors. Mr John Lawrence, who has given a very full account of Mr Gibſon in the firſt volume of his treatiſe on horſes, perhaps goes too far in ranking him on an equality with ſome of our preſent writers; while theſe again have erred as much on the other ſide, in detracting from the merits of a man to whom they are all more or leſs indebted for much of their moſt valuable matter.

Gibſon was followed in his plan for the improvement of farriery by Dr Bracken, a phyſician at Lancaſter, and a pupil of Boerhaave, who publiſhed a work called Farriery Improved. "Bracken (ſays Mr Blaine) was phyſician of great abilities and extenſive knowledge in his profeſſion; a man of conſiderable erudition, a ſportſman, and a wit of a peculiar caſt. His works have by ſome been as much admired and read for the peculiar ſtyle in which they are written, and that peculiar freedom and non-obſervance of rule or form, as for the real information they contain. 63 Bracken.

Though there is great ingenuity in his writings, and though in many reſpects he improved upon Gibſon, yet as a practical work it was much inferior; nor was his information given in a way that could benefit the generality of his readers: independent of his ſtyle being too peculiar, and his reaſoning too abſtruſe for farriers, his manner of purſuing his ſubject was ſo deſultory, that few readers had patience to follow him. Nevertheleſs his works, which were ſeveral, and paſſed through many editions, have raiſed him a fame that can only die with the ſcience."

Theſe two writers may juſtly be conſidered as the fathers of Engliſh farriery; they eſtabliſhed their ſyſtem on

History. on the only ſure foundation, the analogy which prevailed between the ſtructure, economy, and diſeaſes of man and of brutes. The beſt practice in this country has been derived from their inſtructions; and their works formed an example, by following which, later writers have greatly improved the art.

64 Bartlet. The next writer of reputation was Mr John Bartlet, alſo a medical man, who about the middle of the laſt century publiſhed his, Gentleman's Farriery, and afterwards his Veterinary Pharmacopeia. Bartlet had formed himſelf on the model of Gibſon and Bracken, the beſt parts of whoſe writings he has given in his farriery, condenſed into a more compendious view. He alſo enriched his work by the moſt material improvements of Lafoſſe, whoſe memoirs on ſhoeing and on glanders, he tranſlated into Engliſh.

65 Oſmer. Soon after Bartlet, appeared Mr William Oſmer, a ſurgeon and a ſportſman, who practiſed farriery in Oxford ſtreet, London. He was the principal means of introducing into this country the French mode of ſhoeing, which, in his treatiſe on the lameneſs of horſes, he adapted to the Engliſh manners, ſo as to render of ſervice, what had been before nearly uſeleſs and impracticable. Mr Oſmer's mode of ſhoeing will be mentioned hereafter. From the above works many compilations were ſoon made; theſe were generally below mediocrity, amongſt which, one called the Farrier's Dictionary, though a very wretched compoſition, met with a very rapid ſale. We muſt except from theſe a ſmall treatiſe by a Mr Blount, ſurgeon, which is above the common claſs, and worthy of notice, from an ingenious contrivance, illuſtrated by a plate, for ſecuring a fractured limb.

66 Brockleſby. In the year 1746, Dr Richard Brockleſby, a friend of Dr Mead, publiſhed a pamphlet on the diſorder that juſt before raged among horned cattle. It ſhould ſeem that this book is very little known beyond the circle of medical men, as we have not ſeen it referred to by any writer on the diſeaſes of cattle.

67 Layard. Brockleſby was followed on the ſame ſubject by Dr Layard. We ſhall ſpeak particularly of theſe two authors, when we come to treat of the murrains.

68 Clark. About 30 years ago, Mr James Clark, farrier to his majeſty for Scotland, publiſhed an ingenious Treatiſe on Shoeing, and on the Diſeaſes of the Feet of Horſes. This was ſoon followed by his Treatiſe on the Prevention of Diſeaſes Incidental to Horſes. By this latter work Mr Clark has acquired much reputation, as a ſcientific farrier, and a ſenſible writer. It contains ſome judicious obſervations on ſtables, diet, and exerciſe, on blood-letting, rowels, and ſetons; with remarks on the uſes and adminiſtration of the more common remedies. Mr Clark's book is in general well calculated to produce a more judicious and humane method of treating horſes, than uſually prevails. But it would have been more uſeful, had the author omitted much of the theoretic diſcuſſion, into which he has entered on ſome parts of the animal economy, on the nature of diſeaſe, and on the action of remedies. Mr Clark is a good practical writer, but his theory is often very lame, or very obſcure. He had an eaſy opportunity of attending the medical lectures, which were taught at Edinburgh in his youth, when the humoral pathology and the theory of Boerhaave were in full vogue. Mr Clark has here and there interſperſed among his practical remarks much of this old leaven. But as he probably had not received ſuch a previous liberal education as might fit him for the judicious application of what he heard, he is often deficient in that theoretical knowledge which he takes ſo much pains to diſplay.

Some years before the publication of Mr Clark's laſt mentioned treatiſe, viz. in 1778, Lord Pembroke favoured the public with his excellent diſſertation on the management of dragoon horſes, with ſome remarks on ſhoeing. This work is entitled, Military Equitation, or a Method of Breaking Horſes. Though the obſervations, contained in his lordſhip's work, were intended for the uſe of the Britiſh cavalry, they are for the moſt part applicable to horſes in general, and well merit the attention of farriers and others concerned in the management of horſes. We do not well underſtand what Mr Blaine means by aſſerting that Lord Pembroke derived the principle of his medical hints from Mr Clark. If he means that his lordſhip borrowed any thing from Mr Clark's treatiſe on preventing the diſeaſes of horſes, he is certainly miſtaken, as the firſt edition of this treatiſe, which we believe has not been reprinted, appeared in 1788, and in it Mr Clark often quotes Lord Pembroke's work (c). 69 Lord Pembroke.

Much about this time Mr Stubbs publiſhed his elegant plates of the anatomy of the horſe, of which work, as the production of an artiſt, we cannot ſpeak too highly. Mr Stubbs is a very eminent painter of animals, and to much profeſſional excellence in this capacity, he has added a conſiderable ſhare of anatomical knowledge. Hence his figures are in general extremely correct, and will be found very uſeful to thoſe who have not the opportunity of availing themſelves of real ſubjects. 70 Stubbs.

One of the lateſt writers on the ſubject of farriery is Mr Taplin, who for ſome time enjoyed a conſiderable reputation, both as a practitioner and as a writer. But this reputation has been materially ſullied, ſince it was diſcovered, that Mr Taplin is not only ignorant of the anatomy of the horſe, but has liberally copied from thoſe very writers whom he takes every opportunity to vilify and abuſe. As from his flagrant plagiariſm and arrogance, Mr Taplin has well deſerved *the dreſſing* which he has recently received from ſeveral late writers, we ſhall turn him over into the hands of one of his rivals, who does not ſeem diſpoſed to ſhow him any mercy. 71 Taplin.

"This gentleman likewiſe began his career as a ſurgeon, but turned aſide to the then more profitable track of farriery. Mr Taplin ſet out by decrying all that had gone before him, all that were in practice with him, and in fact every thing that has been done by any one ſince. Yet Mr Taplin's works are ſaid to be compilations from thoſe very authors whom he abuſes; and, in ſome inſtances, after abuſing egregiouſly, he copies literally.

(c) We find that Lord Pembroke's work was firſt publiſhed about 1761. The edition mentioned in the text is, we believe, the ſecond.

Hiſtory.

ally. Unfortunately for this gentleman, from ſome late improvements, the people of this country have learned to diſtinguiſh in this art, as well as in others, between ſcientific inveſtigation and verboſe quackery. Had Mr Taplin ſet out by ſtudying the ſtructure and economy of the animal, he might, and undoubtedly would, have proved an ornament to the profeſſion; but when he permits his works to go through ſo many editions, in the face of criticiſms from all quarters, with a chapter on diſeaſes of a part that has no exiſtence in the horſe, i. e. *the gall bladder*, we muſt be aware that he is entirely ignorant of that, upon which every pretenſion to profeſſional merit muſt be grounded. Mr Taplin indulges himſelf in the moſt unreſtrained freedoms in ſpeaking of thoſe who have gone before him, yet copies verbatim from them; he cannot wonder, therefore, that he has been treated with conſiderable ſeverity by later writers; nor can he be ſurpriſed that a practice ſo begun and ſo continued has ended as his has *."

* *Blaine's Outlines*, vol. i. p. 63.

Mr Taplin is the author of ſeveral works on farriery. His firſt publication was, we believe, The Stable Directory, which had a great ſale. He next publiſhed a larger work, in two volumes; and lately he has ſent out a ſmall pamphlet called *Multum in parvo*, which is ſuppoſed to be merely intended to advance the ſale of his prepared horſe medicines.

72 London veterinary college.

The end of the 18th century will ever be memorable in the hiſtory of farriery, for the eſtabliſhment of an inſtitution for the public teaching of the veterinary art in England, in imitation of thoſe ſchools in France of which we have already ſpoken.

73 St Bel.

The veterinary college owes its origin to M. St Bel, a French gentleman, born at Lyons, and who was firſt junior aſſiſtant to the profeſſor of the Royal Veterinary College there, and afterwards profeſſor of anatomy at the veterinary college of Montpelier. This gentleman came to Britain in 1788, and publiſhed propoſals for eſtabliſhing a veterinary ſchool in this kingdom. Theſe propoſals did not, at that time, meet with encouragement; but two years after, when M. St Bel, driven from his native country by the horrors of the revolution, again viſited England, his propoſals were taken again into conſideration by an agricultural ſociety at Ockham in Hampſhire. It had been the intention of this ſociety, to ſend two young men to France, to ſtudy the veterinary art ſcientifically; but on hearing the propoſals of M. St Bel, they abandoned this idea, and appointed a committee to conſult with him on the beſt means of forming a ſchool for teaching the art in this kingdom. To this ſchool they gave the name of *the Veterinary College of London;* and M. St Bel was appointed the firſt profeſſor.

The following gentlemen were appointed to the management of this inſtitution.

His Grace the Duke of Northumberland, Preſident.

Earl Groſvenor, Earl Morton, Earl of Oxford, Lord Rivers, Sir George Baker, Bart. Sir T. C. Bunbury, Bart. M. P. Sir W. Fordyce, John Hunter, Eſq.	Vice Preſid.
Sir John Ingleby, Bart. M. P. Sir H. P. St John Mildmay, Bart. G. M. Aſcough, Eſq. Mr John Baynes, Mr J. Burgeſs, Rev. T. Burgeſs, Rev. J. Cook. Dr Adair Crauford, John Gretton, Eſq. Dr Hamilton, Mr Rennet, Dr D. Mapleton, Granville Penn, Eſq. Mr William Stone, Richard Tophane, Eſq. Dr Williams, J. Wollaſton, Eſq.	Directors.
Meſſrs Ranſom, Moreland, and Hammerſly,	Treaſurers.

A houſe was taken, for the purpoſe of the inſtitution, and pupils were admitted to board in the houſe.

The ſucceſs of this inſtitution, at firſt, by no means anſwered the expectations of the founders. It appears that M. St Bel was prevented, by the embarraſſed ſtate of his circumſtances, from executing the office of profeſſor, with that ardour and activity, which was neceſſary to the reputation of the infant ſchool; and indeed it ſeems, from the ſpecimen he has left us of his profeſſional abilities, that theſe were not adequate to the office he had undertaken. He poſſeſſed conſiderable induſtry, and it is probable that, had he lived, he would have ſucceeded better than his outſet had promiſed. But, in the year 1793, he was attacked with an illneſs, which proved fatal in about a fortnight.

M. St Bel left behind him ſeveral works, viz. An Eſſay on the Geometrical Proportions of Eclipſe. Lectures on the Elements of Farriery. The art of Horſeſhoeing, with Obſervations on the Diſeaſes of the Feet. And a volume of poſthumous works.

We do not pretend to give our own opinion as to the merits of theſe works, as we have not ſeen them. But it is ſaid that the Eſſay is merely an application of the proportions long ago laid down by Bourgelat in his *Elemens d'Hippiatrique*, to a particular caſe; and that many of his meaſurements are incorrect. Mr Blaine roundly taxes him with tranſlating Lafoſſe to furniſh matter for his Elements, and refers for proof of this to the deſcription and treatment of *quittor* in St Bel's Elements, and Lafoſſe's *Dictionaire d'Hippiatrique*.

Mr Blaine brings many other inſtances of M. St Bel's want of information and ſcience, for which we muſt refer our readers to Mr Blaine's Outlines of the Veterinary Art.

On the death of M. St Bel, there appears to have been a competition for the vacant chair, between two gentlemen, who were both well qualified to fill it, Mr Edward Coleman and Mr Morecroft. Both of theſe gentlemen had been bred to ſurgery, and the former had acquired much reputation by an ingenious Eſſay on Suſpended Reſpiration. The latter was lately returned from France, where he had been ſtudying the veterinary art. We are not acquainted with the particulars 74 culars of this competition; but the choice of the ſubſcribers fixed on Mr Coleman, under whoſe management the college has acquired conſiderable reputation.

75 Mr Coleman appointed profeſſor.

The election of Mr Coleman was followed by ſome new regulations. An anatomical theatre was fitted up, with diſſecting rooms for the uſe of the ſtudents. A medical committee was alſo appointed for the purpoſe of examining the pupils, who had completed their education at the college, previouſly to their receiving a diploma as veterinary ſurgeons. This committee, in 1801, was compoſed of the following gentlemen.

76 Examining committee.

Dr Fordyce, ſenior phyſician to St Thomas's hoſpital.
Dr Relph, phyſician to Guy's hoſpital.
Dr Babington, Do.
Dr Bailie, phyſician to St George's hoſpital.
Mr Cline, ſurgeon to St Thomas hoſpital.
Mr Home, ſurgeon to St George's hoſpital.
Mr Aſtley Cooper, ſurgeon to Guy's hoſpital.
Mr Abernethy, ſurgeon to Bartholemew's hoſpital.
Mr Wilſon, lecturer on anatomy and ſurgery; and
Mr Coleman, profeſſor of the college.

The following are the regulations of this uſeful inſtitution as publiſhed in the year 1801.

77 Regulations of the college.

The ſubſcribers of the veterinary college pay two guineas per annum, or twenty guineas for life. For this ſubſcription each ſubſcriber is entitled to ſend, when ſick or lame, any number of horſes to the veterinary ſtables, where no charges are made for medicines, attendance, or operations. The ſubſcriber pays only for the keep and ſhoeing of his horſe, which is generally leſs than the actual expence incurred by the college. A committee of ſtablers is appointed to examine the quality of the forage, and to regulate the price of the keep of horſes. For ſome years paſt, the ſubſcribers paid only 2s. 6d. per night; but in conſequence of the great advance in hay, corn, and ſtraw, and the college, by this moderate charge, having ſuſtained a conſiderable loſs, the keep of horſes is now fixed at 3s. per night. A ſeparate committee inſpects the accounts of the college, and three times in the year reports to the general meeting the ſtate of the finances of the college. No horſes but thoſe the property of ſubſcribers are admitted into the veterinary ſtables; but the profeſſor is allowed private practice, and horſes not belonging to ſubſcribers may be ſent to the college for the profeſſor's opinion.

The horſes not intended to be left in the ſtables of the college may be ſent for the profeſſor's advice on Mondays, Wedneſdays, and Fridays, from twelve to two o'clock. Where medicines are requiſite, they are prepared for ſubſcribers horſes at very reduced prices; and the college receives all emoluments which may ariſe from the ſale of horſe medicines.

The expences incurred by ſubſcribers, for ſhoeing, for the keep of horſes, or for medicines, muſt be paid for before the animal be taken from the college. And as ſome loſſes have been ſuſtained from the ſtrict letter of this regulation not having been always attended to, the clerk has now received poſitive orders from the committee, not to allow any horſe, before all the expences are paid, to be taken from the college. The horſes are placed under the direction of the profeſſor, who reſides on the ſpot, and the medicines he preſcribes are compounded by a proper perſon employed for that purpoſe.

As the great object of the veterinary eſtabliſhment is to form a national ſchool for the improvement of farriery, pupils paying twenty guineas are admitted into the college to learn the veterinary art.

Lectures are given by the profeſſor on the formation, economy, and diſeaſes of horſes, and other domeſtic animals; and moſt of the eminent medical teachers in London, with a liberality peculiar to themſelves, have allowed the veterinary pupils to hear their lectures without any fee or reward. The veterinary ſtudents attend lectures on human anatomy and phyſiology, on the principles and practice of ſurgery, on the materia medica, and chemiſtry, and practice of phyſic.

The period requiſite for obtaining a competent knowledge of the veterinary art, is regulated by the talents, previous information, and induſtry of the individual pupil. The ſtudents continue to attend the college until they are examined and approved by the medical committee. Thoſe pupils who are duly qualified receive a diploma; but thoſe who are found on examination to be deficient, are rejected. There are four general examinations in the year. When examined and approved, if no objections are made to their conduct, during their ſtudy at the veterinary college, they may be recommended to any regiment of cavalry, not already provided with a veterinary ſurgeon.

No fees of any kind are allowed by the college to any of the ſervants of ſubſcribers; neither are the ſervants of the college permitted to receive any perquiſites from the ſubſcribers.

A veterinary college has alſo been eſtabliſhed near Birmingham, and it is ſaid that others are in contemplation in other parts of the empire.

The advantages that have already accrued from this eſtabliſhment, to veterinary medicine in general, and to our national cavalry in particular, are very conſiderable. Almoſt every regiment of cavalry has been ſupplied from the college, with a veterinary ſurgeon; and many of theſe gentlemen have publiſhed works which, for the moſt part, do much credit to themſelves and their academy.

In 1798, Mr Coleman publiſhed the firſt volume, and in 1802, the ſecond, of Obſervations on the Structure, Oeconomy, and Diſeaſes of the Foot of the Horſe. This is a moſt uſeful and valuable work, but it is too ſplendid and coſtly, eſpecially the ſecond volume, for general circulation. The firſt volume contains a very full account of the method of ſhoeing practiſed at the veterinary college, of which we ſhall give an abſtract hereafter.

About this period, appeared alſo a pamphlet by Mr Coleman, On the Formation and Uſes of the natural Frog of the Horſe, with the deſcription of an artificial Frog.

In 1801, appeared the firſt number of the Veterinary Tranſactions, publiſhed by order of the ſubſcribers. This pamphlet commences with a long introduction, ſtating the object of the inſtitution, the progreſs which it had made, and the cauſes that tended to prevent its complete ſucceſs. Theſe originate partly in the party oppoſition of the common farriers, who deem it their intereſt to do all in their power to circumvent the views of the ſubſcribers: but they have ſtill more been derived from the underhand malice of grooms and ſervants, with whoſe intereſt the inſtitution, from the liberal manner in which

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which it is conducted, muſt certainly claſh. The body of the pamphlet is occupied with a very neat view of the conſequences and treatment of wounds of joints, and other circumſcribed cavities, and it is concluded by an account of the regulations of the college (ſee N° 77.) the liſt of the medical committee, a liſt of the examined and approved veterinary ſurgeons that had at that time paſſed at the college, and liſts of the then managers and ſubſcribers to the inſtitution.

78 Bracey Clarke. The firſt pupil of the college, as we believe, who diſtinguiſhed himſelf as an author, was Mr Bracey Clarke; who, in the third volume of the Linnean Tranſactions, publiſhed a very ingenious paper on the *botts* in horſes and cattle, of which we ſhall ſpeak hereafter.

79 Riding. About the ſame time appeared a ſmall volume on Veterinary Pathology, by Mr Riding, veterinary ſurgeon to the 18th regiment of dragoons.

80 Denny. In 1802, Mr John Denny, of the 10th dragoons, publiſhed a ſmall volume on the Diſeaſes of Horſes. In this work Mr Denny has in general given the principles and practice of the veterinary college, and has illuſtrated and confirmed theſe by his own attentive obſervations and long experience.

81 White. In the ſame year appeared a very neat Compendium of the Veterinary Art, by Mr James White of the 1ſt Dragoons. This is only a pocket volume, and of courſe is very conciſe; but the author has given a very comprehenſive view of the nature and treatment of diſeaſes, and of the late improvement in the art of ſhoeing introduced into the veterinary college; and the work will be found an uſeful companion to the young practitioner. This volume alſo contains the ſubſtance of a former work, by the ſame author, on the Anatomy and Phyſiology of the Horſe's Foot. In the year 1804, Mr White publiſhed the Veterinary Materia Medica, containing a brief deſcription of the various ſubſtances employed in farriery, with an account of their particular effects on the body of the horſe. He occaſionally introduces ſome pertinent remarks on the diſeaſes of the horſe; and in the latter part of the volume, compriſing the veterinary pharmacopeia, he has given a number of the beſt and moſt ſcientific recipes that he had ſeen. This work may be conſidered as the ſecond volume of Mr White's compendium; and the author conſidered the two volumes, as forming a complete ſyſtem of the veterinary medicine. Though we are diſpoſed to think very favourably of theſe volumes, as a practical compendium, we cannot help thinking that Mr White might have contented himſelf with that modeſt title without aſſuming the more pompous one of a ſyſtem. We muſt alſo remark, that the materia medica, which is not large, is unneceſſarily ſwelled by the admiſſion of many articles that ſeem to have been introduced merely to tell us, that they are never uſed in the veterinary practice.

Mr White is alſo the author of an Addreſs to the Royal Firſt Devon Yeoman Cavalry reſpecting the management of their horſes, when employed on actual ſervice.

82 Richard Lawrence. In the year 1802, or we believe a little earlier, a work of conſiderable elegance was publiſhed by Mr Richard Lawrence, veterinary ſurgeon at Birmingham. As we have not ſeen this work, we muſt copy the following account of it from Mr Blaine. "It is much to be regretted that a gentleman who poſſeſſes ſo much ingenuity, ſhould paſs over ſubjects of ſuch importance in ſuch a light curſory manner. The deſcription and treatment of ſome diſeaſes occupy fewer lines than (to treat the ſubject in ſuch manner as to prove uſeful) they would require pages. The plates are elegant, and extremely well deſigned, particularly thoſe that regard the proportions and paces of the horſe; thoſe that regard the internal ſtructure and diſeaſes are not ſo happy. The diction is very ſuperior. As a cabinet work, it is moſt certainly elegant and intereſting; but as a uſeful aſſiſtant to the art itſelf, it does not rank ſo high."

83 Boardman. In the ſame year was publiſhed the firſt part of a dictionary of the veterinary art by Mr Thomas Boardman of the third regiment of Dragoons. This work was intended to be completed in ſixteen parts. The author ſeems to have availed himſelf of the lateſt and beſt information on the ſeveral articles that compoſe his work; and he has introduced into it a variety of ſubjects on the principles of general medicine.

84 Feron. One of the lateſt publications by pupils of the veterinary college, is a new ſyſtem of farriery by Mr John Feron, veterinary ſurgeon to the thirteenth regiment of Light Dragoons. This work is printed in quarto, and affords a good inſtance to what an extent a ſmall quantity of matter may be carried by the modern typographical improvements of large type, broad margins, wide ſpaces, and frequent breaks. The work is indeed very elegant both in type, and in plates. It alſo contains ſome uſeful information on the external ſtructure of the horſe, with a view to point out and illuſtrate what appeared to the author to be the moſt perfect form of a blood horſe, with the blemiſhes and defects which appeared moſt likely to impede his velocity. This appears to be the beſt part of the work, and is well illuſtrated by the plates. The latter half of the book is occupied with the conſideration of diſeaſes; and here we are led, from the author's title page, to expect an account not only of the diſeaſes of horſes, but of the principal epidemics to which cattle, ſheep, &c. are ſubject. Theſe epidemics are however diſcuſſed in the courſe of ſeventeen pages; but we are given to underſtand that the author intends in a future publication to give a full comparative deſcription, with the proper mode of treatment of every diſeaſe that affects domeſtic animals. Mr Feron's obſervations are rendered of much leſs utility than they would otherwiſe have been, by the want of a proper index, or table of contents.

85 Freeman. Theſe are, we believe, the principal publications that have proceeded from the pupils of the veterinary college. A few other works on veterinary medicine ſtill remain to be conſidered. In 1796, a very elegant work on horſes was publiſhed by S. Freeman, Eſq. whoſe character is given by Mr Blaine as an amateur in the manege, and a gentleman of fortune, learning and great ingenuity. This publication conſiſted in a *deſcription of the ſtructure and economy of the foot*, accompanied with a ſet of plates highly finiſhed in Skelton's beſt ſtyle. The ſubjects were diſſected under the inſpection of Mr Home, or an aſſiſtant; and except ſome ſlight errors in the ligaments of the navicular bone, appear very correct. This publication, for the elegance of its engravings, and the general ſpirit of the whole, will be long without a competitor. It recommends a very ingeni-

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ous mode of ſhoeing, and the economy of the foot is likewiſe very ingenious.

86 John Lawrence.

About the ſame time Mr John Lawrence publiſhed a ſmall volume on horſes, chiefly compoſed of extracts from St. Bel, Oſmer, Clarke, and Lord Pembroke; and in 1798, this gentleman brought forward his philoſophical and practical treatiſe on horſes, a work which is as remarkable for the good ſenſe and humanity of the author, as for the whimſical eccentricity and angry irritability which he occaſionally diſplays. The work embraces a great variety of ſubjects. It commences with an account of the principal former writers on farriery, in which high eulogies are paid to the memory of Gibſon and Bracken, and a very violent attack is made on the ill-ſtarred Mr Taplin. The latter part of the work contains Mr Lawrence's ſyſtem of veterinary practice, which is chiefly taken from his favourite authors, as Mr Lawrence ſeems at that time not to have had much practical experience. The work alſo contains ſome remarks on the diſeaſes of horned cattle, on the treatment of cows, and on calving,

Mr Lawrence has ſince, in 1805, publiſhed a ſeparate treatiſe on cattle, in which the management of neat cattle, ſheep, and ſwine, are handled in a maſterly manner; and a much fuller account of diſeaſes and their treatment is given than could be expected in his former treatiſe. We venture to recommend Mr Lawrence's works as amongſt the moſt inſtructive and moſt entertaining that we have met with.

87 Downing.

Some years ago there appeared a work on the deſcription and treatment of the diſeaſes of cattle, by a Mr Downing, a profeſſor of cattle medicine; which, though very expenſive, ſold very faſt, and was very generally eſteemed amongſt farmers and graziers. We have not ſeen this work; but from the account of it that is given by Mr Blaine in his outlines, it ſhould ſeem that it abounds with important errors, and frequently inculcates a dangerous mode of practice. We cannot here enumerate the particular examples brought by Mr Blaine in proof of his aſſertions, but we ſhall notice the moſt important of them under their proper heads.

Perhaps no part of veterinary medicine has been ſo little cultivated in this country, as that which conſiders the diſeaſes of cattle. There is ſcarcely a work on this ſubject in the Engliſh language that is worth peruſal. We cannot give a better idea of the little value that muſt be placed on theſe works than by the following extract from Mr Lawrence's treatiſe on cattle.

88 Imperfection of works on cattle medicine.

"I have never yet ſeen any of theſe *cattle doctoring books*, which appeared to me to be written *bona fide*. Well-intentioned ignorance, if not entitled to reſpect, is at leaſt venial; but the ſlighteſt examination of moſt of theſe printed guardians of the health of cattle, by a perſon qualified to judge, will evince, that they are premeditated impoſtures, goods merely varniſhed up for ſale. They have either the names of living men tacked to them, who, in the ſtrongeſt probability, never either did, or could write a line of them, or they are publiſhed in the name of ſome one of the mighty dead, among cow-doctors, who moſt unfortunately died at laſt, after ſixty years practice. One would expect to find ſomething original and valuable, from this long-continued and extenſive practice; but the diſappointment is always complete. The chief of that which we meet with, conſiſts of tranſcriptions from former writers, interlarded with learned, medical, and phyſical diſſertations, perhaps ſound and good enough in their place, to which are looſely and clumſily tacked the moſt nonſenſical and burleſque appendages by Mr Editor. The medicinal forms in theſe books, are frequently the ſtrangeſt jumble that imagination can conceive. Articles of a directly oppoſite nature and intention, are blended in one maſs, which muſt inevitably act upon the animal ſyſtem with an effect ſimilar to that of two men pulling at oppoſite ends of a cord. We find balſam of Peru and Glauber's ſalts married together, the intent of which, no doubt muſt be, as a Suffolk farrier once deſcribed to the late Mr Ruſh, "a kind of heater, and a kind of cooler." Indeed the far greater number of the preſcriptions wear rather the appearance of having been fabricated for the uſe of the book, than of having ever been uſed and approved in real practice. One truly laughable cuſtom was introduced by the book publiſhed under the name of Topham's old one. It was to ſubjoin to every preſcription of note, a ſet character, conceived in the moſt high ſounding terms of panegyric, at the ſame time, with a choice of words, at once ſo droll, and ſo gravely profeſſional, with ſo formal an arrangement, that he muſt be a man far ſurpaſſing me in gravity, grave as I naturally am, who can peruſe them without burſting into laughter. It muſt not be denied, however, that theſe books contain a number of uſeful hints, relative to the management and dieting of cattle, whether or not ſuch may have originated with the doctor, or have been introduced by the editor. They may alſo, to a certain degree, be conſulted as to the ſymptoms of diſeaſes, although by no means to be implicitly relied on even in that reſpect. So far they have their uſe. With regard to doctoring, as it is termed, or preſcribing medicines to cattle, they are moſt truly blind guides; and when, unfortunately, they are ſet to lead the blind, the fate of both parties may be very readily anticipated. I am ſpeaking of books, which have been publiſhed within the laſt half century. As to the ancient veterinary writers, none of them, not even the celebrated Vegetius, were medical men, and their medical practice is utterly beneath modern notice. The ſame kind of books of our old Engliſh writers, conſiſt of a ſtrange medley of ancient practice with various ſage additions of their own. A rational man cannot read over ſome of their preſcriptions without amazement, nor a humane one without extreme pity for the haraſſed victim of ſuch monſtrous practice. By the way, they who, for intereſted purpoſes, fabricate pretended cattle medicines, of the effects of which they are careleſs or ignorant, commit an act of groſs inhumanity and crime, in too probably adding to the load of ſufferings of a helpleſs animal already tortured by diſeaſe. One of the greateſt curioſities we meet with in the old books, is their grand univerſal ſpecific. It ſeems as though they judged by a kind of compound arithmetico-medical logic, that all medicines being conjoined and multiplied one into the other, the product muſt neceſſarily be the prevention or cure of all diſeaſes." *

* *Lawrence on Cattle.*

89 Culley.

Mr Lawrence has excepted from the above general condemnation, a work lately publiſhed by Mr Culley, of Northumberland; which, he ſays, ought to be in the hands of every farmer in Great Britain. He conſiders it as the only original work in our language, and, as containing in a ſmall compaſs, a moſt valuable fund of information,

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information, chiefly from the author's own experience.

90 Morecroft. In the year 1800, Mr Morecroft, the rival candidate with Mr Coleman for the professorship of the veterinary college, published a small pamphlet containing a cursory account of the various methods of shoeing horses, with incidental observations. This work displays considerable ingenuity. We shall notice Mr Morecroft's method of shoeing by and by.

91 Blaine. In 1802, appeared Mr Blaine's Outlines of the Veterinary Art, or the Principles of Medicine as applied to a knowledge of the structure, functions, and economy of the horse, the ox, the sheep, and the dog; and to a more scientific and successful manner of treating their various diseases; in two volumes. Mr Blaine is well known as a practitioner of veterinary medicine, and as the advertiser of a specific against the distemper in dogs. In his Outlines, Mr Blaine, after giving a sketch of the history of medicine in general, enters on the history of veterinary medicine in particular, which he details at considerable length; not however, without several errors, some of which we have already pointed out. He next proceeds to lay down very briefly what he conceives to be the proper means for the attainment of the veterinary art. Then follows a long section on a subject which we should scarcely expect to find in a work of this kind, the history of chemistry. The first part concludes with a sketch of comparative anatomy, in which the structure and economy of the ox, sheep, and dog are passed over much too lightly. The second part, which occupies the rest of the first volume, and one-half of the second, is taken up with a very minute account of the anatomy of the horse, with some observations on the economy and uses of the several parts. We consider this as the best part of Mr Blaine's book; but we think that he has made it unnecessarily prolix, as by carrying it to such an extent, he has not left room for a satisfactory account of diseases, which occupy the rest of the second volume. Here we cannot but consider the author as very defective. Neither the symptoms nor the treatment are given with that accuracy or precision, which the public had a right to expect from a practitioner of Mr Blaine's long experience. Many of the diseases of cattle, sheep, and especially of dogs, are passed over in a manner that is by no means satisfactory. The work is written in a very slovenly manner, and is everywhere filled with an ostentatious parade of medical phraseology that must render it nearly unintelligible to the generality of readers. In his receipts, Mr Blaine has for the most part adopted the new nomenclature, which, however we may approve in medical formulæ, we cannot think calculated for the meridian of farriers. We, however, by no means intend to insinuate that Mr Blaine's work is without merit: it certainly contains much valuable matter; but we must repeat that it is not what we should have expected from the advantages of information and experience which Mr Blaine appears to have possessed.

In the following year, Mr Blaine published a smaller work, which he calls a Domestic Treatise on the diseases of horses and dogs, which appears to be chiefly an abridgement of the Outlines, with a sort of advertisement for the sale of Mr Blaine's patent medicine.

In 1802 appeared a General View of the Agriculture of the county of Peebles, by the Rev. Charles Findlater, minister of the parish of Newlands, in that county. This work, though intended merely as a local survey of the state of agriculture and improvements in a small district, abounds with much excellent matter that must prove of general utility. Besides the observations which the ingenious author has made, on the general management of live stock, in the body of his work, he has added in one of his appendices some valuable information respecting some of the most important diseases of sheep, which are partly furnished from the communications of Dr Gillespie, late physician in Edinburgh, and Dr Coventry professor of agriculture in that university, and partly derived from his own experience. 92 Findlater.

In 1803 was published an elegant work on practical agriculture by Dr R. W. Dickson; the second volume of which contains much useful instruction respecting the choice, breeding, feeding, &c. of all the species of live stock employed on a farm; with a few very concise remarks on the diseases of each species. But as these are merely practical hints, they cannot be of much use, except to those who are already tolerably acquainted with the subject. 93 Dickson.

In the same year, the Rev. William Daniel performed a task, which, however ill suited to the character and avocation of a clergyman, must be highly grateful to every lover of the sports of the field, in the publication of his Rural Sports, which contains perhaps the most complete account of every thing relating to dogs that is to be found in the English language. Among other subjects connected with the management of this favourite companion of man, the reverend author takes occasion to treat pretty fully of his diseases. On this subject, Mr Daniel has not only collected matter from what he conceives to be the best sources, but, what is more useful, as well as more to be depended on, he has added much from his own observation and experience. 94 Daniel.

One of the latest works on the diseases of domestic animals, which we have seen, is An Enquiry into the Rot in Sheep, and other animals, by Dr Edward Harrison, a respectable physician of Horn-castle, in Lincolnshire. Of this pamphlet we shall speak at large, when we come to treat of the disease, whose nature and causes it is intended to illustrate. 95 Harrison.

PART II. ON THE STRUCTURE OF THE HORSE.

96 IN the sketch which we are to give of the anatomy of the horse, we must very lightly pass over such parts as appear not to be of immediate importance in the practice of farriery, in order to dwell more minutely on those organs that are of greater consequence. Thus we shall content ourselves with giving a tabular view of the bones and muscles; we shall entirely omit the brain and nerves; but we shall describe some of the other viscera, as the stomach, and the bowels, somewhat more minutely. We shall be most particular on the anatomy of the extremities, especially of the feet, as on an accurate knowledge of these parts depend the principles of shoeing;

ing; which, without such knowledge, cannot be properly understood, or rationally practised.

On the subject of the anatomy of the foot, we shall be particularly indebted to the writings of Mr Coleman; and we cannot shew the importance of the subject in shoeing better than by the following remarks of that gentleman.

97 Importance of an accurate knowledge of the anatomy of the foot.

"The organization and functions of the foot of the horse will be found rather complicated; but it is of considerable importance to those who wish to investigate the principles, as well as the practice of shoeing, to be well acquainted with every part of that organ. The practical part of shoeing is often well executed without an accurate knowledge of the contents of the hoof.

"But, in many cases, it is very necessary to be well acquainted with the structure and functions of the deeper seated parts, and is most particularly useful for the removal of many diseases incident to the foot. The immense weight supported by the feet of the horse, and the rapidity with which this great animal is conveyed from place to place, without violence to the external or internal parts of the foot, naturally excite a desire to ascertain the cause of so wonderful an effect. If the human foot supported the same weight as the foot of the horse, the sensible parts would be destroyed. Without springs, no external covering could effectually support the weight, and prevent the foot from being smashed. The physiologist will receive infinite satisfaction in the investigation of the functions of this complicated organ; he will find as much order and beauty, as much wisdom and utility, in the formation and economy of the foot, as ever was displayed in the structure and uses of any animal. It will be seen in many instances, that the same part performs various functions, and all of these functions well *".

* *Coleman on the Horse's Foot*, vol. ii.

98 In our description of the structure of the horse, we shall, as far as possible, employ English names to denote the parts described or enumerated, as we think the writers on this subject have done wrong in giving to the parts of the horse the Latin names that are employed in the human anatomy; and we have no doubt that the generality of veterinary students must, from this circumstance alone, be in a great measure deterred from paying the necessary attention to so important a subject. But, that we may avoid affectation, we shall, wherever it appears necessary, add the corresponding Latin name, and some synonyms of the more respectable writers on the anatomy of the horse.

Chap. I. *A Sketch of the Bones of the Horse.*

99 Skeleton.

When we take a general view of the skeleton of the horse, supposed to stand before us, we shall observe that, excepting the head and forepart of the neck, the skeleton forms nearly a square, and approaches more nearly to this form, as the body of the animal is more exactly proportional. We remark this for the sake of painters and sculptors, who commonly err considerably with respect to their proportion of length and breadth in their figures of the horse.

We shall divide the skeleton into the head, the spine, the trunk, and extremities. See Plate CCXI. fig. 1.

1. Bones of the Head. A.

a, *c*, Half of the *frontal bone*, which in the horse is always composed of two pieces.

e, *f*, One of the two *parietal bones*.

g, *h*, *i*, *k*, The *occipital bone*, with a process at *k*, that is peculiar to the horse.

l, *m*, The *temple*, or *temporal bone*, of one side; *n*, the cheek-bone of one side.

o, One of the small bones within the socket of the eye, that answers to the *os unguis* in man.

p, *p*, Bones of the nose.

q, *r*, *s*, The upper jaw-bone.

t, The *intermaxillary* bone, or what is usually called by veterinary writers the *inferior* jaw-bone. This is not found in the human skeleton.

u, *v*, The posterior maxillary bone, which answers to the lower jaw-bone in man.

Bones of the Spine. B.

1, 2, 3, 4, 5, 6, 7, The seven vertebræ of the neck.

a, The atlas; *b*, the second vertebra, called in human anatomy, *dentata*; *d*, *e*, *f*, its transverse process; *e*, its oblique process; *f*, its ridge, answering for a spinous process; *g*, *h*, *i*, *k*, *l*, *m*, *n*, third cervical vertebra; *g*, its body; above the letter is the hole for the transmission of the vertebral arteries and veins; *i*, *k*, anterior and posterior transverse processes; *l*, a protuberance in the fore part of the body.

8—25, The eighteen vertebræ of the back; *a*, the body of each; *b*, the transverse processes that articulate with the ribs; *c*, the oblique processes; *d*, the spinous processes.

26 to 30, The five vertebræ of the loins, which have very long transverse processes, though these are not very easily distinguished in the figure, from its having a side view.

x, *x*, The sacrum bone, composed of five pieces, as in man.

From 31 to 43, the 13 bones composing the tail, answering to the *os coccygis* in man.

Bones of the Trunk. C.

a, *b*, 1, 9, The true ribs; 10 to 18 the false ribs; *a*, the head articulating with the transverse process of the first dorsal vertebra; under is seen the lower branch of the head that unites with the seventh cervical and first dorsal vertebra; *c*, the end that unites with the sternum or breast-bone; *a*, *b*, *c*, *d*, *e*, *f*, *g*, the two hip-bones, answering to the *ossa innominata* in the human anatomy; *a*, *b*, *c*, the ilium, with its tuberosity *a*, forming the haunch or hip; *e*, *f*, the ischium; *g*, *g*, the pubis with its juncture or symphysis between the two letters.

Bones of the Fore Extremity. D. D.

e, *f*, *g*, *h*, *i*, *l*, *m*, The scapula or blade-bone; *e*, its neck, below which is seen its glenoid cavity; *f*, antespinatus fossa; *h*, its spine, which in the human ends in the processus acromion, but as there is no clavicle in the horse, it ends by a tuberosity; *i*, coracoid process; between *m* and *i*, the anterior costa; *l*, between this and *e*, posterior costa; between *m* and *l*, is its base, and the line above it marks the extent and situation of the cartilage of the scapula; *n*, *o*, *p*, *q*, humerus or arm; *n*, its neck, above which is seen its head; *o*, its anterior head, forming the point of the shoulder, as it is commonly called.

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called in the horse; *p*, its tuberosity; *q*, its lower head, behind is seen the cavity for the reception of the olecranon; *r*, *r*, ulna; the upper part forms the olecranon or elbow, the lower part is united by ligamentous fibres to the radius; *s*, *s*, the radius; 1, 2, 3, 4, 5, 6, 7, the carpus or knee; 1, 1, pisiform; 2, 2, scaphoid; 3, 3, lunar; 4, unciform; 5, magnum; 6, cuneiform; 7, trapezoid; *t*, *u*, metacarpus; *t*, canon; *u*, two small metacarpals; *v*, *w*, *x*, *y*, *z*, phalanges; *v*, first phalanx or pastern; *w*, sesamoids; *x*, coronet-bone, or little pastern; *y*, coffin; *z*, navicular or nut-bone.

Bones of the Hind Extremity. E. E.

h, *i*, *k*, *l*, *m*, Thigh-bone; *h*, the neck, above which is the head received into the socket of the pelvis; *i*, great trochanter; *k*, the outer trochanter; *l*, *l*, the inner trochanter; *m*, *m*, the anterior condyles; *n*, *n*, the posterior ditto; *p*, *p*, semilunar cartilage; *o*, *o*, knee-pan or patella; *g*, tibia or leg-bone, commonly called the thigh; *r*, fibula; the tibia is seen terminating in its maleoli, to articulate with the tarsus; 1, 2, 3, 4, 5, 6, 7, 8, tarsus or hock; 1, 2, 1, 2, calces, forming the point of hock, in man the heel; 3, 4, astragalus; 5, 5, great cuneiform bone; 6, cuboid bone; 7, middle cuneiform bone; 8, small cuneiform bone; *s*, *s*, *t*, *t*, metatarsus; *s*, *s*, canon or shank; *t*, *t*, two small metatarsals; *u*, pastern; *v*, sesamoids; *w*, coronet-bone or lesser pastern; *x*, *x*, coffin-bone; *y*, navicular or nut-bone.

Of the Teeth.

100 Teeth.

A male horse has 40 teeth, when he has completed his full number. The mare has usually but 36. They are divided into three kinds; the cutting teeth or nippers; the cuspidatæ or tushes, and the molares or grinders. A knowledge of the horse's teeth and of the changes which they undergo, from their first appearance, is of the greatest consequence, as from it we derive the surest marks of the age of the horse; at least, till he is eight or nine years old.

Figs. 2, 3, 4, 5, 6, 7, and 8, shew the appearance of the teeth from their first cutting to the age of eight years.

Fig. 2. shews the appearance of the colt's teeth at the age of three weeks; fig. 3. that of the colt's teeth at three months. Fig. 4. shews the state of the teeth from three months to about four or five years, where *a*, *a*, are the pincers or nippers; *b*, *b*, what are called the separators; *c*, *c*, the corners, or the last of the front teeth at that age; *d*, *d*, the tusks. Fig. 5. shews the appearance of the teeth at the age of five years, and figs. 6, 7, and 8, their appearance at the respective ages of six, seven, and eight years.

101 Means of ascertaining the age of a horse.

The age of a horse is easily known by his mouth, till he comes eight, after which the usual marks wear out. A horse, like many other brute animals, has his teeth divided into three ranks; viz. his fore-teeth which are flat and smooth, his tushes, and his back-teeth. His back-teeth or jaw-teeth are called his grinders, being those by which a horse chews and grinds his provender, and are 24 in number, 12 above and 12 below: they are strong double teeth, with sharp edges; but when a horse grows old they wear much smoother.

The first that grow are his foal-teeth, which begin to appear a few months after he is foaled: they are 12 in number, six above and six below; and are easily distinguished from the teeth that come afterwards by their smallness and whiteness, not unlike the fore-teeth of a man.

When the colt is about two years and a half old he casts the four middlemost of his foal-teeth, viz. two above and two below: but some do not cast any of their foal-teeth till they are near three years old. The new teeth are easily distinguished from the foal-teeth, being much stronger, and always twice their size, and are called the incisors or gatherers, being those by which a horse nips off the grass when he is feeding abroad in the fields, or in the house gathers his hay from the rack. When a horse has got these four teeth complete, he is reckoned three years old.

When he is about three and a half, or in the spring before he is four years old, he casts out four more of his foal-teeth, viz. two above and two below, one on each side the nippers or middle teeth: so that when you look into a horse's mouth, and see the two middle teeth full grown, and none of the foal-teeth except the common teeth remaining, you may conclude he is four that year about April or May. Some indeed are later colts, but that makes little alteration in the mouth.

The tushes appear near the same time with the four last mentioned teeth, sometimes sooner than those, and sometimes not till after a horse is full four years old: they are curved like the tushes of other beasts; only in a young horse, they have a sharp edge all round the top and on both sides, the inside being somewhat grooved and flattish, inclined to a hollowness.

When a horse's tushes do not appear for some time after the foal-teeth are cast and the new ones come in their room, it is generally owing to the foal-teeth having been pulled out before their time by the breeders or other dealers in horses, to make a colt of three years old appear like one of four, that he may be the more saleable; for when any of the foal-teeth have been pulled out, the others soon come in their places; but the tushes having none that go before them, can never make their appearance till their proper time, viz. when a horse is about four or coming four; and, therefore, one of the surest marks to know a four years old horse is by his tushes, which are then very small and sharp on the top and edges.

When a horse comes five, or rather in the spring before he is five, the corner teeth begin to appear, and at first but just equal with the gums, being filled with flesh in the middle. The tushes are also by this time grown to a more distinct size, though not very large; they likewise continue rough and sharp on the top and edges. But the corner teeth are now most to be remarked; they differ from the middle teeth in being more fleshy on the inside, and the gums generally look rawish upon their first shooting out; whereas the others do not appear in this way. The middle teeth arrive at their full growth in less than three weeks; but the corner teeth grow leisurely, and are seldom much above the gums till a horse is full five: they differ also from the other fore-teeth, in this, that they somewhat resemble a shell; and thence are called the shell-teeth, because they environ the flesh in the middle half-way round; and as they grow, the flesh within disappears, leaving a distinct hollowness and openness on the inside. When a horse is full five, these teeth are generally about the thickness of a crown-piece about the gums. From five to five

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and a half they will grow about a quarter of an inch high, or more; and when a horse is full six, they will be near half an inch, and in some large horses a full half-inch, about the gums.

The corner teeth in the upper jaw fall out before those in the under, so that the upper corner teeth are seen before those below; on the contrary, the tushes in the under gums come on before those in the upper.

When a horse is full six years old, the hollowness on the inside begins visibly to fill up, and that which was at first fleshy, grows into a brownish spot, not unlike the eye of a dried garden bean, and continues so till he is seven; with this difference only, that the tooth is more filled up, and the mark or spot becomes faint, and of a lighter colour. At eight, the mark in most horses is quite worn out, though some retain the vestiges of it a long time; and those who have not had a good deal of experience, may sometimes be deceived by taking a horse of nine or ten years old for one of eight. It is at this time only, when a horse is past mark, that one can easily err in knowing the age of a horse; for what practices are used to make a very young horse or colt appear older than he is, by pulling out the foal-teeth before their time, may be discovered by feeling along the edges where the tushes grow, for they may be felt in the gums before the corner teeth are put forth; whereas, if the corner teeth come in some months before the tushes rise in the gums, we may reasonably suspect that the foal-teeth have been pulled out at three years old.

It will, perhaps, be needless to mention the tricks that are used to make a false mark in a horse's mouth, by hollowing the tooth with a graver, and burning a mark with a small hot iron; because those who are acquainted with the true marks, will easily discover the cheat by the size and colour of the teeth, by the roundness and bluntness of the tushes, by the colour of the false marks, which is generally blacker, and more impressed than the true mark, and by many other visible tokens, which denote the advanced age of a horse.

After the horse has passed his eighth year, and sometimes at seven, nothing certain can be known by the mouth. It must, however, be remembered, that some horses have but indifferent mouths when they are young, and soon lose their mark; others have their mouths good for a long time, their teeth being white, even, and regular, till they are 16 years old and upwards, together with many other marks of freshness and vigour; but when a horse comes to be very old, it may be discovered by several indications, the constant attendants of age, viz. his gums wear away insensibly, leaving his teeth long and naked at their roots. The bars of the mouth, which, in a young horse are always fleshy, and form so many distinct ridges, are, in an old horse, lean, dry, and smooth, with little or no rising. The eye-pits in a young horse (except those come of old stallions) are generally filled up with flesh, look plump and smooth; whereas in an old horse, they are sunk and hollow, and make them look ghastly, and with a melancholy aspect. There are also other marks which discover a horse to be very old, viz. gray horses turn very white, and many of them all over flea-bitten, except their joints. This, however, happens sometimes later and sometimes sooner, according to the variety of colour and constitution. Black horses are apt to grow gray over their eye-brows, and very often over a good part of their face, especially those who have a star or blane fringed round with gray when they are young. All horses, when very old, sink more or less in their backs; and some horses, that are naturally long-backed, grow so hollow with age, that it is scarce possible to fit them with a saddle. Of this kind are several Spanish and Barbary horses, and many Danish and Flanders breed. The joints also grow stiff with old age, and their knees and hocks bend so, that they are apt to trip and stumble upon the least descent, though the way be smooth and noways rugged. After which they can be of little use to the owner *.

* *Boardman's Dictionary.*

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Chap. II. *Principal Muscles of the Horse.*

We shall here only enumerate the muscles of the head, neck, and trunk, as being of less importance than those of the extremities. Of these latter we shall give a table, expressing, besides their usual names, their origin, insertion, and uses.

Muscles of the Eyelids and Eye.

Orbicular of the eyelids.
Elevator of the upper eyelid, *a*, *b*, fig. 10.
Elevator of the eye.
Depressor of the eye.
Adductor of the eye.
Abductor of the eye.
Trochlear muscle of the eye.
Obliquus major.
Lesser oblique.
Retractor of the eye.

Muscles of the Mouth and Jaws.

Orbicular, *g*, *i*, fig. 9. *o*, fig. 10.
Buccinator, *r*, fig. 9. *s*, fig. 10.
Elevator of the corner of the mouth, *m*, *n*, fig. 10.
Long nasal of the upper lip, *l*, *m*, *n*, *o*, fig. 9.
Masseter, *p*, *q*, fig. 9.
Ciliares, *u*, *w*, fig. 9.
Temporal, 2, 3, fig. 9.
Canine, 6, 7, fig. 9. *m*, *n*, fig. 10.
Depressor of the lower lip, 9, 10, fig. 9. *p*, *q*, *r*, fig. 10.
Elevator of the chin, 12. fig. 9.
Dilatators of the nostrils, *a b c d*, *g f*, fig. 9.

Muscles of the Neck.

Sterno-mastoid; *a*, *b*, *c*, fig. 9.
Coraco-hyoideus, *f*, *f*, fig. 9. and *a*, *b*, *c*, *d*, *e*, fig. 10.
Sterno-hyoideus; *g*, fig. 9. *f*, *g*, fig. 10.
Sterno-thyroideus; *h*, *i*, *k*, fig. 10.
Transversals; *h*, *i*, fig. 9. A, B, C, D, E, F, G, H, fig. 10.
Trachelo-mastoid; M, O, P, Q, S, fig. 10.
Rectus internus major capitis; *m*, *n*, fig. 9. and *w*, *x*, *y*, fig. 10.
Intertransversales minores colli; *o*, fig. 9.

Long

Long mufcle of the neck; *p*, *q*, fig. 9. X, Y, fig. 10.
Splenius; *r*, *s*, *t*, fig. 9.
Hyothyroidæus; *y*, fig. 9.
Cricothyroidæus; *z*, fig. 9.
Lower conftrictor of the pharynx.
Rectus capitis pofticus major; *t*, *u*, fig. 11.
minor; *x*, *w*, fig. 11.
Superior oblique of the head; *u*, U, fig. 10.
Inferior ditto; W, W, fig. 10.
Intertranfverfales pofteriores colli; L, &c. M, &c. fig. 11.
Intervertebral mufcles.
Multifidæ fpinæ; *c*, *d*, fig. 12.
Spinales cervicis; R, T, U, fig. 11.

Mufcles of the Trunk.

External oblique; I, K, L, M, fig. 9.
Obliquus internus; *s*, *t*, *u*, *w*, *x*, *y*, fig. 10.
Rectus abdominis; *z*, fig. 10.
Tranfverfalis abdominis; *p*, *q*, *r*, fig. 11.
External intercoftals; 1, 2, &c. fig. 11.
Internal, ditto; 3, 4, &c. fig. 11.
Semifpinalis and fpinalis dorfi; *a*, *b*, *c*, *d*, *e*, *f*, fig 11.
Longiffimus dorfi; *g*, *h*, *i*, *k*, fig. 11.
Sacrolumbal; *l*, *m*, *n*, &c. fig. 11.
Elevators of the ribs; *a*, *b*, fig. 12.
Lateral of the tail; *e*, *f*, fig. 12.
Intertranfverfals of the tail; *g*, &c. fig. 12.
Elevator of the tail; *i*, fig. 12.
Depreffor of the tail; *k*, fig. 12.

103 Table of the mufcles of the extremities.

Table of the Mufcles of the Extremities.

1. *Mufcles of the Fore-leg and Foot.*

Name.	*Origin and Infertion.*	*Ufe.*
Trapezius.	From the 4th, 5th, and 6th cervical vertebræ; from the firft 12 or 13 dorfal vertebræ; and from the cervical ligament, into the fpine of the blade-bone.	To raife and draw backwards the blade-bone.
Larger rhomboid. *Rhomboideus major.* *a b*, fig. 9. Triangulaire Vitet.	From the 3d, 4th, 5th, and 6th dorfal vertebræ, below the cartilage of the blade-bone, into the whole length of that cartilage.	To raife the blade-bone, and draw it a little forwards.
Leffer rhomboid. *Levator fcapulæ.*	From the ligament of the neck, at about the 2d vertebra, into the cartilage of the blade-bone.	To draw the blade-bone forward, when the neck is fixed, or *vice verfa.*
Leffer pectoral. *Depreffor fcapulæ.* *c*, *d*, *e*, *f*, fig. 9.	From the lateral part of the breaft-bone, into the upper and fore part of the blade-bone.	To draw the blade-bone downwards.
Triangular.	From the 4th, and 5th vertebræ of the neck, into the upper and fore part of the blade-bone, above the pectoral.	To draw the blade-bone forwards.
Anterior ferrated. *Serratus anticus.* *g*, *h*, *i*, *k*, *l*, *o*, *p*, fig. 9.	From the true ribs, and from the 6th and 7th cervical vertebræ, into the laft cervical vertebra.	To connect the blade-bone with the cheft, and to draw it downwards, and fometimes to affift other mufcles.
Ante-fpinatus. *a*, *b*, *c*, *d*, *e*, *f*, fig. 9.	From the ante-fpinatus foffa, by two tendons, into the two tuberofities of the head of the fhoulder-bone.	To extend the fore-leg and move it forwards.
Poft-fpinatus. *h*, *k*, *l*, *n*, fig. 9.	From a foffa, fo called, into the outer-fide of the fhoulder-bone.	To move the fore-leg outward, and away from its fellow.
Extenfor of the ligament.	From the coracoid procefs of the blade-bone, into the whole of the capfular ligament.	To prevent the ligament from being pinched between the bones.
Latiffimus dorfi. *r*, *s*, *t*, *u*, *w*, fig. 9.	From all the dorfal vertebræ connected with the mufcles of the back, and with the flefhy pannicle, into the inner tuberofity of the fhoulder-bone, below the blade-bone.	To draw the fore-leg backward, and towards the cheft.
Common mufcle. *Levator humeri.*	From the tuberofity of the temporal bone, and from the four firft cervical vertebræ, into the upper and outward part of the arm.	To raife the arm, and when that is fixed, to draw the head and neck downwards.
Subfcapular. *a*, *b*, fig. 11.	From the hollow of the blade-bone, into the inner fide of the fhoulder-bone.	To move the arm towards its fellow.

Larger

Name.	Origin and Insertion.	Use.
Larger pectoral. 1 2 3 4 5 6, fig. 9.	From the side of the breast-bone, and the cartilages of the six last true ribs, into the inner side of the shoulder-bone.	To draw the fore-leg downwards and backwards.
Sterno-brachial.	From the fore part of the breast-bone, into the inner and lower part of the shoulder-bone, and connected by expansion with the radius.	To draw the fore-legs together, and to assist the last in respiration, when the fore-leg is fixed.
Coraco-brachial.	From the coracoid process of the blade-bone into the lower and back part of the shoulder-bone.	To draw the arm forwards and outwards.
Adductor of the shoulder. *Teres major.* *d*, *e*, *f*, fig. 11.	From the upper part of the posterior edge of the blade-bone, into the inside of the shoulder-bone.	When the blade bone is fixed, to draw the fore-leg upwards and inwards, and *vice versa*.
Long abductor of the shoulder. *Teres minor.* *o*, *p*, *q*, fig. 9.	From the posterior edge of the blade-bone into the outer tuberosity of the shoulder-bone.	To draw the shoulder-bone upwards and outwards.
Short abductor of the shoulder.	Below the last muscle, between the last and the subscapula.	To turn the arm.
Anterior radial flexor. *Flexor longus.* *Biceps in human anatomy.* *i*, *k*, *l*, *m*, *n*, fig. 10.	From the tuberosity of the blade-bone, above the glenoid cavity, into the inner tuberosity of the radius.	To bend the arm.
Oblique brachial flexor.	From the neck of the shoulder-bone into the inner tuberosity of the radius.	To turn the fore-arm, and assist the former in bending it.
Fascialis cubiti. *Extensor longus.*	From the posterior edge of the blade-bone into the olecranon, or elbow.	To bind down the muscles, and assist in extending the arm.
Biceps extensor cubiti. N, O, P, fig. 9.	From the whole length of the posterior edge of the blade-bone into the olecranon.	To extend the arm.
Internal brachial. *a*, *b*, *c*, fig. 11.	Below the inner side of the head of the shoulder-bone, into the inner and upper part of the olecranon.	To oppose the oblique flexor.
Intermediate extensor.	From the neck, and some part of the shoulder-bone, into the olecranon.	To assist in extending the arm.
Large extensor of the canon.	From the outer condyle, and tuberosity of the shoulder-bone, into the anterior tuberosity of the canon-bone.	To extend the canon.
Radial extensor of the canon. *a*, *b*, *c*, *d*, fig. 10.	From the side of the radius downwards from the middle, into the small inner metacarpal bone.	To assist the former, and turn the foot outwards.
External flexor of the canon. *l*, *m*, fig. 11.	From the outer condyle of the shoulder-bone, at its back part, into the pisiform, and small outer metacarpal bones.	To bend the canon.
Inner flexor of the canon. *n o p*, fig. 11.	From the inner condyle of the shoulder-bone, into the back part of the canon.	To assist the former.
Flexor of the carpus.	From the inner condyle of the shoulder-bone, at its back part, into the pisiform bone.	To bend the carpus, and extricate the ligament.
Anterior long extensor of the foot.	From the lower and outer head of the shoulder-bone, and upper part of the radius, into the anterior protuberance of the coffin-bone.	To extend the foot.
The lateral extensor of the foot.	From the outer head of the radius, passing over the knee through an annular ligament, into the upper and back part of the bone down to the foot.	To assist the former.
Perforated flexor of the foot.	From the inner condyle of the shoulder-bone passing behind the knee, into the arch of the coffin-bone.	To bend the foot.
Perforating flexor of the foot.	From the olecranon and the shoulder-bone at the back part, into the arch of the coffin-bone.	To assist the former.

2. *Muscles*

2. *Muſcles of the Hind Leg or Foot.*

Name, &c.	*Origin and Inſertion.*	*Uſe.*
Poſterior gluteus. *m, n, o, p,* fig. 9.	From the interior and poſterior angles of the ilium, into the little trochanter of the thigh-bone.	To extend the thigh, and draw it outwards.
Tenſor vaginæ femoris. *Faſcia lata.* *a, b, c, c,* D, *e, f, g, h,* fig. 9.	From the anterior angle of the ilium, into a tendinous expanſion over the thigh.	To ſtretch the faſcia of the thigh, and draw it inwards.
Semimembranoſus. 17, 18, 19. fig. 9.	From the tuberoſity and lower angle of the iſchium, into the fore part of the thigh-bone, and into the tibia.	To draw the thigh outwards.
Biceps flexor cruris. 3, 4, 5—11, fig. 9.	From the tuberoſity of the iſchium, and beginning of the tail, into the inner ſide of the ſpine of the tibia.	To bend the leg, and draw it inwards.
Poſterior flexor of the leg.	Like the former, into the inner condyle of the thigh-bone and upper end of the tibia.	To bend the leg.
The large gluteus. *q,* Q, *r, s, t,* fig. 9.	From the vertebræ of the loins, and from the ſacrum, into the great trochanter of the thigh-bone.	To extend the thigh, and draw it backwards and outwards.
Capſular. *a, b, c,* fig. 12.	Riſes from the brim of the acetabulum, into the outer ſide of the thigh-bone.	To extricate the capſular ligament.
Gracilis. *e, f,* fig. 9. *u, w,* fig. 11.	From the pubis and iſchium, into the faſcia of the thigh and the inner ſide of the head of the tibia.	To make one thigh approach its fellow.
Sartorius. *Adductor longus.* *p, q, r, s, t,* fig. 11. *t, u,* fig. 12.	From the inner edge of the brim of the pelvis, into the inner head of the tibia.	To aſſiſt the former.
Large pſoas.	From the three laſt dorſal, and four firſt lumbar vertebræ, and from the two laſt falſe ribs, into the inner trochanter of the thigh-bone.	To bend the thigh.
Larger internal iliac. *e,* fig. 10.	From the inner ſurface of the ilium, into the leſſer trochanter of the thigh-bone.	To aſſiſt the former.
Leſſer internal iliac.	From the inner ſurface of the ilium, into the leſſer trochanter of the thigh-bone.	To aſſiſt the former.
Pectineus. *s,* fig. 12.	From the ſymphyſis pubis, inſerted below the laſt.	To bend the thigh.
Triceps adductor femoris.	From the inner edge of the pubis, from the anterior branch of the iſchium, and from its tuberoſity, into the back of the thigh-bone, the upper and inner part of the tibia, and the tuberoſity of the thigh-bone.	To draw one thigh towards its fellow.
Vaſtus externus. *n, o, p, r, s, t,* fig. 10.	From the great trochanter, and the outer ſide of the thigh-bone, into the ſide of the knee-pan.	To extend the leg.
Straight muſcle of the leg. *Rutus cruris.* *g, h, i, k.* fig. 10.	From the ilium above the ſocket, and from the upper part of the thigh-bone, into the upper part of the knee-pan.	To extend the leg ſtrongly.
Vaſtus internus. *b, c,* fig. 10.	From the neck, inner tuberoſity, and whole inner part of the thigh-bone, into the inner ſide of the knee-pan.	To aſſiſt the vaſtus externus, and laſt muſcle.
Crural. 1, 2, 3, 4, 5, 6, fig. 11.	From the fore part of the thigh-bone, into the inner ſide of the knee-pan.	Ditto.
External obturator.	From the inner part of the iſchium, into the hollow of the great trochanter.	To roll the thigh-bone.
Square muſcle of the thigh. *Quadratus femoris.*	From the lower part of the tuberoſity of the iſchium, into the thigh-bone below the great trochanter.	Aſſiſts the former.
Gemini. *f, g,* fig. 10.	From the iſchium and pubis, one above the other, inſerted into the thigh with the laſt.	Oppoſe the laſt.

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Name, &c.	*Origin and Insertion.*	*Use.*
Inner obturator. 1, 2, 3, fig. 12.	From the edge of the thyroid hole, into the thigh with the preceding.	To assist the gemini.
Pyriform.	From the sacrum within the pelvis, inserted as the last.	Ditto.
Popliteus. 28, 29, fig. 11.	From the external condyle of the thigh-bone, into the tibia.	To draw the leg inwards.
Tibialis anticus. 14.	From the fore part of the external condyle of the thigh-bone, into both canons by two portions.	To bend the leg strongly.
Gastrocnemius.	From each condyle of the thigh-bone, into the hock.	To extend the canon.
Plantar. 40, fig. 9.	From the upper part of the spine of the tibia, inserted as the former.	
Perforated flexor of the foot.	From the hollow between the condyles of the thigh-bone, into each side of the pastern-bone.	To bend the pastern and foot.
Larger perforating flexor of the foot.	From the back and outer part of the head of the tibia, into the arch of the coffin-bone.	To bend the foot.
Lesser perforating flexor of the foot.	From the back part of the head of the tibia, inserted with the preceding.	To assist the former.
The long extensor of the foot.	From the tendon of the extensor of the canon, in the anterior protuberance of the coffin-bone.	To extend the foot.
Lateral extensor of the foot.	From the outer head of the thigh-bone, and from the head of the fibula, inserted with the last.	Ditto.
Lesser extensor.	From the tendon of the long extensor to the lateral extensor.	To draw the tendons of the long and lateral extensors together.

The four figures to which we have referred also represent the following parts.

The broad ligaments of the eyelids; *s*, *t*, fig. 9.
Alæ narium; *z*, fig. 9.
Angular vein; 14, fig. 9.
Angular artery; 15, fig. 9.
Parotid gland; 26, fig. 9.

In the Neck.

Common jugular vein; 1, fig. 9.
External anterior jugular; 2, fig. 9.
Posterior external jugular; 3, fig. 9.
Part of the carotid artery; 4, fig. 9.
Branches of the cervical arteries and veins; 1, 2, fig. 10.
Thyroid gland; *a*, fig. 11.
Gullet; *i*, fig. 11.
Windpipe; *k*, fig. 11.
Cervical nerves; 2, fig. 11.
Ligament of the neck; 5, fig. 11.; 7, 8, fig. 12.
External carotid artery; 1, fig. 12.

In the Trunk.

Epigastric artery; *w*, fig. 11.
External iliac; *y*, fig. 11.
The diaphragm; *m m*, fig. 12.
Intercostal artery; *p*, fig. 12.

In the Fore Extremity.

Internal plantar vein; *s*, fig. 9.
Coronary ligament of the foot; 13, fig. 9.
Cartilages of the coffin-bone; *r*, *t*, 11.

In the Hind Extremity.

Vena saphæna; 21, fig. 9.
Capsular ligament of the knee; 3, 4, fig. 10.
Sciatic artery; 34, fig. 11.
Gluteal artery; 35, 35, fig. 11.
Crural vein; 38, fig. 11.
Popliteal artery; 39, 52, fig. 11.
——— vein; 53, fig. 11.
Crural nerve; 35, fig. 12.

Chap. III. *Of the Stomach and Bowels.*

104 Structure of the stomach.

In the horse there is but one stomach, which is very small in proportion to his general bulk; and is partly membranous, partly cuticular, and partly muscular. It is situated immediately behind the diaphragm, in the left hypochondrium, and in part of the epigastrium, with its expellent orifice extending across the spine to the right, which is the reason that lying on that side is judged more wholesome than sleeping on the left. It has two surfaces, which may be called its sides, though one is posterior, and the other anterior; and two extremities, a large and a small; the superior surface of which receives the gullet, and is called its *cardiac orifice;* while the former ends in the duodenum, and is termed the *pyloric orifice;* this extremity, when the stomach is distended, is the most posterior of the two: The hollow part situated superiorly, only forms its *lesser curvature*, as the lower portion forms its *great curvature*.

Thus when the stomach is moderately distended, it lies in an obliquely transverse direction, with its great extremity a little forwards, and its two orifices superior

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or, but the *cardiac* the moſt ſo, with the leſſer extremity rather poſterior to the other, and the great curvature inferior. It is evident that the ſituation of the ſtomach muſt vary much with its diſtenſion: the foregoing deſcription anſwers to it when moderately diſtended only; but where it is very much filled, the left extremity will preſs upon the diaphragm, and the right will be carried more poſteriorly. In oxen and ſheep, where the firſt ſtomach is large, it is found, when diſtended, to have its left extremity carried quite into the left iliac region; in which part it is uſually punctured, when they are hoved: but ſuch an idea of the ſtomach of the horſe would prove very erroneous; for this animal has a very ſmall one, and therefore its ſituation can never be ſuch *.

From a diſtended ſtomach preſſing upon the diaphragm, we are at no loſs to underſtand, why breathing is impeded after a full meal, when a horſe appears to labour for breath; for he is forced to uſe the intercoſtal muſcles, and the muſcles of the ſhoulder and fore extremities, to open the cheſt, the poſterior enlargement being prevented from the diaphragm being fixed by the preſſure of the ſtomach; hence we ſee the great impropriety of galloping horſes after watering, to warm it in their bellies, as it is fooliſhly termed. Horſes, when grazing, if they drink, are never obſerved to do this; if it was neceſſary, nature would dictate it to them. How hurtful it is likewiſe to ride hard, after a horſe has been full fed, is equally evinced. The ſtomach has externally a covering from the peritoneum, which adheres cloſely to it, by means of its cellular portion; and which portion is dipping in between the muſcular fibres. Its middle portion is made up of muſcular fibres, which are more numerous in this animal, than in the ruminant; making this kind of ſtomach a medium between the membranous one of ſome animals, and the true muſcular ſtomach of others. The direction of theſe fibres is various; but they may principally be referred to a longitudinal and a tranſverſe order, though neither of them are regularly ſo, and are intermixed with others, whoſe direction is very oblique, and interlaced with each other. The longitudinal plane is the moſt external of the two, and appears a continuation of the external plane of the œſophagus, with ſome original fibres, which ſpread over the leſſer curvature, being carried obliquely round, and likewiſe over the great extremity, forming themſelves into a kind of vertex, whoſe centre is in the middle of that extremity. The inner plane is by much the larger, and is not quite circular, but ſlightly oblique, croſſing the obliquity of the longitudinal plane. This circular plane is very thick and ſtrong round the cardia, or that extremity into which the œſophagus terminates.

105 Reaſons for the horſe's not vomiting.

They are here ſo very thick as to form a true ſphincter; and to this it is in ſome meaſure owing, that a horſe cannot vomit; for when the circular and longitudinal fibres are acting from the pylorus to the cardia, by any irritation that reverſes the uſual motion, producing an effort to vomit, the circular and longitudinal fibres of the cardia being infinitely ſtronger and more numerous, are contracting this orifice (eſpecially the circular), as the others are contracting the other parts; for as the muſcular fibres exiſt equally throughout the ſtomach, by which the motions are effected, it cannot be ſimply from the exiſtence of the circular covering to the firſt portion of his ſtomach, that he cannot vomit; for it is reaſonable to ſuppoſe the fibres act throughout the ſtomach by the common conſent of parts; nor do they of actual neceſſity want an immediate ſtimulus to their ſurfaces; for were this the caſe, the fibres of the œſophagus would not by the preſence of the maſticated bolus be ſtimulated to contract through the cuticular coat, which equally here lies over the fibres; nevertheleſs, the cuticular coat of the ſtomach is probably aſſiſting in this difficulty to regurgitate: it does it by leſſening the liability to nauſea, which ſeldom takes place in the horſe; and as vomiting is only an effort to remove nauſea or its cauſe, ſo nature not having given the diſeaſe, has not provided the means for its removal. As likewiſe vomiting appears to be a reverſing of the periſtaltic motion of the ſtomach; which motion, in its natural ſtate, begins from the cardia, and ends at the pylorus; ſo in this reverſed ſtate, it commences at the pylorus, and ends at the cardia, thus regurgitating its contents; ſo it is very probable that the cuticular covering may leſſen this inverted periſtaltic motion in the upper portion, though it cannot wholly deſtroy it; and hence cannot be the only, or the principal reaſon of the impoſſibility, or rather of the difficulty with which this animal vomits; for inſtances have occurred where it has taken place. A horſe in Suſſex was ſeen to regurgitate a large quantity of grains, and we have heard of one or two other inſtances; but theſe muſt be regarded as very rare occurrences.

It is not, therefore, that the ſtomach of the horſe cannot be irritated to make an attempt to vomit, that no ſuch effect generally takes place; for though it is but very ſeldom that nauſea occurs, and perhaps never in a ſtate of nature, yet it may be excited by means of aconite, hellebore, and ſome other ſubſtances, which have cauſed fruitleſs efforts to vomit. But the true and principal reaſon that a horſe may be ſaid, naturally not to be able to vomit, ariſes, in that nature has wiſely ſo conſtructed the parts, that the very effort to it increaſes the reſiſtance by the very ſtrong ſphincter placed at the mouth of the cardia. Had this reſiſtance not been placed, and every means taken to increaſe the almoſt impoſſibility of vomiting in a horſe, it is evident that from the curtain of the palate ſtopping the opening of the mouth, this action, had it taken place, would have occaſioned ſuffocation. The inner coat of the 106
ſtomach is compoſed of two portions, the one cuticular and the other villous. This ſpecies of cuticular covering to nearly one half of the ſtomach, is peculiar to ſuch animals as appear deſtined to live on grain, as horſes, aſſes, rats, and mice; and this forms a third ſpecies of ſtomach between the true membranous one of graminivorous animals, and the muſcular of the carnivorous tribes, and it may be conſidered in a ſlight degree, as a ſpecies of gizzard, reſembling the ſtructure of thoſe animals, as fowls, who have organs to make up for the want of teeth. For a horſe has not the means of re-maſtication, as in oxen or ſheep, nor does he uſually maſticate his food at firſt ſufficiently to comminute it; for the wants of the conſtitution ſtimulate him to a haſty deglutition of his food, which, if there was not ſome other ſtructure than that common to ſtomachs in general, would not be ſufficiently digeſted: for the food is ſolid, and the ſtomach ſmall; therefore this cuticular coat may be uſeful, as its inſenſibility allows it to preſs in

* *Blaine's Outlines*, vol. ii.

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in a ſmall degree upon the food, and perform a ſlight trituration upon it. This cuticular coat is ſpread over the firſt portion of the ſtomach, taking in all the great extremity, and forming between a third and half of its extent. It is formed into folds at the cardia in the ſame manner as at the internal part of the œſophagus; but as ſoon as it has paſſed this orifice, theſe folds take an irregular direction, but are leſs than thoſe formed on the villous ſurface.

The villous or ſenſible portion of the ſtomach, though it occupies more of the length of the ſtomach, yet perhaps in real extent is little more than half of its ſurface. It unites with or is connected to the cuticular. Its external ſurface is firm, and appears as it were a diſtinct portion, but is only denſe cellular ſubſtance, which has given riſe to the deſcription of four tunics to the ſtomach. The *tunica villoſa* is ſo called from its reſemblance to the pile of velvet; its fine villi are probably the extreme fine ends of veſſels ſecreting the gaſtric juice. The villous coat being much larger in extent than the muſcular, is thrown into folds, which are more conſiderable than thoſe of the cuticular coat. Theſe are largeſt at the portion toward the great extremity, and are irregularly waving: towards the duodenum they become leſs, and when at the pylorus they form a fold that makes a kind of valve to this part of the ſtomach, preventing the return of the food, and its too ſpeedy paſſage out. The folds not only hinder the too ſpeedy paſſage of the food, but by this means apply the gaſtric juice more certainly to all the parts; but the principal end is to increaſe the ſecreting ſurface, which is here more extenſive than thoſe of the human *.

* *Blaine's Outlines.*

107 Bowels.

The remainder of the alimentary canal is continued from the lower orifice of the ſtomach, to the anus, or end of the paſſage, forming a long canal of different dimenſions, called *inteſtines*. They are uſually divided into ſmall and large. In ſome animals they hardly merit this diſtinction, there being but little difference in point of ſize: but in the horſe, the proportion is very different; the ſmall inteſtines being not much larger than the human, but the large of an immenſe bulk. This canal is connected through its whole extent to membranous productions of the peritoneum, eſpecially to thoſe called *meſentery* and *meſocolon*. The whole canal varies in point of length in different ſubjects; but is ſeldom leſs than 24 yards, and often more. The inteſtines are contained within a prolongation of the peritoneum, which ariſes in moſt inſtances from the meſentery: the two folds of this membrane ſeparate and ſurround the inteſtines, forming their external coat. The next coat is muſcular, and formed of two layers of fibres, a longitudinal and a circular; the latter are in greater proportion, and by the contraction of theſe the vermicular motion, called *periſtaltic*, is performed, from the longitudinal fibres ſlightly ſhortening them, and the circular diminiſhing their ſize. Within this muſcular coat there is a quantity of cellular membrane rather more denſe than in ſome other parts; and this uſed to be regarded as a coat, and was called the nervous, but is only a layer of cellular membrane. The third and inner coat of the inteſtines is the villous, which is very vaſcular and ſenſible. There are no conſiderable folds of the inner tunic of the inteſtines, as in the human. In this animal theſe are rendered unneceſſary by the great length of his inteſtines, and the ſlow paſſage of the aliments through them by this length and his poſition.

108 First portion.

The firſt portion of the bowels, which anſwers to the *duodenum* in man, though in the horſe it is nearer 20 inches than 12, is attached to the ſtomach, having its pyloric orifice ending in it; its courſe in the horſe is rather different from that in the human, and by this it acquires a more complete covering from the peritoneum. It hangs looſe and pendulous, being attached to the concave ſurface of the liver, where making a turn, it is fixed to the vertebræ: it then takes the name of *jejunum*. It appears rather larger in circumference than the other ſmall inteſtines, and is remarkable for having the pancreatic and biliary ducts penetrating it, ſometimes entering it obliquely cloſe together, and ſometimes at a diſtance from each other.

109 Jejunum.

The *jejunum* and *ilium* differ very little from the ſame bowels in the human ſpecies.

110 Large inteſtines.

The great inteſtines are very properly ſo called in the horſe; and as they have very little reſemblance to the human large inteſtines, they require a particular deſcription.

111 Cæcum.

The *cæcum* is ſituated in the back part of the belly, and is a very large canal, which is entered abruptly by the ilium. The fore part of this canal projects forward two or three feet, into a ſort of bag of the ſame ſize of the colon; but the back part terminates in what is called a blind end. The cæcum uſually occupies the right ſide of the belly, and appears immediately on opening the peritoneum, with its commencement from the colon and ilium in the right iliac region, extending forwards to the right ſide, with its blind end cloſe to the diaphragm and liver. This termination is not furniſhed, as in ſome animals, with an appendix vermiformis, but terminates by a ſimple blind end. Through the peritoneal covering are ſeen four muſcular longitudinal bands, extending from the extremity along the muſcular coat, and dividing the gut into four longitudinal portions. One or two of theſe are uſually covered with fat, and are not ſo regularly longitudinal as the others. The internal membrane is folded up between the longitudinal bands, and by interſecting them forms numerous cavities called the cells.

On the ſlighteſt inſpection we ſee a great peculiarity in the form of the cæcum of the horſe; and in a more accurate view, are ſtruck with the importance of the ſtructure to this animal, and are led to conſider the cæcum as little leſs than a ſecond ſtomach. This is in fact the caſe; for the food coming in a macerated maſs from the ſmall inteſtines, is mixed in the cæcum, with the bile, and pancreatic juice, and here undergoes a farther change, to which the ſtructure of the cæcum is evidently favourable, as it is fitted to retain the maſs for a conſiderable time within it, and to circulate it through all its parts. It has two blind ends, one forming its baſis, and near this enters the ilium; the other forming its point, and extending up towards the diaphragm. From one part of the baſe the colon commences by a very contracted portion, for the purpoſe of preventing the entrance of the contents of the ilium, till they have paſſed through the cæcum. In many animals the cæcum is a very inconſiderable part; in ſome it has one or more appendicles; in others it is almoſt entirely wanting;

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and in all but the horfe its ufe is obfcure, and apparently not very important; but in the horfe it is certainly little lefs than a fecond ftomach, for its whole ftructure proves, that it is purpofely defigned that all the food taken in fhall be poured into the bafe of this gut, by the contraction of which it fhall be forced towards the apex, and either in its paffage or return fhall be detained in the cells to be in fome way farther acted upon, and to undergo fome change neceffary to the fyftem. Having undergone this change, whatever it is, it is forced into the colon.

112 Colon.

The colon commences fmall from the fide of the bafe of the cæcum; and as the ilium cannot be faid to enter it together with the cæcum, as in fome animals, there is in the horfe no fuch part as the valve of the colon properly fo called. The ilium has, however, a fort of protrufion with its inner membrane, by which in fome meafure it prevents the return of the contents of the cæcum. As the colon paffes, it is farther contracted, and then enlarges into a very long and large canal, which, after having made nearly the whole circumference of the belly, is again flightly contracted. It then again enlarges, paffes again round the belly, and is a third time contracted, juft where it ends in the rectum or ftraight gut. The fmall inteftines reft on the turns of the colon and on the cæcum. The colon is furnifhed with four ligamentous bands in its large portion, but there are only two in the fmall portions; thefe form longitudinal fræna, which are interfected again by internal folds, fo as to form the cells of the colon. It is connected and fupported in its fituation by that portion of the mefentery termed *mefocolon*. This inteftine is very different in the horfe to what it is in moft other animals, in confequence of its variations in fize, being in moft other inftances of one general fize; it is likewife this gut and the cæcum that are the principal feat of the inflammation arifing from violent purging medicines.

113 Rectum.

The *rectum* is the continuation of the colon, and paffes backwards from the lumbar vertebræ to the anus. Its mufcular coat is thicker than that of the other inteftines, and it is thrown internally into cavities by the inner membrane, in fome manner fimilar to the cells of the colon, though lefs; were it not for this, the inteftine might be too conftantly ftimulated to expel its contents, but by this means the fæces are received and retained till they are collected in a confiderable quantity, when they are expelled. The rectum is attached to the fpine and facrum by the peritoneum, is here called meforectum; but the true fold of peritoneum does not inveft its whole portion, but leaves it as it approaches the rectum, which is at this place only covered with the cellular part of it. The mefentery bands of the rectum are very ftrong, and terminate at the anus in a kind of ligamentary expanfion attached to the *os coccygis*.

The *anus* is the termination of the rectum, and is opened by the force of the periftaltic motion and the confent of the parts, and fhut by a mufcular band round the extremity of the gut called the *fphincter*. It is likewife elevated and retracted by two pair of mufcles.

Chap. IV. *Of the Foot.*

In our account of the anatomy of the horfe's foot, it will be neceffary to defcribe only one foot, as thofe belonging to both extremities are fimilar in ftructure.

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114 Bones.

The bones which compofe the foot of the horfe are fix in number, confidering the foot as commencing at the fetlock joint. Of thefe fix bones two are included within the hoof, viz. the coffin-bone, and the navicular-bone; and four are fituated above the hoof, viz. the large paftern-bone, the fmall paftern-bone, and the two fefamoid bones.

We fhall begin from above, with the large paftern-bone, as this contributes to form what is called the large paftern joint.

115 Large paftern bone.

The large paftern-bone, (1, fig. 13, 14, and 15.) is of an oblong cylindrical form, and, as is the cafe with all fuch bones, is fmaller in the middle than at either extremity. It articulates above with the lower head of the canon-bone, and below with the upper head of the fmall paftern-bone. At its upper extremity there are three depreffions, one on each fide, large and fuperficial (*a*, *c*, fig. 13.) to receive the outer and inner convexity of the lower head of the canon-bone, and one in the middle, *b*, for receiving the middle narrow convexity of the fame bone. The fore part of this bone is flightly rounded, and rough towards its upper extremity, as at *d d*, for the firmer attachment of ligaments. Behind, at its back part, it is flatter; and here there is a rough depreffion (C, fig. 14.) alfo for the attachment of a ligament that is deep feated, and is fixed to the two fefamoid bones. At the lower extremity the large paftern-bone is convex on each fide (D, E, fig. 14.) for entering into two concavities of the fmall paftern-bone; and there is a depreffion (*f*, fig. 13.) for the attachment of a tendon. At the lower extremity there is alfo a roughnefs on each fide at *e e*, for the infertion of ligaments. Both extremities are covered with very fmooth elaftic griftle, which is kept conftantly moift by the fynovia or joint oil.

116 Sefamoid bones.

At the upper end of the large paftern-bone, towards the back part, are placed the two fefamoid bones, AA (fig. 14.). Thefe are of an irregular wedge-like form, and are covered with cartilage, articulating both with the canon-bone, and on the back part they are very fmooth to admit of a tendon readily fliding over them. The upper edges of thefe bones on each fide have a rough irregular furface, into which is inferted a ftrong ligament that comes from the upper and back parts of the canon-bone, is faftened feparately to each of the fefamoid bones, from which it proceeds downwards and obliquely forward to be inferted into the tendon of the large extenfor mufcles, (fee *a a a*, fig. 16.) a little below the large paftern-joint. Thefe fefamoid bones are of confiderable ufe in the mechanifm of the large paftern-joint. "In confequence of their forming the back part of the large paftern-joint, and articulating with the lower and pofterior part of the canon, they contribute very effentially, by always receding whenever the foot comes in contact with the ground, to act as a fpring to the animal, and to prevent concuffion. All the weight received by the upper head of the large paftern-bone is conveyed to bones below; but a confiderable portion of the burthen is received by the fefamoid bones. While the animal is at reft, and alfo during motion, thefe bones fuftain part of the weight; and where the paftern bones are long and oblique, the fefamoids often receive fo much of the weight as to put the ligaments violently on the ftretch, and occafion lamenefs *."

* *Coleman on the Horfe's Foot*, vol. ii.

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117 Small paftern bone.

The fmall paftern-bone (2, fig. 13, 14, 15.) is about half the length of the large one, and is as broad as it is long. Befides the two concave depreffions, (*h*, *h*, fig. 13.) mentioned before, there is a ridge between them, *i*, that enters a correfpondent depreffion, *g*, in the lower head of the large paftern-bone. The fmall paftern-bone has at the back and upper part (F, fig. 14.) a fmall projection, for the infertion of a long ligament, that comes from the fefamoid bones. The lower articulating furface is more extenfive than the upper, as it is connected with the upper furface of two confiderable bones, viz. the navicular and coffin-bone. It is of great confequence to underftand the mechanifm of the joints that are formed by this connection, as it is on this part that the principal ftrefs of the animal falls. The union of the fmall paftern-bone with the navicular and coffin-bones, forming what is called the *coffin-joint*, is one of the principal methods provided by nature to prevent concuffion.

118 Navicular bone.

The navicular-bone (3, fig. 13, 14, 15.) is connected above with the back part of the fmall paftern-bone, and the lower edge of this bone is attached by a large ligament to the back part of the coffin-bone. The navicular-bone is flightly concave, to receive the back part of the lower head of the fmall paftern-bone. The upper edge of the navicular-bone behind is rough (*g*, fig. 14.) and thick, for the attachment of the upper ligament; and the lower edge of the navicular-bone receives at the back part a ftrong flat ligament from the coffin-bone, immediately above the infertion of the flexor-tendon. The lower furface of the navicular-bone is covered by cartilage, and has a fmall ridge in its centre, (*l*, fig. 13.) to be received into a correfponding depreffion in the long flexor-tendon. This bone may be confidered as forming two diftinct joints, one of which is compofed by the connection of one part of the bone with the tendon of the flexor-mufcle, and the other is formed by the connection of another furface of the navicular-bone.

The whole weight of the animal, fupported by the fmall paftern-bone, is thrown upon the coffin and navicular bones. Of this weight the coffin-bone receives the greater fhare; but the navicular-bone receives a confiderable portion of it, though this bone does not contribute to prevent concuffion fo much as Mr Freeman has endeavoured to prove. The navicular-bone, when the hoof touches the ground, defcends a little, and thus prevents that concuffion which the horfe's body would have received if this bone had been immoveably fixed; and when the hoof is again raifed from the ground, the elafticity of the parts below the navicular bone lifts up this bone into its former pofition, thus acting as a fpring in facilitating the motion of the animal. As the weight fupported by the navicular-bones of the hind feet is lefs than that fupported by the fame bone of the fore feet, their defcent in the former is lefs than in the latter. The organs connected with the navicular-bones of the hind feet are alfo lefs fubject to difeafe.

119 Coffin-bone.

The coffin-bone (4, fig. 13, 14, 15.) is fo named from its being concealed, or as it were buried within the hoof. It is alfo fometimes called the foot-bone. On its fore part it is rounded, having very nearly the fhape of the external hoof. Its upper furface is flightly hollowed (*m*, *m*, fig. 13.) to receive the lower end of the fmall paftern-bone, with the fore part of which it articulates, as it does behind with the fore edge of the navicular-bone. At the back part the coffin-bone ends in two proceffes on each fide, the upper of which are tipped with cartilage. At the upper part of the front of the coffin-bone there is a fmall protuberance, (*w*, fig. 13.) extending upwards above the joint, and ferving for the infertion of the tendon of the mufcles that extend the foot. Below this the coffin-bone is extremely porous, for the paffage of nerves and blood-veffels; and towards the lower part in particular there are about 13 holes, for the tranfmiffion of confiderable arteries, which go to fupply the fenfible fole. At the heels and quarters the coffin-bone is ftill more porous, and is fupplied with a greater number of arteries, but thefe are proportionally fmaller. The lower furface of the heels of this bone is alfo very porous, where it unites with the fenfible fole, but the reft of lower furface is generally fmooth. There are here two hollow furfaces, which receive two correfponding rounded parts of the fenfible fole. They are unequal, the foremoft being the larger. Into the hollow on the back part, the tendon of the flexor-mufcle is inferted. (A, fig. 16.)

120 Ligaments.

There are feven ligaments belonging to the coffin joint, of which there are three pairs, and one fingle. The firft pair of ligaments take their origin from the heels of the coffin-bone on each fide, and pafs obliquely upwards as high as the middle, to which they are attached, and at which part of the fmall paftern-bone (B, fig. 16.) they are blended with the fibres of the lateral ligaments of the fmall paftern-joint. The fecond pair of ligaments on each fide arife from the edge of the coffin-bone, near the heels, and pafs obliquely forward to be inferted into the middle of the fmall paftern-bone (C, fig. 16.) near the attachment of the extenfor-tendon. The third pair take their origin from the lateral edges of the anterior procefs of the coffin-bone, and are inferted into the edges of the cartilages. The ufe of thefe ligaments is to unite the cartilages more firmly to the coffin-bone. The extenfor-tendon being inferted into the upper edge of the anterior procefs of the coffin-bone, prevents the neceffity of a ligament at this part. The fingle ligament of the coffin-bone is connected with the pofterior and inferior concave furface of the coffin-bone, immediately above the infertion of the flexor-tendon, and alfo with the lower edge of the navicular bone. Befides this ligament there is another attached to the whole of the upper and back part of the navicular-bone, by which means that bone is enabled to fupport a greater fhare of the weight that refts upon it. By means of thefe ligaments this important joint is rendered very ftrong, while by the elafticity of the cartilages, and the conftant fupply of lubricating fluid within the joint, all the motions of the animal are rendered fafe and eafy.

The fmall paftern-joint is alfo well fecured by means of ligaments, and by the fheath of the flexor-tendon. There are alfo ligaments proceeding from the fefamoid bones, which enter the fheath of the flexor-tendon, and are attached to the fmall paftern-joint. (*a*, *a*, *a*, fig. 16.)

" The weight which the fefamoid bones, by means of ligaments fuftain, is very different in different horfes; and bears no proportion to the bulk and weight of the animal. The paftern joints of large horfes deftined for flow motion, are conftructed very differently from thofe of

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of blood horses. Their pastern bones are short, and the joints nearly straight; but thorough-bred horses of light weight have long and very oblique pastern joints; and, as in proportion to the obliquity of the large pastern, or fetlock joint, the canon conveys more of the weight to the sesamoid bones, the ligaments that support the sesamoids are necessarily put into motion, and more on the stretch, as the weight presses down the lower and back part of the canon on the sesamoid bones. Short pastern joints are as much adapted to the frame of heavy horses as longer joints are to that of lighter horses. The ligaments that support the sesamoids above also contribute to assist the flexor muscles and tendons in preserving when at rest, and in motion, the large pastern-joint in its proper place." *

* *Coleman on the Horse's Foot*, vol. ii.

Before we proceed in describing the structure of the foot, it will be proper to shew how the hoof is formed, and how it is connected with the parts within.

121 Structure of the hoof.

The hoof of the horse forms a sort of organized shoe, which is adapted to the foot with the greatest nicety; so that every part of the cavity is completely filled, without the foot's being subjected to any unequal pressure.

A correct knowledge of the natural form and structure of this part of the horse's foot, and of the deformities produced in it by improper treatment, is of the utmost importance; as on this must depend the most advantageous method of shoeing, and the only rational means of correcting the unnatural deviations. It will be obvious, that, in order to form a just idea of the original shape of the hoof, we must examine it before any shoe has been applied to it; for, unless this shoe has been so constructed and fitted to the foot, as to preserve unaltered the original form of the hoof, this will be so changed, that we cannot recognize from it what was the original shape. That the methods of shoeing usually employed are calculated rather to deform the hoof, than to preserve its original figure, will appear presently.

A vertical section of the hoof shows it to be nearly conical; the broadest part of the cone being next the ground. This inferior surface, in a hoof that has not been shod, especially in the fore foot, appears nearly circular; or the diameter, from side to side, is nearly equal to the diameter from toe to heel, (see fig. 17.)

The hoof is composed of a horny substance that is entirely without sensation. It is divided into crust, sole, frog, and bars.

122 Crust.

The crust surrounds the foot on the fore part, and on the sides, like a wall (A, A, fig. 17.) It grows obliquely downwards from the coronet, and becomes broader as it approaches the ground. It is thicker at the toe, than at the quarter; and the outer quarter is thicker than the inner. On the outside it is smooth and rounded, but within hollow and laminated (B B, fig. 15.) to unite with the coffin-bone. The crust is the only part into which nails can with safety be driven in shoeing.

123 Horny sole.

The horny sole (B B, fig. 17.) unites with the lower part of the crust, and is situated below the coffin-bone; but between it and the coffin-bone, there is a vascular substance to be presently described, called the *sensible sole*, from the blood-vessels of which the horny sole is formed. On the outside next the ground, the horny sole is hollow, but rounded within next the coffin-bone. The horny sole protects the sensible sole from injury, and in the horse's motions it embraces the ground, acting as a stop. When the laminated substances of the hoof lengthen, the horny sole descends, and thus assists in preventing concussion.

124 Bars.

The bars, or binders, (C C, fig. 17.) are two horny substances placed between the sole and the frog, and forming at the heels a close solid union with the crust. The small part of the bars called the *toe*, sometimes reaches almost as far as the toe of the frog. Within the frog, the bars are laminated like the inner part of the crust, and are closely united to the horny sole. The bars on the outside keep the horse's foot extended, and within, they tend to prevent the separation of the sensible sole from the horny sole. In the natural state of the hoof, there is a considerable cavity between the bars and the frog on each side.

125 Frog.

The frog (D D, fig. 17.) is that hard rounded protuberance, which we observe in the middle of the lower part of the hoof, pointed towards the toes, and expanded towards the heel like a wedge. In the middle of this broad part, there is a fissure (E, fig. 17.) The external frog is united within the hoof to a narrow substance of a similar shape, but of a more elastic structure, and possessing sensation, and therefore called the sensible frog. This substance is connected above with the navicular bone, towards the back part; and at the extremity of the heels, it is united with cartilages on each side. The toe of the sensible frog is united to the coffin-bone, but by far the greater part is behind this bone. The back part of the frogs being united with elastic and moveable substances, admit of considerable motion, the frog rising when the hoof touches the ground, and descending when the foot is raised. By the ascent of the frog, the heels are prevented from contracting, and the cartilages are expanded, so as to afford the horse a considerable spring, whilst the form of this part fits it for embracing the ground, and thus prevents the horse from slipping. The convex form of the frog clearly shows that it was always intended to touch the ground, and experience has fully proved, that, unless this contact takes place, the healthy state of this organ cannot be preserved. It has been supposed that the frog is intended to defend the principal tendon or back sinew; but Mr Coleman has shown that this is a mistake.

126 Weight of the horse not supported by the sole and frog.

The weight of the horse is chiefly supported by the crust, and not by the sole or frog; for when these parts have been removed, or by being diseased, become soft and fungous, and thus incapable of resistance, it is found that the crust is still competent to bear the whole of the weight. If the sole and frog really supported the weight, it is evident that when these parts are removed or diseased, the foot would slip through the crust.

127 Importance of the frog's receiving pressure.

The union of the sensible frog with the horny frog, and the connection thus formed between the sides of the sensible frog and the lower cartilages, effectually prevents dislocation. When the horny frog touches the ground, both that and the sensible frog ascend; but when by any means the horny frog is prevented from pressing on the ground, its proper functions are suspended. The cartilages partake of the motion of the frog; and, in proportion as this receives pressure, they recede from each other, and allow the sensible frog to ascend between them. But when the cartilages are rendered immoveable by becoming bony, or by contraction of the

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the foot, the sensible frog is much confined in its motion. By this immobility of the cartilages, the horse is deprived of a powerful spring. When the frog does not press on the ground, and consequently the cartilages are deprived of motion, the moisture of the crust evaporates; and hence the quarters and heels of the hoof become contracted much more than the fore part of the crust, and this contraction is increased by the frog not being allowed to rise between the cartilages. Thus, the natural circular shape of the hoof is destroyed by the frog not receiving pressure.

Fig. 18. represents the lower part of a horse's hoof, as it is usually lengthened or contracted by improper shoeing.

128 Sensible sole.

We have not yet described the sensible sole. This is situated between the horny sole and the coffin-bone, and is united to the lower cartilages immediately behind the latter (C C, fig. 15.). Its lower edge is firmly connected with the sensible laminæ, at the lower edge of the coffin-bone; but at the extremity of the heels, the laminæ are continued for about an inch, forming what are called the *sensible bars*. The sensible sole is well supplied with blood-vessels, but when these are emptied, it appears of a ligamentous texture. From the vessels of this part, the horny matter of the horny sole and bars is formed and renewed.

129 Coronary ligament.

The only other part of the foot that we shall describe, is an important ligament, which surrounds the junction of the coffin-bone with the hoof, and is called the *coronary ligament*, (D D, fig. 16.) This ligament is attached at its upper part, to the anterior protuberance of the coffin-bone, and to the lateral cartilages; and extends a little above the coffin joint, being united on its outside to the skin. Below it is united to the sensible laminæ, at their origin. On its outside it is convex, and is received into a correspondent hollow in the crust, called the *coronary ring*. It is ultimately inserted into the heels of the sensible frog. The uses of this ligament are very important. By its union with the sensible laminæ, lateral cartilages, sensible frog, and coffin-bone, it assists the action of all these parts, increasing their strength and connection; and in particular, preserves the proper situation of the cartilages, and prevents their being dislocated, to which they would otherwise be liable, by being separated by the rising of the sensible frog between them, when the horny frog touches the ground.

We have thus described the structure and functions of the foot and hoof, as far as appeared to us to be absolutely necessary for understanding the principles and practice of shoeing. The names, insertions, and uses of the muscles of the foot, have been already concisely given in the table of the muscles of the extremities (see page 437.) The blood-vessels, nerves, and absorbents are well described, and most beautifully figured in Mr Coleman's elegant work on the structure, economy, and diseases of the foot of the horse; to which, and to Mr Freeman's work on the same subject, we refer such of our readers as wish for a complete and accurate account of that curious and important piece of mechanism, the foot of the horse.

We shall conclude this chapter with a summary recapitulation of the more important circumstances that have been mentioned, as we shall immediately apply them in describing the most approved method of shoeing; and they will be the better understood, and the more easily remembered, by being brought together in a comprehensive point of view. It appears then, 130

Recapitulation.

"That the natural form of the hoof of the fore feet of horses, before any art has been employed, approaches to a circle; and,

"That the internal cavity of the hoof, when circular, is completely filled by the sensible parts of the foot.

"That the hoof is composed of horny insensible fibres, that take the names of crust, sole, bars, and frog.

"That the crust is united with the last bone of the foot, by a number of laminated elastic substances.

"That the uses of the laminæ are to support the weight of the animal, and from their elasticity to prevent concussion.

"That the horny sole is externally concave, internally convex, and united by its edge with the inferior part of the crust.

"That the uses of the horny sole are to act as a spring, by descending at the heels; to preserve the sensible sole from pressure, and (with its concavity) to form a convexity of the earth.

"That the external bars are nothing more than a continuation of the crust, forming angles at the heels.

"That the internal bars are a continuation of the laminæ of the crust, attached to the horny sole at the heels within the hoof; and that these insensible laminæ are intimately united with sensible laminated bars, connected with the sensible sole.

"That the use of the external bars, is to preserve the heels expanded; and the use of the internal horny bars, to prevent separation and dislocation of the horny sole from the sensible sole.

"That the external frog is convex, and of an insensible horny elastic nature.

"That the internal sensible frog is of the same form, very highly elastic, and united with two elastic cartilages.

"That the frogs are not made to protect the tendon, as Mr St Bel and other writers have supposed.

"That the use of the frog is to prevent the horse from slipping, by its convexity embracing the ground; and from the elasticity of the sensible and horny frogs they act as a spring to the animal, and keep expanded the heels" *.

* *Coleman on the Horse's Foot*, vol. i.

PART

PART III. OF THE OPERATIONS USUALLY PERFORMED ON DOMESTIC ANIMALS.

Chap. I. *Of Shoeing.*

131 The principles and practice of ſhoeing are uſually explained at the end of treatiſes on the veterinary art, immediately after deſcribing the uſual ſurgical operations. We think it better, however, to treat on the ſubject of ſhoeing in this part of our article, immediately after having deſcribed the anatomy of the horſe's foot; the neceſſity of underſtanding which has been fully explained in the laſt chapter.

132 It is very uncertain at what period mankind firſt began to ſhoe their horſes with iron; but it is probable that this practice commenced as ſoon as they were ſufficiently civilized, to have ſuch roads as were compoſed of ſolid, hard materials, fitted for the purpoſes of conſtant traffic. In many countries where ſuch kind of roads are not required, as in the deſerts of Arabia, and in many eaſtern countries, we know that to this day the horſes are not ſhod; and we have been aſſured, that ſome years ago, when the roads in moſt of the United Provinces of America were not ſo hard as they are at preſent, horſes were ſhod only on the forefeet (D).

We ſhall firſt briefly deſcribe the mode of ſhoeing commonly practiſed by the ſmiths of this country, and ſhall then give a ſhort account of the moſt important improvements that have been made in the art, from the time of Lafoſſe to the preſent method employed at the veterinary college.

In the common mode of ſhoeing, the bars are totally cut away, and the frog is conſiderably pared down, by means of a cutting inſtrument called a *butteris*. The reaſon aſſigned for cutting away the bars, or opening the heels, as it is called, is, that the heels may not contract, and that the ſhoe may not preſs upon the ſole, and occaſion corns. The hoof being thus prepared, the ſhoe is to be applied. The common form of this ſhoe is nearly elliptical, being broader at the fore part, and growing narrower towards the heels, where it is thicker than at the toe. It is convex on its outer ſurface where it is to touch the ground, and concave on its inner part, which is applied next the hoof. It is faſtened to the hoof by means of eight nails, four in each quarter; and the heads of theſe nails are nearly cubical, ſtanding out a little beyond the ſhoe. This ſhoe is commonly applied nearly red-hot, in order, as we ſuppoſe, 133 Common method of ſhoeing.

(D) Attempts have been made to prove that the ancients underſtood the uſe of iron ſhoes, and paſſages have been quoted both from Greek and Roman writers to ſupport this aſſertion. But we think that the learned Beckman has fully demonſtrated the fallacy of this opinion, and has ſhown, that although leathern ſhoes were ſometimes employed on the feet of horſes and other beaſts of burden, the uſe of iron horſe-ſhoes was entirely unknown both to the Greeks and Romans. Indeed, if ſuch ſhoes were in uſe among them, the ancient authors who have treated on horſemanſhip, huſbandry, and the veterinary art, as Xenophon, Julius Pollux, Columella, and Vegetius, could not poſſibly have omitted to notice them. It cannot be ſuppoſed that theſe writers would have been ſilent with reſpect to the ſhoeing of horſes, when they treat ſo particularly of the breeding and rearing of theſe animals, and preſcribe remedies for the accidents and diſeaſes to which they are ſubject.

Beckman is of opinion that iron horſe-ſhoes were uſed in Europe as early as the ninth century, for in the works of the emperor Leo, who lived about that period, they are expreſsly mentioned by the name of σελενια σιδηρα. The emperor alſo ſpeaks of horſe-ſhoe nails by the appellation of καρφια, and mentions that a certain number of pounds of iron ſhould be given out from the imperial ſtores to make σελενια, and other horſe furniture. The antiquity of horſe-ſhoes is alſo confirmed by their being ſpoken of in the writings of Italian, French, and Engliſh authors of the ſame century. " When Boniface marquis of Tuſcany, one of the richeſt princes of his time, went to meet Beatrix, his bride, mother of the well-known Matilda, about the year 1038, his whole train were ſo magnificently decorated, that his horſes were not ſhod with iron, but with ſilver. The nails were even of the ſame metal; and when any of them dropped out, they belonged to thoſe who found them. The marquis ſeems to have imitated Nero; but this anecdote may be only a fiction. It is related by a cotemporary writer, but unfortunately, his account is in verſe; and the author, perhaps, ſenſible of his inability to make his ſubject ſufficiently intereſting by poetical ornaments, availed himſelf of the licence claimed by poets to relate ſomething ſingular and uncommon. However this may be, it is certain that the ſhoes of the horſes muſt have been faſtened on with nails, otherwiſe the author could not have mentioned them.

" Daniel the hiſtorian, ſeems to give us to underſtand, that in the ninth century, horſes were not ſhod always, but only in the time of froſt, and on other particular occaſions. The practice of ſhoeing appears to have been introduced into England by William the Conqueror. We are informed that this ſovereign gave the city of Northampton as a fief, to a certain perſon, in conſideration of his paying a ſtated ſum yearly for the ſhoeing of horſes; and it is believed that Henry de Ferrers, or de Ferriers, who came over with William, and whoſe deſcendants ſtill bear in their arms ſix horſe-ſhoes, received that ſurname, becauſe he was entruſted with the inſpection of the farriers. We may here obſerve, that horſe-ſhoes have been found with other riding furniture, in the graves of ſome of the old Germans and Vandals in the northern countries; but the antiquity of them cannot be aſcertained." *Beckman on Inventions*, vol. ii.

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suppose, to adapt it better, and make it fit closer to the hoof.

134 Defects of the common mode.

The consequences of this method of shoeing must be, 1. That the function of the bars, whatever it may be, (and we have shewn that they are intended to prevent contraction of the feet,) must be destroyed. 2. That cutting away the frog, exposes this part to injury, and is productive of many diseases. 3. That the heels of the shoe being higher than the toe, will prevent the frogs from embracing the ground, for which we have shewn they were naturally intended. 4. That by making the shoe concave at the quarters, and placing the nails near the heels, the growth of the crust in these parts is impeded, and thus the foot is contracted, and its proper shape destroyed. 5. That by fastening the shoe near the insensible frog at the heels, the proper action of the frogs and sole, as a spring to assist the motions of the animal, is destroyed. 6. That by putting on the shoe hot, the moisture of the crusts is dried up, and thus the contraction of the foot is still farther increased; and, 7. That by making the shoes rounded next the ground, the sure footing of the horse is greatly lessened, much to the danger of his rider.

135 Lafosse's method.

The first modern writer who attempted to reform the common mode of shoeing, appears to have been Lafosse. It is true that an exeellent mode of shoeing was recommended about 300 years ago by Cæsar Fiaschi, an Italian writer on horsemanship; but his plan never came into general use, and Lafosse appears to have all the merit of the improvement, as it is more than probable that he had never seen Fiaschi's work. The shoe recommended by Lafosse was what he called the *half-moon shoe*, being nearly semicircular, and reaching little further than to the middle of the foot; the nails being placed round the toe. Lafosse's shoe was never very generally employed in this country, even though the improvement was rendered familiar by Bracken and Bartlet, who, as we have said, translated Lafosse's treatise into English. It has been considered as useful in some cases of diseased feet, and for strong feet which have begun to contract, or appear likely to do so, provided such horses are not employed on very hard, rough roads; but it is by no means applicable to the majority of our horses. Its principal disadvantages appear to be, that the heels wear too fast, and that in running, horses are apt to slip with it.

136 Osmer's method.

Mr William Osmer, whose work on shoeing we have mentioned in N° 65. improved considerably on the shoe of Lafosse. He forbade the frogs and bars to be cut away, except when they were ragged. He however, remarks, that the feet of all horses should be pared according to their length; the crust being made perfectly smooth by paring or rasping. His shoe was everywhere of an equal thickness, rather narrower behind than before, of a flat surface next the ground, and bevilled away from about the middle of its breadth inwards, leaving a flat surface for the crust to rest on.

137 Lord Pembroke's method.

The next improver of shoes was Lord Pembroke, though Mr Blaine most unaccountably places him after Mr Clark. Lord Pembroke's remarks on shoeing are exceedingly ingenious. He observed that the weight of shoes must, in a great measure, depend on the quality and hardness of the iron. If the iron be very good it will not bend, and in this case the shoes cannot possibly be too light; care, however, must be taken, that they be made of a thickness so as not to bend, for bending would tear out the nails, and ruin the hoof. That part of the shoe which is next the horse's heel, must be narrower than anywhere else, that stones may be thereby prevented from getting under it, and sticking there, which otherwise would be the case, because the iron when it advances inwardly beyond the bearing of the foot, makes a cavity, wherein stones being lodged, would remain, and by pressing against the foot, lame the horse. The part of the shoe which the horse walks upon, should be quite flat, and the inside of it likewise; and only just room enough should be left next the foot, to put in a picker, (which ought to be used every time the horse comes into the stable, and often on marches) and also to prevent the shoe's pressing upon the sole. Three, or at most four nails of a side, hold better than a greater number, and keep the hoof in a far better state. He advises that the toe of the horse be cut square and short, and that no nails be placed in that part. By these means narrow heels are prevented, and many good effects produced. His lordship advised the hinder feet to be shod in the same manner as the fore-feet, except in hilly and slippery countries, where the shoes on the hinder feet may be a little turned up behind.

The utmost severity, (says Lord Pembroke), ought be inflicted on all those who clap shoes on hot. This unpardonable laziness of farriers in making feet fit shoes, instead of making shoes fitting feet, dries up the hoofs and utterly destroys them. Frequent removals of shoes are detrimental, and tear the foot, but sometimes they are very necessary. This is an inconvenience which half shoes are liable to (though excellent in several other respects), for the end of the shoe being very short, is apt to get soon into the foot, and consequently then must be moved.

138 Mr Clark's method.

The shoe recommended by Mr Clark did not differ very much from that of Osmer. He does not, however, recommend the hollowing of the surface of the shoe next the foot. Mr Clark recommended that the hoof and frog should not be pared or cut away without necessity, and was much against raising the heels with calkins; to the use of which he preferred that of an ice nail. He, however, admits, that sharp calkins may be necessary in hilly countries.

139 Method of the veterinary college.

The shoe originally used at the veterinary college by the first professor, was very similar to that of Osmer; but when Mr Coleman succeeded to the professorship, he adopted the half-moon shoe introduced by Lafosse. This was, however, soon given up, as experience shewed that it was not adapted to the generality of horses in this country. Within these few years, a method of shoeing has been introduced by Mr Coleman, which appears in most instances preferable to any former method. We shall therefore consider it pretty much at large.

Mr Coleman has laid down two general principles, by which the practice of shoeing for all horses, in every country, must be invariably followed. "So long as nails and iron are employed to protect the hoof, the crust is the part that should receive the nails, and the pressure of the shoe; and the sole of every horse employed for every purpose, is a part that should *not* be in contact with the shoe." These are Mr Coleman's general rules, and to these it must be added, that the frog 140

Operations. frog should, in almost every case, be allowed to come in contact with the ground, where this is practicable, whenever the horse sets down his foot.

Two general circumstances are to be observed in shoeing; the cutting of the hoof, and the application of the shoe. Some parts of the hoof require to be removed, before the shoe can be applied; while others must be carefully preserved. These circumstances are at least of as much consequence as the form of the shoe, but are not in general so fully attended to.

In Mr Coleman's method of shoeing, he first recommends that a part of the horny sole between the whole length of the bars and crust, be pared away with a drawing knife, as the heels of the sole cannot receive the pressure of the shoe, without corns being produced. The sole must therefore be laid hollow, that it may not come in contact with the shoe. This he considers of the greatest consequence. The heels of the shoe must be made to rest on that part of the hoof where the bars unite with the crust. See fig. 19. If the heels have been previously lowered by means of the butteris, there may perhaps not be left sufficient sole to admit of the application of the drawing knife, without penetrating to the sensible sole; so that it is better, first to cut the sole, as it may then be easily determined how far the heels may be lowered, and the toe shortened, with propriety. When the hoof is cut in this way, the sole readily descends when the hoof touches the ground, without being obstructed by the shoe; and stones, or other foreign bodies that have gotten between the shoe and the hoof, are thus readily pushed out. It is found by experience, that the sole never suffers from stones and gravel, when there is sufficient space left between the bars and the crust. The cavity between the sole and shoe should also be left sufficiently wide after the shoe is applied, to admit of the introduction of a large horse-picker, especially between the bars and the crust. If the sole should be naturally concave, a shoe that has a flat surface next the hoof will not touch any part of the sole when applied to the crust; and even should the sole be flat, or rounded in the middle or towards the toe, yet the quarters and heels may generally be made sufficiently hollow by the drawing knife, to avoid pressure on a flat shoe.

141 If it is found that a shoe with its upper surface flat, does not leave a space large enough to admit the picker between it and the sole, it is necessary to make either the sole or the shoe a little hollow. Sometimes the sole appears ragged and in flakes, and of considerable thickness. It is then proper to make the whole of the sole hollow with the drawing knife, before attempting to lower the heels or shorten the toe. When the sole is made hollow, the shoe will rest only on the crust; but if we cannot hollow the sole, we must, to prevent pressure, make the upper surface of the shoe hollow. As the hoof is always growing, and is preserved from friction by the shoe, it is necessary to pare the toe of the crust about once in every month. The more we can remove from the toe of the crust, in hoofs that are not well shaped, the sooner we shall be able to apply a shoe of the proper form and thickness.

142 Bars and frog not to be cut away.

"The bars and frog should never be removed. Where there are ragged and detached parts of the frog, it is better that they should be cut with any small knife, by the groom, than by the farrier; for if the latter is once allowed to touch the frog, the sound parts are generally destroyed. Where the frogs are not large and projecting, and the heels are higher than the frogs, then it is adviseable to lower the heels, which may be done by a rasp, or the butteris; for in every case we are to endeavour to bring the frog in contact with the ground. We should never lose sight of this principle, that the frog must have pressure, or be diseased. If the frog does not touch the ground, it cannot perform its use; and no organ can be preserved in health, that does not perform the functions for which it was made. Nevertheless, where the frog has been disqualified for its functions for a considerable period, and become soft, it must be accustomed to pressure by degrees." *

* *Coleman on the Horse's* vol. i.

143 When it is necessary for the horse to work, though his frog is soft and diseased, it must be gradually accustomed to pressure, by cutting down the hoof about one-tenth of an inch at every fresh shoeing, that the frog may become hard, and equally protuberant with the heels. If the horse be not required to labour, much advantage will be derived from allowing him to stand in the stable without shoes.

144 Shoe to be adapted to the hoof.

The feet of most horses have been deformed by bad management. It will therefore be necessary to use a particular shoe to each particular form of hoof. Any one form employed indiscriminately for all feet, cannot be alike successful for all. It is from not having sufficiently attended to this simple fact, that the shoe recommended by the veterinary college has not been more generally adopted. It is therefore necessary to vary the length, breadth, and thickness of the shoe, according to the form of the hoof to which it is to be applied. If the heels or fore-feet are two inches and a half or more in depth; if the frog be sound and prominent, and the roads dry, the toe of the hoof only requires to be shortened, and afterwards covered by a short shoe, which may be made of the usual thickness at the toe, but must be thinner gradually towards the heel. The proportional thickness of a shoe of this kind for a common saddle-horse, as recommended by Mr Coleman, is three-eighths of an inch at the toe, and one-eighth at the heel. By means of such a shoe the frog is completely brought in contact with the ground; the heels are expanded; and corns, thrushes, and canker are prevented. The horse may continue to wear such a shoe as long as the weather is warm, and the ground dry.

Race-horses, who generally have the heels high, and 145 the crust thicker and stronger than heavy horses, may generally wear short shoes, at least on the fore-feet. But such as have weak legs, bent knees, long pasterns, or low heels, must not wear such a shoe.

146 Changes to be made gradually.

A long shoe is necessary in wet weather, and even in summer, when the heels of the hoofs are low. In winter, when the heels are too high, they should be lowered by means of a rasp, rather than suffered to wear down, by being exposed to the ground with a short shoe; for moisture is very destructive to the hoof; and thus as great a part of it may be removed as is necessary. Besides, when a horse has been accustomed to high-heeled shoes, if he was suddenly made to wear those with thin heels, the frog might be bruised or inflamed, and the muscles and tendons of the leg considerably strained. It is therefore necessary to bring the heels of the shoe to the proper degree of thinness gradually, Operations. dually, obferving that the heels of each fucceeding fhoe be made fomewhat thinner than thofe of the laft. In general, as much as poffible of the horny part of the hoof next the toe is to be removed, and as little iron employed next the heels every time of fhoeing, till the feet be brought as nearly as may be to their natural fhape.

147 In horfes that have been accuftomed to wear fhoes of an equal thicknefs all round, and where the frog is healthy, we may in general apply a fhoe, much thicker at the toe than the heel, by paring down the toe, and taking nothing from the heel; and if a horfe appear to fuffer no inconvenience from a thin-heeled fhoe, during the firft month after it is applied, it may be continued with fafety, and will greatly improve the hoof. In young horfes, however, that have never been fhod, and in horfes juft taken up from grafs, the toe feldom admits of being pared down, and a thin-heeled fhoe cannot be applied at once.

148 In all cafes where the frog does not embrace the ground with a thin fhoe, the heels muft be lowered; and if the horfe has been accuftomed to wear high-heeled fhoes, both the fhoe and the hoof muft be gradually lowered, till the frog can fafely and eafily perform its proper function.

A few horfes require to be fhod in a manner different from that which we have defcribed, but ftill dependant on the fame principles.

149 Weight of fhoes. Different weights of fhoes are required for different horfes. Mr Coleman lays down the following proportions, for horfes of various defcriptions.

150 For a coach-horfe. A moderate-fized coach-horfe will require a weight of fhoes and nails, from eighteen to twenty ounces; an inch wide, and half an inch thick at the toe, and three-fourths of an inch wide, and one-fixth of an inch thick at the heels.

151 A faddle horfe. An ordinary faddle-horfe will require only from 12 to 14 ounces; and the fhoe may be three-fourths of an inch wide at the toe, and half an inch at the heel, and three-eighths of an inch thick on the outfide of the toe, but only one-eighth at the infide of the toe, and at the heel.

152 Coleman's ordinary fhoe. The fhoe moft recommended by Mr Coleman, is concave on its upper furface, where the fole is flat or convex, but it is flat on the reft of the upper furface; but if the fole admits of being hollowed, the whole upper furface may be flat. It is regularly concave on its lower furface next the ground; and it is faftened to the cruft by means of eight nails placed round from the toe backwards, fo as to leave a part of the fhoe about an inch and a half from the heel. Hunting-horfes ufually require an additional nail on each fide, next the quarter. The nail-holes are made with a punch of a wedge-like form, and to correfpond to this the heads of the nails are made conical, fo that as long as any part of the head of the nail remains in the hole, the fhoe cannot eafily come off.

153 For hunters, and fuch horfes as run in fhafts, it is recommended by Mr Coleman to turn up the outer heel; but, as in this way there is often fome inequality of pofition, the outer heel of the foot is to be lowered, while the inner heel of the fhoe is fomewhat thickened. By thefe means cutting is avoided.

In fuch horfes as have weak low heels, Mr Coleman recommends the ufe of the bar-fhoe, as the bar affords a fupport to the frogs, without wearing out the heels. When the bar-fhoe has been employed long enough to admit of the heels growing to the proper fize, the ordinary thin-heeled fhoe may be adopted.

The method recommended by Mr Coleman, as de- 154
fcribed above, has been for fome time followed with confiderable fuccefs by the board of ordnance, whofe horfes, as well as thofe of the Britifh cavalry in general, are now fhod after this manner. The method has, however, met with confiderable oppofition, partly from fuch as do not underftand the principles on which it is founded, and partly from its having been too haftily adopted, in cafes to which, as Mr Coleman himfelf allows, it is not generally applicable.

Fig. 19. and 20. illuftrate Mr Coleman's method of fhoeing.

Fig. 19. reprefents the hoof turned upwards, to fhew the manner in which the fhoe is applied. It may be feen from this figure that the web of the fhoe is hollow; that the heels at *a a* are narrower than the other parts of the fhoe, and that the nails are placed all round from the toe backwards. Fig. 20. fhews that the heels of the fhoe are much thinner than the point, and alfo fhews the manner in which the nails are rivetted or clinched on the outfide of the hoof round the toe and cruft.

The only remaining method of fhoeing that we fhall 155 Mr Morecroft's method.
here mention, is that of the ingenious Mr Morecroft. This gentleman has acquired much celebrity by his invention of *cafting* fhoes, by finking them in dies, by which means horfes may be fitted with any fhoes beft adapted to their hoofs. Mr Morecroft's fhoe differs from Ofmer's, in being concave within for more than half its width. He condemns the ufe of calkins, on the principle that the public roads are now much more folid than when calkins were in general ufe; and, confequently, that inftead of finking them into the ground, they rather tend to raife the heels above it, and thus the frog is prevented from receiving the neceffary preffure. Mr Morecroft, however, allows calkins to heavy draught-horfes, for whom he recommends two on each fhoe; but in lighter horfes of the fame defcription, one on the outfide of each fhoe. The latter is alfo recommended for hunters, but for other riding horfes, he forbids the ufe of calkins. The number of nails in Mr Morecroft's fhoe is ufually eight, but in heavy draught-horfes they are not to be placed on the fides of the fhoe, but all round at equal diftances, leaving a fpace at the heels of about two inches or two inches and a half. In frofty weather, Mr Morecroft recommends nails with a lozenge head, or a double counterfink, terminating in an edge inftead of coming to a point, which greater breadth of furface prevents its being rubbed away fo faft as a point. The thicknefs in the middle gives it ftrength, and the regular taper to the fhank caufes it to apply exactly to the fide of the hole in the fhoe, by which it is equally fupported, and prevented from bending or breaking.

Mr Coleman confidering preffure as neceffary to the 156 Coleman's artificial frog.
healthy action of the frog, has contrived a method of affording this preffure in thofe cafes in which, from difeafed feet, or bad management in fhoeing, it cannot naturally receive it; and where, if the heels were lowered, in order to bring the frog in contact with the ground, there would be danger of ftraining the tendons. Mr Coleman's patent artificial frogs are intended to produce

Operations. duce preffure on the natural frogs, while the horfes are ftanding in the ftable, and thus to give time for the growth of the heels, and to avoid the evils that would arife from lowering thefe too fuddenly, or from allowing the frog to remain elevated above the ground. For the particulars of this ingenious invention, we muft refer to Mr Coleman's pamphlet.

157 Shoes for oxen.

Where oxen are worked in farming bufinefs like horfes, it is generally thought neceffary to defend their hoofs in a fimilar manner by means of iron fhoes. The form and manner of fitting thefe do not appear to be univerfally the fame in all places; nor are we acquainted with the methods ufually practifed. We know that M. St Bel recommended the following methods; either to fhoe the ox with a flat plate of iron, having fix or feven nail-holes on the outer edge, accompanied with a projection of four or five inches of iron at the toe, which paffing the cleft of the foot, is bent over the hoof: or with eight fhoes, one under each nail; otherwife with four, one under each internal nail; or only two, one under the external nail of each fore-foot.

Chap. II. *Of Cafting.*

158 Cafting.

There are feveral tedious and painful operations that we are fometimes obliged to perform, and which it would be difficult, or impoffible to execute, were the animal left at full liberty to refift us. It is, therefore, neceffary to render ourfelves completely mafters of him, by throwing him down on the ground, and in a convenient fituation, fo as not to expofe him or ourfelves to injury. This operation is called *cafting*, and is ufually thus performed.

The firft object is to prepare a thick bed of ftraw or litter, not lefs than eight feet fquare, to prevent the animal from being hurt in the fall. If the ftable be fufficiently large to admit of the bed being made there, it is to be preferred, as, during the operation, to prepare for which cafting is neceffary, the parts operated on will fuffer lefs from expofure to the air in the ftable, than without doors.

But, if there is not room in the ftable, the bed muft be made in the ftable-yard, or rather, if poffible, in fome field or park adjoining.

The animal is now to be brought to one fide of the bed; a ftrong leather ftrap, with a buckle at one end, and having an iron ring fixed to it, at a convenient diftance from the buckle, is to be fixed round the paftern of each of the four legs, in fuch a way, that the rings of the ftraps that are round the fore-feet fhall be directed backwards, and thofe of the ftraps on the hind-feet fhall be oppofite to thefe; while the buckles point outwards, to prevent hurting the animal. A pretty ftrong cord, ten or twelve feet long, is to be faftened to the ring of that ftrap that has been placed on the fore-foot on that fide of the animal which is fartheft from the bed: from this ring it is to pafs through the ring on the hind-foot, on the fame fide, from which it paffes through the ring on the other hind-foot, then through the ring on the other fore-foot, and laftly, through that to which it was firft faftened. The animal being thus fettered, a number of men are to place themfelves befide him, fo that he may be between them and the bed, while others are to ftand on the oppofite fide of the litter. Now, the men that are befide the animal, laying hold of the end of the rope, are to pull gradually with confiderable force, fo as to bring the four feet of the animal as near as poffible together. When this is done, the men on the other fide, ftanding in a row, one at the head of the animal, another at his cheft, a third at his haunches, a fourth at his tail, &c. pull the animal toward them and complete his fall.

It is neceffary to obferve that the men who pull the rope, and thofe who receive the animal on the bed, muft not act at the fame time; as in this cafe the fhock would be fo great and fudden, as probably to occafion fome accident, either to the men or to the animal. It is alfo proper to remark, that the animal muft be caft in fuch a manner, that the part to be operated on may be fully in the view and reach of the operator.

When the animal is once on the bed, his head muft be held down by a man, and it will be proper to cover his eyes. Another affiftant muft ftand by the cord, which for greater fecurity, fhould be faftened with a knot at the firft ring.

There are fome little niceties to be obferved in cafting an animal, according to the operation that is intended to be performed on him; but of thefe we fhall fpeak, when we defcribe the operations themfelves.

Chap. III. *Of Bleeding.*

Bleeding is diftinguifhed into *general* and *local.* 159 Bleeding.
General bleeding is performed for the purpofe of taking away a quantity of blood from the general mafs, and confifts in opening fome large vein, or fome confiderable branch of an artery. The vein ufually opened, in horfes and cattle, is the vein that runs along the neck, and which is called the *jugular vein.* This vein may be eafily felt, as it is generally confiderably raifed above the mufcles.

The vein is ufually opened by means of a fleam, which is forced into the vein, by ftriking it with a fmall wooden mallet, called by farriers a *blood-ftick.* There are many objections to this mode of bleeding. In the firft place, it is extremely clumfy; and, if the vein happens to roll, which is very commonly the cafe, a large wound may be made in the fkin, without drawing blood. Again, thefe animals, efpecially horfes, are eafily frightened by any fudden motion of the hand; and fome perfons have a way of fhaking the blood-ftick before they give the ftroke; and, in doing this, they often ufe more exertion than is neceffary. The animal alarmed at thefe ftrange motions, toffes up his head, and thus renders the ftroke uncertain.

Many prefer the ordinary lancet ufed by furgeons; and, in feveral cafes, particularly of local bleeding, this is the moft convenient inftrument. But in opening the jugular vein, we do not confider it as much fuperior to the common fleam. When this latter is employed, the back of it fhould be made of confiderable thicknefs, as, when it is too narrow, as is commonly the cafe, when the inftrument is ftruck with the ftick, it finks into the channel of the vein, which is often not opened, as the prominent mufcles of the neck receive the ftroke.

For moft purpofes of bleeding, we would recommend the fpring-fleam, as being eafily applied, and much more certain in its effect. 160 Danger of ufing a ligature about the neck.

It is a common practice with grooms and farriers, to tie a rope or other ligature about the neck of the animal, Operations. animal, previous to the bleeding in the jugular vein. They do this from a suppoſition that the vein will thus ſwell the more readily, and that it will be opened with greater certainty. But this ligature is in moſt caſes unneceſſary, and will at ſome times be highly dangerous.

Where exerciſe is not improper before bleeding, it will be ſufficient that the animal be gently trotted previous to the operation, as thus the circulation will be promoted, and the ſuperficial veins will be ſufficiently filled with blood. Where general exerciſe is improper or inadmiſſible, the filling of the vein may eaſily be promoted by briſkly rubbing the neck for ſome time with a wiſp of ſtraw or hay; and juſt before applying the fleam, it will be proper to preſs with one finger upon that part of the vein that is between the ſhoulder and the place where the fleam is applied.

The danger of a ligature will appear both from reaſon and experience. When the ligature is faſtened round the neck, it produces a ſwelling of the vein on each ſide; and thus the circulation being in a great meaſure impeded, and the return of much of the blood from the head prevented, an accumulation of blood takes place in the veſſels of the brain. If the ligature be continued round the neck, which muſt happen when, by want of dexterity of the operator, or by the horſe being frightened, the vein has not been opened at the firſt attempt, the ſtagnation of the blood in the head goes on to an alarming degree, and the horſe not unfrequently falls down in an apoplectic fit. "In ſuch caſes, (ſays Mr Clark), I have obſerved the operator greatly diſconcerted, and deſiſt from any further attempts to draw blood at that time, being prepoſſeſſed with the idea that the horſe was vicious and unruly, although the very treatment the horſe had juſt undergone rendered bleeding at this time the more neceſſary, in order to make a ſpeedy revulſion from the veſſels of the head; therefore a ligature or bandage ought never to be uſed till ſuch time as the opening is made into the vein, and even then it will not be neceſſary at all times, if the horſe can ſtand on his feet, as a moderate preſſure with the finger on the vein will make the blood flow freely; but if the horſe is lying on the ground, a ligature will be neceſſary."

But further, the concuſſion or ſhock the horſe receives from his falling down, in the above ſituation, which will always happen if the ligature is too long continued, may cauſe a blood-veſſel in the head to burſt, and death may be the conſequence.

161 Place where the vein is to be opened.

The place where the vein is to be opened is of ſome conſequence, as, when the opening is made too far from the head, where the vein lies deep among the muſcles, both the vein is not ſo eaſily opened, and the wound is not ſo readily healed. The moſt proper place for opening the jugular vein is about an inch below the joining of the ſmall branches that come from the lower jaw. This is generally about a hand-breadth from the head, but it may be eaſily ſeen by the ſwelling of the vein when preſſure is made on its trunk.

Before opening the vein, it is uſual to wet the hairs that lie above it, and to ſtroke them in the direction of the intended orifice. This is a good practice, as the inſtrument thus paſſes though the ſkin more readily, not having to overcome the reſiſtance of the hair. In mentioning the direction of the orifice, it is worth while to remark, that this ſhould neither be longitudinal nor directly acroſs the vein, but rather oblique; as the flow of blood from an oblique orifice is moſt eaſily ſtopped.

162 The blood to be ſaved.

When the vein is opened, it is highly proper in all caſes to catch the blood in ſome convenient veſſel. It is a very abſurd practice, although it is commonly adopted, to allow the blood to flow at random on the ground or on a dunghill, by which means no preciſe eſtimate can be made of the quantity of blood taken away. This may either be ſo ſmall, as to be of no advantage; or it may be ſo conſiderable as to produce fainting, before the operator thinks of ſtopping the orifice.

For the purpoſe of meaſuring the quantity of blood taken away, Mr White recommends a graduated tin veſſel, capable of containing five quarts; every pint being marked on the inſide of the veſſel, ſo that the quantity of blood that is taken off may be exactly known. The blood ſhould always be preſerved, that we may judge from its appearance of the nature of the diſeaſe, and whether it is proper, or not, to repeat the operation. If the blood continues fluid for a conſiderable time, it ſhows that there is an inflammatory ſtate of the body; and if a jelly-like ſubſtance, of a whitiſh or light buff colour, and rather firm conſiſtence, appears on the ſurface after the blood has cooled, and eſpecially if the ſurface is hollowed, we may be certain that the animal's complaint is of an inflammatory nature, that the bleeding has been proper, and muſt be repeated, if the ſymptoms continue or increaſe; but if the blood coagulates quickly, is uniformly of a dark liver colour, looſe, and eaſily broken, with a conſiderable quantity of water upon its ſurface, it denotes debility, and ſhews that the diſeaſe ariſes from a weakneſs of the ſyſtem; that inſtead of *bleeding*, *tonic* and cordial medicines are to be employed, with every thing that may tend to reſtore the animal's ſtrength *.

163 Securing the orifice.

When a ſufficient quantity of blood has been taken away, it is for the moſt part neceſſary to ſecure the orifice, in order to prevent future accidental bleeding. This is uſually done by thruſting a common pin through the lips of the wound, and twining about it a little horſe hair. As in this way the wound often rankles, and becomes a ſore difficult to heal, which we are diſpoſed to attribute to the braſs pin employed, as often as to any other cauſe; we would recommend a pin of ſilver, or at leaſt of poliſhed ſteel. The pin need not paſs through more than the ſkin, and in ſome caſes when the horſe can conveniently be faſtened to the rack after bleeding, the pin may be entirely diſpenſed with.

As it is often required to bleed on either ſide of the neck, or on both ſides, it is proper that the operator ſhould be able to bleed with either hand. This is indeed not quite ſo neceſſary in bleeding horſes and cattle, as in the human ſubject; but it will be often found very convenient in both.

164 Opening the temporal artery.

In ſome caſes, eſpecially in inflammation of the brain, where a ſudden and copious loſs of blood is required, it becomes neceſſary to open the temporal artery. This is eaſily effected, as the artery is ſituated very ſuperficially, about an inch and a half backwards from the upper and outer corner of the eye. It is moſt conveniently opened with a lancet; and when a ſufficient quantity of blood has been drawn, the flow is in general very eaſily ſtopped by making continued preſſure upon the artery; or, if this ſhould not ſucceed, and a dangerous effuſion of

* *White's Materia Medica.*

Operations. of blood should be apprehended, this may be effectually prevented by completely dividing the artery.

165 Cases requiring bleeding. General bleeding is one of the most efficacious remedies in most of the acute diseases to which horses and cattle are subject. "When a horse appears dull and heavy, (says Mr White), and indifferent about his food, by bleeding we often prevent a fever. If a horse is bled at the commencement of a cold, the complaint generally proves moderate, and of short continuance. In all cases of internal inflammation, or symptomatic fever, bleeding is the most essential remedy, provided the operation be performed at an early period, and the blood drawn in sufficient quantity. In such cases I have often taken away five quarts, and repeated the operation the following day, when it appeared necessary. By bleeding copiously at first, these formidable diseases are crushed at once; while by suffering them to proceed, or become at all violent, which they will do, unless this practice is adopted (or if only a small quantity of blood is drawn) they generally prove fatal; nor will bleeding then be of any service *."

* White's Materia Medica.

166 Cautions. Mr Clark very justly remarks, "that although the cases which may require bleeding are numerous, yet there is one general caution to be observed, viz. never to take away blood but when it is absolutely necessary; as it is a fluid that may be easily taken away, but cannot be so easily replaced; besides, that the practice of bleeding frequently, or at stated times, is exceedingly improper, as it disposes the body to become lax, weak, and plethoric.

"In bleeding, therefore, a due regard must always be had to the constitution, age, strength, &c. of horses, and the state or habit of body they are in at the time.

"It is commonly said that the taking away a little blood from horses, even when they are in health, or when they are in the least indisposed, will do no harm: this in one sense may be allowed to be literally true; but why draw blood from them on every trifling occasion, unless there may be such symptoms attending as may require it? I have observed in many horses who have been very frequently blooded, and which may be easily known, from the cicatrices or marks on the neck veins, that their blood had lost much of its tenacity, together with a considerable portion of its florid and red colour. Butchers who slaughter calves, may find their account in bleeding them frequently, as it renders their flesh white, by taking away the red particles of the blood. But in horses it is quite otherwise; as they are destined for hard labour and active exercises, it impairs their constitutions, subjects them to disease, and hastens a premature old age.

"As the blood of horses, more especially those who are constantly employed in hard labour, or in active exercises, when drawn from a vein, appears of a darkish or deep red colour, even in the highest state of health, it is commonly said to be bad blood, and more so when a thick yellow or buff-coloured crust forms on the surface after it is cold; hence these appearances are said to require repetition of bleeding; for it very unluckily happens, that most of the diseases to which horses are subject are thought to proceed from some impurities or humours, as they are called, in the blood, which require to be drained off by bleeding, and other evacuations *."

* Clark on preventing Diseases in Horses.

167 Topical bleeding. Topical bleeding is useful in several cases, as in inflammatory affections of the feet, which are often relieved by opening the coronary veins, or the vein that encircles the coffin-bone; in inflammation of the eyes, in which blood may be often drawn, from the angular veins, with considerable success; and in affections of the mouth, where it is sometimes useful to draw blood, by scarifying the bars of the mouth, or even, in some urgent cases, by opening the veins of the palate. Topical bleeding is best performed with a lancet.

Almost the only method that is practised for bleeding sheep, or dogs, is to cut off a joint or two of the tail; and this is certainly often productive of good consequences, as the flow of blood is sometimes pretty considerable. Unfortunately, however, we can seldom have recourse to this mode of bleeding more than once or twice, whereas cases often occur in which it is necessary to repeat the bleeding. It is also a cruel method, and we see no reason why the veins in these animals may not be opened like those of horses and cattle. In the sheep, indeed, the thickness of the wool will commonly prevent bleeding in the neck, but the temporal artery and the veins of the foot may be opened without difficulty; and in most dogs we may bleed in the jugular-vein with nearly as much ease, as in the horse or cow.

Chap. IV. *Of making Rowels and Setons.*

Rowels in horses and cattle are much the same as issues in the human body. The operation consists in opening the skin, so as to insert between it and the cellular membrane some foreign body, which is kept there, in order to produce and keep up a suppuration, or running of purulent matter. The operation is usually performed in the following manner. An incision is made through the skin by means of a very sharp pair of scissars, or what appears better, a sharp knife. The finger is then introduced below the skin, so as to separate it from the flesh all round, as far as the finger will reach. A piece of leather, about the size of a crown-piece, and of a circular form, with a hole cut in the middle, is then inserted between the skin and muscles, having been first anointed with some stimulating ointment. A small piece of tow or caddice spread with the same ointment, is put over the hole in the centre of the leather; the skin is laid down over all, and the part is covered with a pledget, also covered with ointment, to keep out the external air. 168 Rowelling described.

The leather is left in this situation for two or three days, during which the parts adjoining the rowel swell, and at the end of the time there appears a discharge of a yellowish matter, which gradually becomes thicker and whiter. In three days at farthest the part must be examined, and the plug removed from the central hole, to allow the matter to flow out. The rowel is now complete, and may be continued as long as shall be found necessary. The action of the rowel is easily explained; the leather introduced excites a degree of inflammation between the skin and the flesh, and no means being taken to check this, it goes on, like most other inflammations of fleshy parts, to suppuration. Thus a discharge is produced from the part, which is found to have considerable effect in checking inflammation of some more important organ near which the rowel

Operations. rowel has been inferted. Thus, in inflammation of the lungs, after copious bleeding, a rowel in the cheft, like a blifter in the human body, is found to have confiderable effect in checking the progrefs of the difeafe.

169 Situations proper for rowels. Rowels may be placed in moft of the flefhy parts of the body; but they are moft commonly inferted in the belly, the breaft, the infide of the thighs, the outfide of the fhoulders, and the hips. They are fometimes placed between the jaw-bones, below the tongue; but this is very improper, as a good fuppuration can feldom be brought on in this place.

It is fometimes found neceffary to make feveral rowels at the fame time; but they fhould always be placed, as nearly as poffible, to the feat of the affection which they are intended to relieve.

Befides dangerous inflammations, rowels are found ferviceable in large fwellings of the hind legs, in obftinate cafes of greafe, and in ftrains of the fhoulder.

170 When improper. Though rowels are thus found extremely ufeful in many cafes, they are, like many other operations performed on brute animals, fometimes made where they are unneceffary or improper. Where there is confiderable debility, the infertion of a rowel would be very injudicious, as it would not fuppurate kindly, and as the difcharge produced would tend ftill farther to increafe the debility. The difcharge in thefe cafes is ufually thin and ichorous; fometimes they are perfectly dry, and not unfrequently a mortification is produced. When a rowel is found to be attended with any of thefe effects, it muft be immediately removed, and the parts muft be fomented with a warm decoction of the chamomile-flowers, and fome ftimulating herbs; or muft be bathed with fpirit of wine or oil of turpentine. If gangrene fhould have come on, it will befides be neceffary to adminifter cordial and ftrengthening remedies.

171 Setons. Setons are inferted through an opening made in two oppofite parts of the fkin, and the extraneous body introduced is a cord.

The opening is made by means of a fharp-pointed inftrument with an eye at the other end for receiving the cord. The fides of the inftrument muft be proportioned to the opening to be made, and the fize of the cord to be inferted.

172 Their ufe. Setons are particularly ufeful for the purpofe of gradually draining off matter from abfceffes or fuppurating tumours, that are either fo deeply feated as not to be eafily opened in any other way, or fo large that the fudden difcharge of matter from them while opened by the knife, would be attended with bad confequences. They are beft employed in large abfceffes of the back withers, and the upper part of the neck behind the ears. Setons are alfo attended with the advantage of draining off the matter without expofing the infide of the abfcefs to the air.

173 Mode of introducing them. The method of inferting the feton for the purpofe of opening an abfcefs is this. When it is found that there is a confiderable accumulation of matter, the needle, furnifhed with a cord of the proper fize, is to be introduced at the higheft part of the tumour, and brought out towards its loweft part, fo that the matter may more eafily drain off. The cord, which muft previoufly be rubbed with ftimulating ointment, is now to be cut from the eye of the needle, and then faftened together at both ends, to prevent its being pulled out; but if the cord fhould not admit of being thus tied, a fmall button of wood may be faftened on each end. It is better, however, if poffible, to tie the ends together, as every time the fore is dreffed, the feton requires to be drawn a little round. When the difcharge appears to be nearly ftopped, except what evidently arifes from the prefence of the cord, this may be gradually removed, by drawing out a fingle thread of it at every dreffing.

In introducing the needle, great care muft be taken to avoid large blood-veffels and nerves; and where there is a danger in encountering thefe, it is better to pafs the needle through a fheath. This may eafily be done, by firft making a fmall opening with a lancet at the upper part of the tumour; and through this introducing the fheath, which is to be pufhed down till it reaches the part at which the needle is intended to come out. The needle in this way will pafs through the fheath without danger of wounding any important nerve or veffel.

Chap. V. *Of Firing.*

THIS operation confifts in applying to the fkin, or other parts of the body, a metallic inftrument heated to a greater or leffer degree of rednefs. The inftrument is called a cautery, and the operation was well known among the ancient furgeons, by the name of the actual cautery. 174 Firing.

The inftruments employed for firing are ufually made of iron, fometimes of copper; but iron is to be preferred. They are of various forms, according to the part to which they are to be applied, and the purpofe for which the operation is to be performed. Thefe will be confidered in defcribing the cafes to which firing is applicable.

The operation is found of ufe on feveral occafions: 175 Its ufes.

1ft, In order to oppofe the progrefs of mortification. With this view a cautery fhaped like a knife, with a blunt edge and a thick back, is to be employed. This form will alfo anfwer for many other cafes. There fhould be feveral inftruments of the fame kind, that when one becomes too cool, another may be ready of the proper degree of heat. The heat of the iron intended for the prefent cafe fhould be that of a cherry-red. In applying the iron, the parts adjoining to the mortified place are to be paffed over with the edge of the inftrument in fucceffive parallel lines, fo as the heat may penetrate to the living parts, and thus produce fuch a degree of healthy action as may enable them to throw off the mortified flough. When the iron has been applied for a fufficient time, which muft be regulated by the nature of the part, and the extent of mortification, the wound is to be covered with a pledget fpread with fome ftimulating ointment.

2d, Firing is employed to brace the fkin, and to ftrengthen the finews. The inftrument above defcribed is ufed on this occafion, but its heat muft be fomewhat greater. The mode of applying it is to pafs the edge lightly and quickly over the fkin, defcribing parallel lines from one end of the part to the other. When one iron has been ufed in this way, a frefh one is to be taken, and made to retrace the lines firft formed, beginning where the laft iron left off; and this is to be repeated as often as appears neceffary, taking care not to deftroy the texture of the fkin. It is recommended by

Operations. by some to apply the hot iron, so as to burn away the hair, for some time previously to firing the skin; as much time is otherwise lost before the proper impression can be made by the iron. After firing a blister is sometimes applied, as this is thought to increase the good effect produced by the iron. When firing is employed on the hind legs, or on any part where the operator would be exposed to danger from the horse's kicking, it is necessary to confine the legs by means of fetters.

3d, This operation has been found useful in spaving, ring-bones, old callous swellings of the back sinews; and in wind-galls. For this purpose the irons are used as already directed. It is the custom with some farriers to apply a blister in these cases before firing, in order to reduce the swelling; as they suppose that firing employed without this precaution would tend to fix the swelling, and render it incurable. There is probably little foundation for such an idea.

4th, Firing is very frequently had recourse to by way of a styptic in stopping or checking profuse bleedings, from accidental wounds, or surgical operations. The iron employed with this view has generally a rounded extremity, except in the operation of docking, where an iron in the form of a ring is generally employed.

5th. Another use of firing is in wounds of the joints, or other circumscribed cavities, where it is employed to promote a kindly circulation, and consequent granulation of healthy flesh. It has been employed in these cases by Mr Coleman, with considerable success.

6th, Firing has been found one of the most effectual remedies in those superficial ulcers that accompany farcy or glanders in the horse; and,

Lastly, The use of the hot iron has been found the only certain means of preventing the dreadful effects arising from the bite of a mad animal, when properly applied after cutting out the bitten part.

Chap. VI. *Of Docking.*

176 Docking first used in England.

The honour of having introduced this most useful and humane practice, belongs, we believe, solely to this country. It appears that it was in use in England, so long ago as the end of the eighth century; for at a council held there, about that time (*concilium Calchutense*, or council of Calchute), there was a canon enacted, expressly forbidding this practice, as indecent and abominable.

It does not appear that this operation is performed among the Arabians, or other eastern nations; or at least, if it be, it is not intended as an ornament to the animal, but either from necessity, when the tail is diseased, or by way of mark, to distinguish some particular horse.

Docking has been practised in Germany for about 300 years; and probably much longer in France. It was certainly unknown to the Italians at the latter end of the fifteenth century; for we are told, that when the army of the emperor Maximilian was in Italy in 1497, the Italians were much surprised to see his cavalry mounted on docked horses.

177 Its absurdity.

It is strange that prejudice and false taste should lead mankind to deprive their horses of a part, which, to the eye of reason and unsophisticated nature, must appear not only an ornament to the animal, but as designed by the Creator as a protection against flies, gnats, and innumerable other winged enemies, which harass them in the summer months. It is true indeed, that in Britain, where the summer heats are in general not so lasting, or so violent, as in the more southern countries of Europe, these insects are not always so troublesome as they are found in those climates. But even here they are sufficiently so, to render the protection of the tail necessary; and when our cavalry are unhappily sent to the continent, the loss of the horses tails proves a very serious obstacle to the success of the troops. More than one instance of this has occurred. At the battle of Dettingen in 1743, great part of the British cavalry were absolutely dismounted, from the death of the horses, occasioned in a great measure by the torment which they experienced from the bite of gad-flies, and other insects; and at the battle of Minden, in the seven years war, the cavalry of the allies were thrown into so much disorder by these petty enemies, that they had nearly lost the battle. Lord Pembroke declares, that he has seen the cavalry horses belonging to our army, sweating, rushing against each other, refusing their food, and absolutely devoured by flies, for want of their tails to brush them off; while those of the horses of the foreign cavalry that had not been deprived of this necessary defence, were cool, tranquil, fed well, and were in good condition. From the inconveniences which our cavalry have suffered from the want of the horses tails, it has been for some years the custom to employ long-tailed horses.

The principal reasons that have been assigned for this absurd practice, are, that a long tail is extremely inconvenient to both horse and rider, when travelling through dirty roads and bushy forests; and that when the tail is of its ordinary length, the animal cannot carry it in that fine, arched, cocked-tail direction, which seems to form one of the chief beauties of the modern racer.

We apprehend that few horses enjoy such an ample length of tail as that of the redoubted Hudibras; of whose horse we read that,

> "His draggling tail hung in the dirt,
> "Which on his rider he would flirt,
> "Still as his tender side he prickt
> "With arm'd heel, or with unarm'd, kickt."

As to the beauty of a cocked-tailed horse, we profess ourselves not competent to judge; but with due deference to the gentlemen of the turf, and the respectable fraternity of jockies, we should humbly conceive (we speak with submission) that a horse with a long tail is a much finer object than one that is perpetually perking and wriggling his tail in the air, and exposing his bare breech to the broad stare of open day.

178 Mode of performing the operation.

Docking is usually performed on horses, by laying the tail upon a block, and chopping off the part by means of a cleaver or hatchet struck with a mallet. Perhaps it would be rather less bungling to perform the operation by means of a knife, and it would not take up much more time. When this is done, the hair must be previously clipped away, that the knife may cut more easily; and previous to making the incision, the skin should be drawn up forcibly towards the rump. The incision may be made by beginning on one side, and cutting round from below upwards, so as to perform the whole

Operations. whole as nearly as poſſible at one ſtroke. When the ſkin and muſcles have been completed divided, the part of the tail is to be cut off at the joining of two of the bones as nearly as poſſible to the edges of the wound, ſtill keeping the ſkin drawn up. When the part has been removed, the fleſh is to be ſeared all round with a hot iron, to ſtop the effuſion of blood. The iron employed in France for this purpoſe is formed like a ring, ſo that it is eaſily applied to the fleſh without injuring the bone. The wound muſt be covered from the air, and the animal muſt live rather low to prevent inflammation.

The practice of nicking, or cutting acroſs the muſcles that draw down the tail, ſo that thoſe which pull it upwards may exert their full power, is ſtill more inhuman and abſurd than that of docking; and as we will contribute nothing towards extending this abominable practice, we ſhall omit the operation altogether.

Chap. VII. *Of Cropping.*

179 Cropping. * Taste and faſhion have introduced another operation, by which the ears of horſes and dogs are changed from their natural ſhape and ſize, to thoſe which are conſidered by their owners as more handſome or agreeable. The ears of the horſe and the dog are ſeldom of ſuch a ſhape or ſize, as to render them inconvenient to the animals, or to unfit them for the purpoſes for which nature has deſigned them. This may, however, ſometimes happen; and there are ſome caſes of wounds or diſeaſes that may render cropping neceſſary: but in performing this operation, it ſhould always be kept in mind, that as no part of the animal is made in vain, no more of the ears ſhould be taken away than what is abſolutely neceſſary. We not unfrequently ſee horſes and dogs cropped cloſe to their head, a practice which is cruel and abſurd, and which is always followed by more or leſs deafneſs, and expoſes the animals to much inconvenience from the weather. In thoſe dogs that are employed in rabbit warrens, or for ſimilar purpoſes, where they are required to enter burrows, cropping is attended with the worſt effects, as the ears of the dog are unavoidably expoſed to the particles of ſand and earth that he bruſhes away in his paſſage through the burrow.

The operation of cropping ſcarcely requires deſcription. In the dog it is uſually performed by means of a pair of ſciſſars, but theſe ſhould be very ſharp. In the horſe, more nicety is required; and a particular inſtrument, called the *cropping iron*, is required, and a ſhape of the ſize of which it is intended the ear ſhall be, is applied to the ear, to mark the line of ſection. After the ear is cut, the ſkin and muſcles recede conſiderably from the griſtly part; but this ſeems of little conſequence, and the wound heals in a few days without any other attention, than confining the animal within doors, and keeping him on a moderate, cooling diet. Horſes ears are ſometimes trimmed, as the grooms call it; that is, they are deprived of the fine ſoft hair that lines the inſide of the cavity. This practice is equally abſurd with cropping, as will appear from the following obſervations of Mr Clark.

180 Abſurdity of trimming horſes ears. "The ears of horſes, as of other animals, (ſays Mr Clarke), are covered on the inſide with a ſhort down, intermixed with long hairs, which line the external cavity of the ear, which ſeems deſigned by nature to prevent harſh ſounds from making too great an impreſſion upon the brain, and likewiſe to prevent the cold air, rain, duſt, flies, &c. from annoying the internal ear. The means commonly uſed to remove this down, &c. is by the ſciſſars, the flame of a candle, or that of a burning torch. Both the latter are cruel and barbarous, and cauſe a deal of pain to the animal, not only from the bliſters that ſometimes riſe on the ears after this manner of ſinging them, but likewiſe from the means that are uſed to make horſes ſtand with patience to undergo the operation, that is a twitch on the noſe; and perhaps, if he is troubleſome to the operator, one put on the ear. It is to be obſerved, that horſes are very much guided or directed by the ſenſe of hearing. This is obvious in thoſe that hear diſtinctly, from the motion of their ears, and the direction they give them to whatever quarter any ſound comes from, the attention they pay to what paſſes around them, or to what is ſpoke to them. Many of them, particularly the fineſt kind, as they only are liable to this kind of treatment, have the ſenſe of hearing conſiderably blunted, if not rendered quite deaf from the above operation.

As this operation is generally firſt performed on young horſes at the time they are breaking, it is the more hurtful; as the uncommon ſounds, as the rattling of carriages, drums, &c. which are entirely new to them, and to which they are then more expoſed on the roads or in ſtreets, muſt make the greater impreſſion on the ſenſe of hearing; and perhaps it may be owing to the above cauſe only, that many horſes are timorous to paſs carriages, and remain ſo ever afterwards.

Another diſadvantage which attends this operation upon the ears of horſes, is, that they will not go on cheerfully when travelling in oppoſition to the wind, more eſpecially if it rains; for as the wind and rain get free acceſs into the ears, they are continually ſhaking their heads and endeavouring to turn from it; and thoſe who are of a more impatient temper, will wheel ſuddenly round, in order to avoid what gives them ſo much uneaſineſs. They are then ſaid to be reſtive; the whip and ſpurs are applied by way of chaſtiſement for a ſuppoſed fault only.

From what has been ſaid, it will be obvious, from the practice of taking away the natural covering from the inſide of the ears, that the internal ear muſt be expoſed to be conſiderably injured, particularly from cold, duſt, &c. which blunts the ſenſe of hearing, and perhaps cauſes deafneſs; for it is obſerved in thoſe horſes who have been much uſed to this treatment, that they loſe that lively, active motion of the ears, and appear dull and inattentive to what paſſes around them, and even to the voice of their keeper *.

* *Clark on Prevention.*

Chap. VIII. *Of Caſtration.*

181 Caſtration. It is found of uſe to deprive the males of ſeveral of the domeſtic animals, eſpecially of horſes and cattle, of the means of propagation, either to render them more mild and tractable, or, in the caſe of cattle, to promote their fattening, and render their fleſh leſs rank. It has been diſputed whether the caſtration of the ſtallion is productive of ſuch advantages as are not counterbalanced by the loſs of ſtrength and ſpirit, which the animals ſuſtain

Operations. sustain by the operation. It is not our intention to discuss this point, and we shall here only describe the usual modes of performing the operation.

182 Mode of castrating. The most prudent mode of castrating an adult or grown horse, appears to be the following. Let him be thrown on some convenient spot, on the off side, and when down, let the off hind leg be drawn towards the neck, by which the scrotum will be fairly exposed. Holding the scrotum firmly, make a cut at once through it, not of too great length, but sufficient to admit the testicle being pressed out; this being done, apply the clams or a pair of nippers on the cord within an inch of the testicle, and hold the clams sufficiently tight to stop the flow of blood, but not to bruise the cord; the stone may then be cut off with a scalpel, or it may be seared off with a burning knife. If it is cut off with a scalpel immediately before the clams let go their hold, sear the end of the cord. Some apply a little powdered resin on it before searing, after which the clams may be loosened. When this is finished, proceed to remove the other in the same manner.

After both are removed, a pledgit of lint, wetted in warmed spirits, may be introduced just within the edges of each wound; but no salt should by any means be introduced, as is the practice of some farriers; nor will any kind of bandage be easily retained, and if any thing of this kind is used, it should be very loosely applied, so as not to irritate.

When this operation is performed on a full grown horse, if he is at all fat, he should be previously bled, and kept rather low; and it will be prudent to choose mild weather for the operation; and the place likewise he is put into after the operation, should be of a moderate temperature.

Sometimes there is a considerable degree of inflammation, and when this happens, it is by no means proper to trot the horse about as is commonly done, but to bleed and purge, and apply a solution of sugar of lead to the parts. It will also be of advantage to insert a seton smeared with blistering ointment into the inside of the thigh.

Some operators separate the epididymis from the testicle and suffer it to remain, by which means they think that a portion of the animal's spirit is retained. A similar custom is said to prevail in France; but the French operators object to it, on the idea that it produces fistulous sores in the part. The fact is, that when any portion of the testicle is suffered to remain, though it cannot secrete semen, yet it has some action going on within, by which it produces some influence both on the mind and form; and as such, the future growth of the animal may perhaps be slightly affected by it, and perhaps his temper too, but the addition to the latter may probably not be a very favourable one *.

* Blaine's Outlines, vol. ii.

183 Time of performing it. Where the operation is to be performed, the best time is probably when the foal is about three months old, though some prefer a much more advanced age, as six, or even 12 months, and more in some cases. In all animals there is, however, the least danger of inflammation while they are young in performing such operations. Besides it is better to cut colts before they have any propensity to hanker after mares, and get bad habits. When the foals are early, and the weather is not too hot, the latter end of May or beginning of June may be a good and proper season.

Some of the Yorkshire breeders, however, think that they find advantage in deferring the operation till the horses are two years old, as they suppose they become the stronger and handsomer for it. And where the operation is performed at one year old, they find that the foals have not recovered the check they sustained by weaning before they experience another in this operation. They experience no greater difference in their recovery at two years old than one. The foals should be kept up some time before the gelding is to be performed. *

* Dickson's Agricult. vol. ii.

The castrating of male lambs is performed at different periods in different districts; but it seems the most proper to be done in the first fortnight in the stronger sort of lambs, and in those of the weaker kind from a fortnight to three weeks, or a month old, according to circumstances. Some, however, advise its being done at a much later period. When done early, there is, however, the least danger of too much inflammation coming on, if the lambs be in a healthy condition. When performed while very young, on tender, delicate lambs, mortification may sometimes be apt to come on and destroy them. †

† Ibid.

Chap. IX. *Of Spaying.*

184 Spaying. Spaying is an operation performed on the females, chiefly on cattle and dogs, to prevent their producing young. It consists in taking away the *ovaries*, or those appendages to the womb in which are formed the rudiments of the young. It is supposed that it is attended with considerable advantage, in cows or heifers, as it greatly promotes their fattening. In bitches, it is generally employed to prevent the unpleasant circumstances that often occur in the time they are in heat.

Spaying is usually performed after the animal has been newly impregnated, as at that time the ovaries are larger than before impregnation, and are of course more easily discovered. In performing the operation, a cut is made through the integuments of the belly, between the haunch-bone and the last ribs, and through this opening the fingers are to be introduced. If the animal has not been impregnated, a roundish hard substance will be felt attached to the loins. This is to be drawn out and cut off, and that on the other side is now to be felt for, drawn out, and cut away. The ovaries, as has been said, will be much more readily found, especially the inmost one, when the animal is impregnated, as the young within the horns of the womb afford a good direction to the finger. It is sometimes necessary, when the animal is not in a state of impregnation, to make an opening on each side of the belly, one for the extraction of each ovary; but when this is found requisite, it will be better to delay the second operation till the animal is in some measure recovered from the first. When the ovaries have been cut away, the openings must be closed by means of a stitch through the integuments of the belly, and must be carefully covered with sticking plaster, to prevent the admission of the external air.

Mr Daniel remarks, that this operation does not always succeed in bitches, unless done by a skilful person, who can be relied upon. If it be ill done, although the bitches can have no puppies, they will notwithstanding go to heat, which defeats the purpose. There is a difference of opinion, whether a bitch should be 185

spayed

Operations.

ſpayed *before* or *after* ſhe has had a litter of whelps; Mr Daniel, however, has tried, and found both periods to anſwer. The beſt time is 14 or 15 days after ſhe has taken the dog, and when the puppies juſt begin to be knotted within her. All the roots of the veins ſhould not be taken away; her ſtrength and ſwiftneſs will be injured by ſo doing. They ſhould be kept low for ſeveral days before the operation is performed, and fed on thin meat for ſome time after *.

* *Daniel's Rural Sports.*

Chap. X. *Of Delivery in Difficult Labours.*

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Delivery.

In general, Nature is all-ſufficient for bringing forth the young of domeſtic animals, and man has little to do, except to take care that the females be not in ſuch a ſituation as may expoſe themſelves or their young to injury. It is proper always to watch a mare, or a cow, that is near the time of bringing forth; and to be at hand, to afford aſſiſtance where neceſſary. Mares do not often require aſſiſtance, as with them, difficult labour is uncommon. Where this does occur, the directions we are about to give for the cow, will in general anſwer for the mare.

Cows, particularly the ſhort-horned ſpecies, often need the aſſiſtance of the accoucheur. The natural preſentation of the calf, is with its head and fore-feet, the noſe between the feet, and the back upwards. Downing enumerates ſeven preternatural poſitions: namely, 1ſt, Reverſe preſentation, or tail firſt. 2d, Fore-feet, no head appearing. 3d. Side-belly upwards, head reverſed over one ſhoulder, legs appearing. 4th, Fore-feet, with head under the briſket. 5th, Head alone, or one fore-leg only with it. 6th, Head and one leg, or head alone. 7th, Calf lying on its back, its four legs folded nearly together, and cloſe up to the cow's back; the head appearing, or doubled back, even with the ribs, on one ſide or other; one hind-leg, perhaps, appearing.

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Directions for delivering cows in croſs poſitions.

The following general rules are given by Mr Lawrence.—Timely aſſiſtance before the cow is exhauſted. Extraction never to be attempted in an improper poſition. Supple the hand and arm with warm water and freſh lard. Examination beſt made, the cow ſtanding, and in the interval of pains. In pulling at the feet, incloſe the claws in the hand, that the horn may not bruiſe the cow. Navel ſtring burſting, and the uſual flux of blood, of no conſequence. Inſtruments to be uſed only in the laſt reſort, and by experienced and ſteady perſons only. The proper hook is of hard iron, four inches long, with a loop for the cord at the ſtraight end.

In a natural poſition, if the cow ſhould want help, the poſition of the calf may be aſcertained after the waters have been ſeen. A cord ought to be in readineſs, to attach to the fore legs of the calf, in order to aſſiſt each natural exertion. The head to be kept clear of obſtruction.

Preternatural poſition. N° 1. as above. No attempt to turn the calf (this poſition being favourable for extraction), but uſe expedition, for fear it be ſuffocated. Preſs the haunches back with the palm of the hand, take hold of the bend of the hough of one leg, pull at it, and reach the foot; both feet may thus be brought forth. N° 2. Reduce the head to its proper ſituation, between the fore-legs, either by hold of the noſe, or the face-bone. A long arm is needful, which muſt be kept to the full extent in the body, that inſtant advantage may be taken of every throe, the fingers being properly fixed. N° 3. Gently move the calf back, and bring the head forth to the legs. N° 4. Puſh the calf back to find the head; pull at the noſe; this requires addreſs, but it is uſeleſs to employ force, until the head be in its proper place. N° 5 and 6. Puſh the calf back againſt the ſhoulders and briſket; the feet will be found folded under the belly; bring the feet forward, one at a time, the hand being gently placed on the bend of the knee. Should the head be too much ſwelled and bruiſed, to be returned, it muſt be ſkinned and amputated. Diſſect in a ſtraight line from the poll to the noſe, force the ſkin back over the firſt joint of the neck, divide the head from the body, puſhing the latter back to obtain hold of the knees. The looſe ſkin muſt be previouſly wrapped over the ragged bone, and an aſſiſtant ſhould have faſt hold, in order to guide it clear of the haunch-bones of the cow; ſhould it hitch there, put back inſtantly. N° 7. If one hind-leg appear, put it back; the calf cannot be brought forth with a hinder and fore-leg together, and the difference between the knee and hough will be immediately diſcovered. The head being doubled back, muſt of courſe be reduced to its proper place. The cow being ſtrong and quiet, the buſineſs may be effected with care and patience; but ſhould the hook be poſitively neceſſary, hold muſt be taken, either in the ſockets of the eyes, cavity of the ears, or in the jaw. The caſe of *dropſy* in the calf will be ſufficiently apparent by its preternatural ſize; uſe the knife carefully, ſhould that be neceſſary, to pierce the belly of the calf. *

* *Lawrence on Horſes,* vol. ii.

188
In preternatural contraction of the paſſage.

There is a very material obſtruction which frequently happens to the calving of cows. It is called a horning of the lye or calf-bed, when the paſſage of it is contracted into a very ſmall circumference, inſomuch, that at the full time of geſtation, it will not admit ſo much as the ſmalleſt hand, and grows ſo ſinewy or horned, as renders it utterly impoſſible for the cow to calve without aſſiſtance, and many cattle have died under this dreadful inconvenience, when it might have been eaſily prevented; but ſo little has been known hitherto of the diſeaſes peculiar to black cattle, that many thouſands have fallen victims to untimely death, that a ſimple remedy or operation might have ſaved.

In the caſe before obſerved, it muſt take a conſiderable length of time, before it is contracted, as it is often found; but no ſuſpicion or dread can reaſonably take place, until near the time when the beaſt has arrived at the end of nine months, her full time of bearing young: when they generally make a regular preparation, or falling of the parts of generation, for a few days, or weeks before calving; but in caſes of this hornedneſs of the calf-bed, it is obſerved that they are backward in making theſe neceſſary alterations, preparatory to the approaching change; and when this is noticed, more than uſual obſervation ought to be taken, for when they do not prepare in a regular manner, they ſeldom have the efforts of nature in due courſe, for the delivery of their burthen.—But when the beaſt is obſerved ſick for calving, and has reached the end of her time, and any dread of this apprehended, there is no danger or impropriety in ſearching with the hand, in order to be ſatisfied, whether that part is open, or grown

Hygeiology grown up, as previoufly defcribed; yet the greateft care is neceffary, that the inquiry be made with judgment, and the hand that is introduced muft be well lathered with foap and water, or greafed with tallow, frefh butter, or fome fuch thing, that will not caufe irritation in the neck of the womb.

Now, if it be found in the ftate defcribed in any degree, and a certainty of the beaft being at its full time, with the common ficknefs and fymptoms for calving, no time fhould be loft until the animal be relieved. The difficulty greatly depends on knowing to what degree it is grown up; it is fometimes fo ftrait as not to admit the end of a finger, but with fome exertion, it may give fo much way as that a fmall knife may be introduced, whofe blade fhould not be above an inch and a half in length, and very fharp, with a hollow on the back part of the point, for the end of the fore-finger to guide the knife when cutting, and to cover the point and edge, when introduced, which muft be covered as much as poffible with the hand. Its handle ought to be fhort, and the fore-finger of the operator fhould always be kept forward on the knife, to prevent any danger that might arife from the edge of it. The horny circle is fometimes fo hard and griftly, that it takes more exertion than may have been expected from the nature of the place; but as foon as it is cut through, the beaft will find a very material difference, and ftrive to void her burden, if poffible, when every exertion of art ought to be ufed for her relief. Many people have fuffered the beaft, fo difordered, to die a miferable death before their eyes, without offering to render her any affiftance, and fome have attempted to take the calf out at the fide of the animal, a practice commonly known by the name of the Cæfarean operation; but the other method is to be preferred, when the obftruction is the refult of hornednefs. But operations of this kind in general fail, from neglecting the attempt until every natural hope is gone, and the patient fo much weakened, as to die under the hands of the perfon who has undertaken the tafk. It is, therefore recommended, that no time be loft in afcertaining the caufe of any delay in calving, and that every exertion be ufed, while the animal has ftrength to undergo the operation, and to fecond the attempt. When the bufinefs is happily over, the wounded parts within muft be taken care of, by providing one pint of rectified fpirit of wine camphorated, to anoint the wound, and any other parts which may have been expofed to the air, bruifed, or over diftended. This may be conveyed up the neck of the womb by a fyringe, fpunge, or linen rag filled with it, and carried thither by a fmall hand, well fomented with fome of the foregoing articles for that purpofe. Let the beaft be kept moderately warm, and in a comfortable fituation, allowing her at all times a plentiful fupply of good, dry, and fweet litter. We have taken the above from Rowlin's Complete Cow-doctor.

PART IV. HYGEIOLOGY; OR, THE MEANS OF PRESERVING THE HEALTH OF DOMESTIC ANIMALS.

189 BEFORE we enter on the confideration of the difeafes, that affect domeftic animals, whofe medical treatment is to form the fubject of the remaining part of this article; it will be proper to lay down fome inftructions for the management of thefe animals in a ftate of health, with a view to that moft important object, the avoiding of the caufes of difeafe. The prefervation of health muft ever be confidered as one of the principal objects of the medical practitioner, and has exercifed the pens of fome of the moft eminent phyficians in all ages. But the confideration of this fubject is ftill more neceffary in the treatment of the inferior animals, than in that of man. In the former the cure of difeafe is rendered much more difficult and precarious, on account of the obfcurity in which the fymptoms are often hid, and the difficulty which we frequently experience in inveftigating the caufes of morbid affections.

190 Habitations. The management of domeftic animals in a ftate of health, chiefly refpects the habitations in which they are placed, when taken from their native fields; their food and drink; cleanlinefs, and exercife.

CHAP. I. *Of Stables, Cow-houfes, and Kennels.*

IN a ftate of nature, all the animals at prefent under our confideration, are conftantly expofed to the open air, and only feek for fhelter from the inclemencies of the weather under woods and thickets. The young of all thefe animals when domefticated, except the dog, are for a long time left in a fimilar ftate, till, for the convenience of their mafters, it is found neceffary to place them in habitations. The ftructure of thefe, that is of ftables, cowhoufes, and kennels, and the method of treating the animals confined in them, is of the utmoft confequence; as on thefe the animals health and comfort muft in a great meafure depend.

1. *Of Stables.*

Stables fhould be built on a dry foil, that is fomewhat elevated; or, at leaft, they muft not be built in a hollow, or in the neighbourhood of boggy or marfhy land. The damp cold air, arifing from moift, low fituations, is extremely prejudicial to the health of all animals, particularly horfes, and, as we fhall fee hereafter, to fheep. It renders them fubject to colds, rheumatifm, and not unfrequently to fever. Stables built in thefe fituations are therefore always dangerous; and more particularly fo, when the animals return to them after having been heated by violent exercife or labour. 191 Should be built on a dry and elevated place.

Stables fhould be roomy in proportion to the number of horfes that it is propofed they fhould contain. Perhaps no ftable fhould be made to hold more than five or fix horfes, as many inconveniences arife from keeping too many of thefe animals in the fame apartment. Not only is the air thereby much more vitiated, but the reft and fleep, fo neceffary to repair the fatigues of the day, are thus prevented or difturbed. Some horfes will not fleep, or even lie down, if not perfectly at their eafe; and hence, in large ftables, that are made to contain a dozen or more horfes, as is often the cafe in livery ftables, 192 Should be roomy.

Hygeiology bles, and ſuch as are attached to large inns, the frequent entrance of grooms, oſtlers, and other perſons with lights, into the ſtable, and even the reſtleſs noiſe of ſome of the horſes, who are more watchful, or have been leſs fatigued than others, muſt be a great diſturbance to theſe latter. Where neceſſity requires a long range of ſtables, it is better to have them divided, by thick partition walls, into ſeparate apartments, each made to contain not more than ſix horſes. The additional expence of this would be trifling, compared to the greater eaſe and comfort of the animals.

It is uſual in large ſtables, for the ſake of keeping more horſes conveniently under the ſame roof, to make them double-headed, as it is termed; that is, to have a range of ſtalls along each wall, with a ſpace between, for perſons to paſs to and fro. Stables of this kind are very improper; the ſpace between the two ranges is often ſo narrow, that when the oppoſite ſtalls are occupied at the ſame time, the horſes can reach each other

193 Double ſtables improper.

with their hind feet, eſpecially when ſtanding, as they often do, at the full length of their halter. Hence, in the conteſts that often ariſe between quarrelſome or mettleſome horſes, very ſevere bruiſes, and even lameneſs, are not unuſually the conſequences of the animals being within each others reach. The danger that threatens paſſengers in theſe narrow ſpaces is alſo not ſmall; we have often trembled, when obliged to paſs between two rows of horſes, kicking and wincing under the currycombs, where the intermediate ſpace did not exceed three or four feet. If double-headed ſtables muſt be uſed, the ſpace between the ranges of ſtalls ſhould be at leaſt eight feet.

194 Roof ſhould not be low.

The roof of ſtables ſhould not be low; for, as the foul and vitiated air, generated by reſpiration and the exhalations of animal bodies, naturally aſcends to the higheſt parts, the horſes, who uſually carry their heads very high, are, when the ceiling of the ſtable is low, fully expoſed to the noxious influence of this vitiated atmoſphere. This is not the place to enlarge on the vitiation that the air undergoes from the action of the animals that are confined in it; this ſubject has been already fully conſidered in the article CHEMISTRY when ſpeaking of *reſpiration*; and, from what has been there delivered, the reader will ſee the neceſſity of pure air to horſes and other animals as well as man, and will be able to judge of the propriety of the above maxim, and ſome others which we ſhall preſently lay down.

The walls of the ſtable ſhould be of ſtone or brick, and by no means of wood; they ſhould alſo be left bare, or at leaſt only covered with plaiſter. The temperature of the air, in buildings of ſtone or brick, is much more equable than in thoſe built of wood, they are not ſo eaſily penetrated by the heat of ſummer, or the cold of winter, and they are alſo attended with another important advantage, that they reſiſt the ſpreading of fire.

195 Stalls.

The ſtalls in which the horſes are to ſtand ſhould be divided from each other by ſtrong wooden partitions, that ſhould riſe ſufficiently high to prevent the horſe from ſtepping over, but not ſo high as to impede the free circulation of air, and admiſſion of light from one ſtall to another. The breadth of each ſtall ſhould be ſuch as will freely admit of the horſe turning himſelf, and ſtretching at his full length when he lies down; but they ſhould not be ſo wide as to allow of his kicking againſt the partition. The floor of the ſtall ſhould have a gentle declivity, from the manger backwards. This allows the urine and water to run eaſily off; it alſo relieves the fore quarters of the horſe, and adds much to the grace of his appearance behind. Too great a ſlope, however, muſt be avoided, as when the declivity is too rapid, all the weight of the horſe is thrown on his hind legs; and, as it is extremely uneaſy for the animal to remain long in this poſition, he is obliged to preſs his body forward, which he cannot accompliſh, without keeping the hind legs always on the ſtretch; the paſtern-joint, from its ſituation, receives the whole additional weight, and the ligament which connects it is invariably ſtrained in all horſes which are kept in this ſort of ſtable for any length of time.

A ſlope of one inch in ſix feet will be ſufficient to anſwer every purpoſe.

This declivity ſhould terminate in a hollow ſpace a few inches from the end of the ſtall, forming a ſort of gutter, extending the whole length of the ſtable, and paſſing out through the wall at each end, where iron bars ſhould be placed, to admit of the water, &c. paſſing out of the ſtable, which is the intention of this gutter, but preventing the intruſion of rats, and other noxious animals.

The floor of ſtables is commonly paved with ſtone, or hard bricks made for that purpoſe. This kind of flooring has the advantage of being more durable than any other; but it is not without its inconveniencies. The ſtones or bricks become ſmooth by wearing, and, when the ſtable is wet, the horſe, eſpecially if he be very friſky, is apt to ſlip, and endanger ſtraining or otherways injuring his limbs. Again, by the pawing, or ſtamping, to which theſe animals are often ſubject, the pavement may be looſened or broken. For theſe reaſons, it would perhaps be better that at leaſt the ſtalls ſhould be floored with ſtrong oaken planks well ſeaſoned, and laid acroſs the ſtall, with their extremities below the partitions, and having their joining edges accurately adapted to each other. A flooring of this kind has the advantage of being more elaſtic, and of preſerving a more equable temperature than pavement; and it is not liable to the inconveniencies which we have mentioned, as attending this latter. A wooden flooring is indeed expenſive, but this is more than counterbalanced by the advantages to the horſe. It is of little conſequence how the reſt of the ſtable is covered; ſome gentlemen floor their ſtables with a ſort of cement, which in courſe of time becomes as hard as ſtone, and has the advantage of being perfectly ſmooth and even. The gutter ſhould of courſe be well paved.

196 Floor.

197 Manger.

The manger for receiving the horſes corn ſhould be about a foot broad, and five or ſix inches deep. The manger is uſually made of wood, and when this is the caſe, the boards compoſing it ſhould be ſo cloſely joined, that the corn cannot get through between them. The front of the manger ſhould riſe about three feet, or a little more, from the ground; ſhould ſlope a little, and ſhould terminate above by a ſtrong rounded border. This, if the manger be made of wood, ſhould be covered with tin plate, or white iron, as horſes are very apt, when without food, or when allowed to remain long in the ſtall, to bite the front of the manger, and thus acquire a very bad habit, which farriers call *cribbiting*. Some chuſe to make the manger of ſtone, which

Hygeiology which has the advantage of wood in being more durable and cleanly, wood acquiring by uſe an unpleaſant ſmell, and being ſoon rotted by the moiſture of the food, which it often receives. The bottom of the manger ſhould ſlope a little forwards.

The manger is ſometimes made to extend the whole length of the ſtable, when it is in general divided into ſeveral cavities, one for each horſe. It is of little conſequence whether it be one continued cavity, or whether there be a ſeparate manger for each ſtall; but the manger ſhould by no means be ſupported on legs, ſo as to make it moveable, as is ſometimes done; as this prevents the litter from being conveniently ſtowed below the manger, and expoſes the horſe or the manger to accidents. It ſhould therefore be firmly fixed at the back to the wall of the ſtable, and to each partition of the ſtall. Sometimes a hollow is made at one end of the manger, or at one end of each diviſion of it, for the purpoſe of holding water. When this is done, there ſhould be a hole in the bottom of this cavity fitted with a plug, to draw off the water when the horſe has done drinking, or when the manger has been waſhed.

In the middle of the front of the manger, in its thick edge, there is uſually fixed an iron ring, turning eaſily in an eye bolt, for the purpoſe of paſſing through the halter, by which the horſe is faſtened. Sometimes, inſtead of this ring, a hole is made through the border of the manger for the halter to paſs through; but as the halter does not ſlip backwards and forwards eaſily through ſuch a hole, and wears very faſt by rubbing againſt the wood, the iron ring is to be preferred. The horſe ſhould always be faſtened in ſuch a way, as that the halter ſhall ſlide backwards and forwards with every motion of the horſe's head; and he ſhould on no account be tied by the halter, as this expoſes him to accidents, by twiſting the halter about his neck or legs.

198 Rack.

The rack ſhould be placed at ſuch a height above the manger, as that the horſe can eaſily reach it, to pull out the hay; it ſhould be very ſtrong and firmly fixed, and ſhould incline a little outwards from the wall of the ſtable. The bars of which it is compoſed, ſhould not be above four or five inches aſunder, that the hay may not fall out and be waſted.

One circumſtance particularly to be attended to in the conſtruction of ſtables is, to preſerve a free circulation of air.

199 Stables ſhould not be too cloſe.

The generality of ſtables are by much too cloſe and warm; not a chink is left for the free admiſſion of air; the door, and windows (if there are any), are made ſo cloſe, as perfectly to exclude the air; or, if this is not the caſe, the crevices are frequently ſtopped with hay, under the idea that the horſes cannot be kept too warm. This is a moſt abſurd and miſtaken notion; and is contradicted both by reaſon and daily experience. When we conſider that horſes in a ſtate of nature, or even in their uſual paſtures, are perpetually expoſed to the open air, and that, under theſe circumſtances, they are more vigorous and active than under the moſt attentive care of their maſters, we muſt be convinced of the impropriety of keeping them for hours together in the foul and heated atmoſphere of the ordinary cloſe ſtables. Whoever enters one of theſe ſtables when the door is firſt opened in the morning, after it has been cloſely ſhut up all night, will be able to judge from his own ſenſations, whether ſuch an atmoſphere can be wholeſome to the animals that breathe it. Beſides the great heat of the ſtable, which, if many horſes have been ſhut up in it all night is nearly intolerable, the air will be found highly impure from the continued reſpiration of ſo many animals, and the ſteams ariſing from the exhalations of their bodies, which have probably ſweated profuſely from having been ſo long confined in an atmoſphere ſo foul and heated. Add to this the impregnation of the air by the effluvia ariſing from the litter, &c; and it is not eaſy to conceive a more unhealthy ſituation for an animal, who, to perform the offices required of him with activity and vigour, ſhould be in the full poſſeſſion of all his ſtrength. Now it may eaſily be ſuppoſed, that ſuch an air as we have deſcribed, cannot be calculated to ſtrengthen the body of the horſes. On the contrary, it muſt be in a high degree weakening and relaxing. In this relaxed ſtate, the horſe is probably taken out immediately into the open air, whatever may be the ſeaſon or weather, and made to enter on his daily taſk. The effect which ſuch a ſudden change muſt have on the conſtitution of the ſtrongeſt horſe, need not be deſcribed. The ſudden action of the cold and probably moiſt air on a body that has been expoſed for ſo many hours to the heated air of the ſtable, muſt be productive of the worſt conſequences to the health and vigour of the animal. Accordingly, fevers, colds, rheumatiſm, aſthma, and a number of other formidable diſeaſes, may be traced to this debilitating ſource.

We ſhould think, that the analogy of nature would have taught men to avoid ſuch abſurdities. We learn from thoſe authors who have written on the natural hiſtory of the horſe, that the Arabians, who live in tents, and are extremely careful in the management of their horſes, allow them to ſtand all day, when not employed, at the door of the tent; and at night bring them within the tent, where they lie down in the ſame apartment with their maſter and family, ſheltered indeed from the dews of the night, but freely expoſed to the circulation of air that muſt conſtantly prevail in theſe temporary dwellings.

200 Mode of ventilation.

To avoid the inconveniences ariſing from confined air, the ſtable ſhould be made high and roomy; the door and windows ſhould not be made too cloſe; and the ſtable ſhould be provided with proper ventilators. Perhaps a good method of preſerving a free circulation of air in the ſtable at all times, would be to carry up a flue diagonally through the wall at each extremity, terminating above in a ſort of chimney; and below, within the ſtable, in an opening ſufficiently wide in any part of the wall that is not immediately within the ſtall.

201 Windows.

The free admiſſion of light into ſtables is nearly of as much conſequence as that of air. It is a very erroneous opinion which is maintained by ſome grooms and ſtable-keepers, that horſes feed beſt in the dark. Theſe animals naturally love the light, and are much more cheerful and ſpirited in ſtables where this is freely admitted, than in the dark and diſmal hovels that we ſometimes find attached to inns and farm houſes. There is one bad conſequence that follows keeping horſes in a dark ſtable, which does not appear to be ſufficiently attended to. By being kept ſo long excluded from the light, the horſes eyes become weak, and unable to ſupport the full glare of open day. The pupils being ſo long

long habituated to an unuſual degree of dilatation, do not readily contract when the animal is brought out into the open air; hence his eyes being offended with the ſtrong light, to which he is ſo little accuſtomed, are perpetually winking and watering; the horſe appears as if half blind, and ſtarts and ſtumbles at almoſt every ſtep.

The ſtable ſhould, therefore, be furniſhed with glazed windows, in number proportioned to the ſize of the building. In general, no ſtables ſhould have fewer than two windows; and they ſhould be placed in ſuch a ſituation, as that the horſes may not receive the rays of light too directly on their eyes. Where the ſtable has only one range of ſtalls, this point can be eaſily effected, and in ſuch ſtables, the windows ſhould always be placed at the back of the horſes. But in double ſtables it is not eaſy to place the windows ſo as not to incommode ſome of the horſes, ſince, on whichever ſide of the ſtable they are made, the horſes on that ſide are expoſed to the full glare of the light; another argument againſt double ſtables. The windows ſhould by all means be ſaſhed; and ſhould be made to draw down from the top, as well as to be thrown up from below. They ſhould not be made too ſmall, and ſhould be carried up as near the ceiling of the ſtable, as is compatible with the ſtrength and ſymmetry of the building. Windows conſtructed in this way not only add much to the appearance of the ſtables and to the comfort of the horſes; but they afford one of the beſt means of promoting a free circulation of freſh air through the ſtable. For by throwing one of them up, and drawing another down, the ventilation becomes nearly as complete as poſſible.

Nothing has aſtoniſhed us more, when viewing the handſome offices attached to ſome of the gentlemen's houſes in this country, than to ſee the deficiency of the ſtables in the article of windows. When viewing them from without, we have congratulated the animals confined in them on the comfort of light and air, which they muſt enjoy from the fine ſaſh-windows, which we ſaw on each ſide of the ſtable door. How great has been our aſtoniſhment on entering the building, to find all gloomy and dark within; and that the fine ſaſh-windows which we thought we had ſeen at a diſtance, were nothing but efforts of the painter to deceive our ſenſes, and to preſent an appearance of what certainly ought to have been a reality!

We muſt be permitted here to draw what we hope will not be conſidered as an invidious compariſon between the Scotch and Engliſh method of lodging their horſes. In England we have rarely ſeen ſuch miſerable hovels as, in many parts of Scotland, are uſed to ſupply the place of ſtables. We have indeed in the former country ſeen the ſtables ſometimes very ſmall, or even conſiſting of a thatched building not very well defended from the weather; but they are for the moſt part tolerably well ventilated, and we believe ſcarcely ever without windows.

201 Lofts above the ſtable improper.

It is a common practice to build ſtables of two ſtories, the upper ſtory forming a loft for the purpoſe of keeping the horſe's hay and corn; and in gentlemen's ſtables, where the building is ſufficiently large, it is uſual to have apartments on the upper ſtory for the grooms and other ſervants employed about the ſtables to ſleep in.

The apartment employed as a hay loft has uſually a vacancy in that part of the flooring which is immediately over the rack, for the purpoſe of more conveniently ſupplying the horſes with hay. This mode of building ſtables has its convenience in an economical point of view, and theſe apartments in the upper ſtory add much to the ſhowy appearance of the building; but there are ſeveral material objections to this conſtruction.

1. The hay and corn being kept immediately over the ſtable, are conſtantly expoſed to the foul and heated air and putrid ſteams riſing up from the ſtalls through the rack, and are thus rendered liable to be heated and mildewed; while the duſt riſing from the ſhaking of the hay into the rack is very prejudicial to the lungs of the horſes. On this account it is much better, where this can be conveniently done, to keep the hay and corn in ſome place diſtinct from the ſtable, and bring from time to time a ſufficient quantity of hay nearly to fill the rack, into which it might be put while the horſe is abroad.

2. Another ſerious objection to having lofts and chambers above the ſtable, is that the building is thus much more expoſed to accidents from fire, owing to the careleſſneſs of the ſervants. And,

3. Theſe apartments above the ſtable render the latter much too cloſe and warm.

Where, from convenience or fancy, a gentleman chooſes to build his ſtables in the manner which we have juſt deſcribed, it will be adviſable to have the flooring above the ſtable made as cloſe as poſſible, and covered with thin bricks or ſtones for the purpoſe of checking the progreſs of fire; and for preſerving the hay and corn as much as may be from the ſteams of the ſtable, a partition wall may be raiſed from the extremity of the flooring immediately over the rack all the way to the roof of the loft, with a door opening over the rack in each ſtall. The entrance to the hay loft or chambers above the ſtable ſhould be without, and by no means, as is generally the caſe, by a trap door and ladder within the ſtable. If, as we frequently ſee in gentlemen's offices, the ſtables are built on each ſide of the coach-houſe, the entrance to the rooms above may be conveniently made by a ſtair from the coach-houſe.

The building of which the ſtable forms a part, ſhould be as much as poſſible detached from other buildings, ſo as to admit of a free circulation of air all around.

202 Stable ſhould be apart from the dung-hill.

It is a vile practice which is common on many farms and in ſome inns, to have the dung-hill or midden, cloſe to the ſtable. This nuiſance ſhould be removed as far as poſſible from the door and windows of the ſtable, as the heat and noiſome vapours ariſing from the fermenting dung impregnate the air to a conſiderable extent.

203 Neceſſity of cleanlineſs.

It is of great conſequence that the ſtable be kept ſweeped and clean. It ſhould therefore be regularly ſwept every morning, and every part of the litter that is wet and dirty ſhould be removed to the dunghill, while what is clean and dry ſhould be put up cloſe below the manger, unleſs where the horſe is lame, or has any affection of the feet or limbs, which renders it neceſſary for him to ſtand upon ſoft litter. Where the horſe is perfectly healthy, no litter ſhould be allowed in the day time, much leſs ſhould the ſtall be crammed with litter, as is often done, and is ſuffered to remain in this ſituation for many days, for the purpoſe of increaſing the quantity of manure. Nothing injures the

Hygeiology feet of horfes more, or more frequently produces foftnefs of the hoof, canker, and greafy heels, than allowing them to ftand night and day on hot, fermenting dung. It is alfo impoffible for the horfe to lie down in comfort in fuch a hot-bed; and if the poor animal is obliged to recline himfelf for a time, he is foon compelled to rife again, and repeatedly making the fame attempt at reft, and finding it impracticable, he is forced at length to ftand altogether, perhaps fhifting his legs from one part of the ftall to another, to avoid the heat of the dung.

Lord Pembroke is of opinion that after working, and at night of courfe, as alfo in lameneffes and fickneffes, it is good for horfes to ftand on litter; it alfo promotes ftaling, &c. At other times it is a bad cuftom; the conftant ufe of it heats and makes the feet tender, and caufes fwelled legs. Moreover it renders the animal delicate. Swelled legs may frequently be reduced to their proper natural fize, by taking away the litter only, which, in fome ftables, where ignorant grooms and farriers govern would be a great faving of phyfic and bleeding, befides ftraw. "I have feen, (fays he), by repeated experiments, legs fwell and unfwell, by leaving litter, or taking it away, like mercury in a weather-glafs."

204 Clothing. It is a very common practice to keep horfes, while in the ftable, covered up with warm cloathing. This is in fome cafes neceffary, efpecially when they are under a courfe of phyfic, or are otherwife fo delicate, as that they would be liable to injury from too much expofure to the air. But its indifcriminate ufe is highly improper, as it tends to render the horfe too delicate, and expofes him to the danger of catching cold whenever he goes out into the air. While a horfe is in complete health, and ftands idle, he requires very little, if any covering, unlefs the ftable be extremely cold, or ill fheltered. When indeed he comes into the ftable, much heated by violent exercife or hard labour, it may be proper to throw over him a fingle cloth, that he may cool gradually. Some grooms think it neceffary, befides enveloping the horfe with body clothes, to gird them faft round his belly with tight rollers; and this is done with the view of taking up the horfe's belly, as they term it. The practice is exceedingly abfurd, for thefe tight rollers impede the circulation in the fuperficial veins, produce difficult breathing, and if they be applied, as is often the cafe, after eating, they greatly obftruct digeftion.

To finifh the fubject of ftable economy, we have only to make a few remarks on currying, or dreffing horfes.

205 Dreffing. Friction employed on the horfe's fkin is not only neceffary to keep him clean, and to promote the infenfible perfpiration, by freeing the fkin and hair from impurities, but it is exceedingly ufeful when confidered as a kind of exercife. It promotes the free circulation of the blood, which is much impeded by the horfe ftanding long idle in the ftable; and it much improves the appearance of the horfe's coat. Horfes fhould therefore be regularly dreffed, at leaft twice a-day.

There are, however, fome cafes in which general friction ought not to be employed; fuch are cafes of internal inflammation, efpecially of the bowels; or when there is a difcharge of fharp ichorous matter from any part, efpecially the legs and heels. In thefe cafes the affected parts fhould not be rubbed, as it would tend to increafe the pain and diftrefs arifing from the inflammation. Hygeiology

2. *Of Cow-houfes, or Byres.*

After what we have faid on the conftruction of ftables, we need not here enlarge on that of cow-houfes or cattle byres, as thefe buildings, fo far at leaft as refpects their outfides, are conftructed on fimilar principles. We fhall take occafion, when treating on the manner of feeding cattle, to defcribe a byre that appears to us to afford a good model for buildings of this kind. 206 Cow-houfes, or byres.

It is of material importance in the wintering of young ftock, to keep them more warm, and fheltered from wet, than is ufually done, as by this means they thrive fafter, with a lefs confumption of food, than in the contrary circumftances. This may be effected, either by tying them up in ftalls, in houfes for the purpofe, or by keeping them in good fheds in well inclofed yards.

The queftion of feeding the cattle tied up, or loofe in the yards, in winter, has not been yet decided. Each method has probably advantages. In the firft, the cattle thrive better than when left at liberty to run about the yards. Mr Marfhall found that in Yorkfhire, cattle kept tied up, and regularly fed with ftraw in a moderate proportion, did better than in the fouthern parts of the ifland, where left loofe in the midft of greater plenty. Whether this effect is to be afcribed to the greater warmth, the refting better, or the being fed more regularly, *and eating with an appetite*, he cannot determine. Some experiments of Mr Young's alfo lead to the conclufion that cattle ftock thrive better when tied up. They likewife fhow that the practice of tying up is the only one that can be had recourfe to, where ftraw is not in great plenty, and the quantity of the ftock very inadequate to its confumption. 207 Propriety of tying cattle.

In the latter method there is the advantage of a large fupply of manure, efpecially where the farmer has the convenience of litter. Where however the farmer has convenience, the former method is probably in general the moft beneficial. In either mode of management much attention is neceffary to keeping the ftock conftantly fupplied in an evenly proportioned manner, as in this way there will be great advantage, both in the faving of food, and the condition of the animals.*

208 Ox-houfes. The neceffity of providing fhelter for cattle in bad weather, is now we believe pretty well underftood by every intelligent farmer; and experience has proved that proper buildings erected for winter feeding are attended with confiderable advantages. The erection for this purpofe at Hafod in Wales, the refidence of Thomas Johnes, Efq. M. P. for the county of Cardigan, and one of the moft eminent improvers of the prefent time, feem to be calculated upon a moderate fcale. The whole length of the building is fifty feet, the roof fhelving, its chief height being fourteen feet, the lower extremities, one feven and a half, the other fix feet. A ftone wall running up to the fummit, parts the feeding-houfe from the other and fmaller apartment, which is a receptacle for dung. Width of the feeding-houfe, nineteen feet within-fide. Stalls each twelve feet long by four feet two inches wide. Gangway three feet and a half, at the heels and tails of the cattle, leading from the doors, the firft door being for the cattle, the other for

* *Dickfon's Agricult.* vol. ii.

Hygeiology for the attendants. Similar doors at the opposite ends of the building. Running water in troughs, with racks, and mangers. The cattle lie on wooden platforms, perforated for the passage of the urine. The urine runs, and the dung is pushed through apertures in the wall, each of which is two feet square, and one between every two stalls. There are 12 wooden flaps or windows to give light and air, to each stall. The dung pit is about twelve feet wide, sunk some feet deep in the earth, extending the whole length of the building. The walls are built partly with stone, and in part with wood, the roof with larch wood, as an experiment of its durability in that exposure.

According to Mr Lawrence, the round or quadrangular form might perhaps, either of them, be more economical as to space and materials for a building to contain a considerable number. The oxen would most conveniently stand around with their tails toward the wall, contrary to the usual practice, for the more easy throwing out the dung from a gangway, through apertures purposely made in the wall, into a pit, under cover, sunk around the building. The area within would, of course, be for feeding, and every necessary purpose of attendance. A store-chamber above completes the building, the chief objection to the form of which, is the greater expence attendant upon the reversed position of the cattle, which perhaps is compensated by the great saving of labour, in the more easily getting rid of the dung. The gangway will in course be sufficiently wide to admit the beasts to and from their stalls; the dung aperture in the wall may be closed in cold weather." *

* *Lawrence on Cattle.*

209 Sheep-cots. Of all domestic animals, sheep are the most exposed to the inclemencies of the weather. This arises chiefly from their numbers, which renders complete shelter very difficult; but even in the case of a small flock, the prejudices of many feeders have prevented their procuring proper shelter for their sheep, under the idea that it would render them too lazy to provide for themselves. These prejudices, however, are gradually wearing away, and few sheep-farms are at present unprovided with shelter, either of trees or buildings. Mr Findlater, in his able survey of Peebles, strongly recommends shelter for sheep. "It would be (says this gentleman) for the interest of every proprietor of sheep farms, to encourage the farmer to rear shelter of trees, by allowing him the weedings of the plantation, and becoming bound to pay the farmer, at the rate of perhaps eight-pence or ten-pence a piece, for every tree left standing at specified distances, at the expiry of his lease; such an interest communicated to the farmer, would give the most effectual security for the protection of the trees. Shelters are also procured by buildings, enclosing a square open area in the middle, furnished with shades, on every side. *Stells* (that is circular spaces of area, proportioned to the size of the flock, enclosed by a five or six feet wall of stone, or sod, without any roof) were the primeval shelters invented by our forefathers. The circular figure of the building causes the drifting wind in snow storms to wheel round it, without rising over it, and depositing the snow in the calm region within. The sheep are fed, in winter storms, with such provision as can be procured, under the trees, in the sheds, and within the circles. Even where no feeding is administered, much advantage results to the animals, from mere defence against the weather; and they are much the more alert in searching for natural food, so soon as the storm ceases. The mode of acting of the sheep gives a pretty certain indication of the weather to be expected: Upon the near approach of a storm, those accustomed to shelters are observed to make for their shelters. Upon the near approach of thaw, their presentiment leads them to be less industrious in digging the snow for food, as if conscious that such labour was no longer necessary." *

* *Findlater's Survey*, p. 154.

According to Mordaunt, who wrote about the middle of last century, sheep pens and houses, were then not uncommon in Essex and Gloucestershire. He directs the pens to be made at some convenient corner of a pasture, or where several fields, commons, or pastures meet, so as to be common to them all. They should also be erected on a dry spot of ground, and stones laid at the bottom to keep the sheep dry and clean, whilst under examination. The pens to be divided into partitions to hold about forty sheep.

"The *sheep-houses*, for warmth in the winter season, are made low, and a third part longer than broad, and rather large, the sides lined with furze or boards, for warmth; the bottom laid with large stone slabs, and very level, that the urine run not away, but soak into the litter. It would be proper to have the sunny side well lined with moveable hurdles, that when the sun shines it may be laid open to give the sheep a refreshment, by letting them into some close or croft, wherein the sheep-house stands: the house to be well covered."

3. *Of Dog-kennels.*

210 Dog-kennels. It is usually recommended to erect a particular building, for the sole purpose of a kennel; and certainly where the proprietor's fortune will admit of it, such an appropriate building is to be preferred. A common barn has, however, often been employed as a kennel; and Mr Daniel says, that the excellence of the hounds kept in such a building has been rivalled by few that were lodged in the most sumptuous edifices.

Whatever may be the form or original intention of the building, *cleanliness* is absolutely necessary, both to the nose of the hound and the preservation of his health. The sense of *smelling* is so exquisite in a hound, that every stench must be supposed injurious to it; upon that *faculty* all our hopes depend, and nostrils clogged with the effluvia of a dirty kennel, are ill adapted to carry the scent over greasy fallows, or guide one through the soil of deer, or over ground tainted by sheep. Dogs are by nature cleanly; where they lie, if they can avoid it, they seldom dung. Air and fresh straw are essential to preserve them healthy. They are subject to the *mange*; nastiness very much contributes to this, and although at the first appearance it may be easily checked the remedies that are used are in themselves strong in their operation, and will do no good to the hounds constitution. Let the *cleanliness* of the kennel, therefore, be carefully attended to; a resort to these remedies will then be unnecessary, and all injury to hounds from this source will be prevented.

On the presumption that a kennel is to be erected, its site is strongly pointed out by Somerville.

"Upon

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"Upon ſome little eminence erect
"And fronting to the ruddy dawn, its courts
"On either hand wide opening to receive
"The ſun's all-chearing beams, when mild he ſhines
"And gilds the mountains tops."

But this ſelection of a high ſituation is incompatible with a running brook; and as theſe two advantages cannot be united, water is to be preferred, with the aſpect to the *morning ſun* as much attended to as poſſible.

The number of its inmates muſt determine the ſize of the kennel; and the architecture ſhould be neat, with-

211 Duke of Richmond's kennel. out being uſeleſsly expenſive. The moſt magnificent is the duke of Richmond's at Goodwood, which coſt 19,000l. and is ſufficiently extenſive for two packs of hounds. The building compriſes five kennels, two 36 by 15, three 30 by 15, and two feeding rooms 20 by 15 feet, with ſtoves to warm the air, when too cold. The huntſman and whipper-in have each a parlour, kitchen, and ſleeping-room.

The nearer to the houſe the kennel is placed the better. There are reaſons againſt its too cloſe approach, but they yield to others which forbid a great diſtance. To mention one, derived indeed from a vulgar ſaying, "that the maſter's eye makes the horſe fat;" recollect that the inſpection of the kennel, is even more needful than that of the ſtable; for in both, cleanlineſs is no leſs eſſential than food.

212 Size. The kennel ſhould be of ſufficient dimenſions at its firſt building; room for two kennels ſhould be under the ſame roof; when there is but one, it is ſeldom ſweet; and when waſhed out, the hounds, particularly in winter, not only ſuffer during the time of cleaning, but as long afterwards as it remains wet. The ſecond kennel affords opportunity for drafting the hounds intended to hunt the next morning. In a few days they will be drafted with little trouble, will readily anſwer to their names; and with equal eaſe as a ſhepherd numbers his ſheep, you may count your hounds into the hunting kennel.

213 In a morning, upon the feeder's firſt entering the kennel, he ſhould let the hounds into the outer court; the door of the hunting kennel, when not occupied by the drafted hounds for that day's hunting, ſhould be opened in bad weather to ſhelter them; the lodging-room ſhould then be thoroughly cleaned, the windows and doors opened, the litter well ſhaken, and the kennel made ſweet, before the hounds are again ſhut into it. Every omiſſion prejudicial to the hounds ſhould be immediately pointed out to the feeder, who muſt be made to remedy it; and alſo obſerve that the *great court and the other kennels* are equally objects of his attention.

214 Lodging-room. The lodging-room ſhould be bricked, and ſloped on both ſides to the centre, where ſhould be a gutter to carry off the water, that when waſhed, the floor may be equally dried: but flag-ſtones, or large ſquare bricks termed *pammonds*, are far preferable; there are fewer interſtices, and conſequently leſs filth or water can there accumulate, and the ſurface is ſooner dry. Let the floor be kept in thorough repair, that no water may remain in any cavity, until the maſon can be had, when at any time wanted; let the ſtagnant water be carefully ſtopped up; for nothing is more hurtful to hounds, than *damp*, or more refreſhing than *warmth* after hard work.

The kennel ſhould have three doors; two in front 215 Doors.
and one behind; that in the back to have a lattice window in it, with a wooden ſhutter, which is to be kept always cloſed, except in ſummer, when it ſhould be left open the whole of the day. This door has a two-fold utility, it ſerves to carry out the dirty ſtraw, and being oppoſite to the window, will admit a thorough air, when the lodging-room is cleaned, which will much contribute to render it ſweet and wholeſome. The front doors will be uſeful in drying the room when the hounds are out; and as one is to be ſhut and the other hooked back, ſo as to allow a ſingle dog to paſs, they are not liable to any objection. The large centre window ſhould have a folding ſhutter, which at night, according to the weather, may be wholly or partially cloſed; and thus the *warmth* of the kennel may be regulated as is judged moſt ſalutary. The two great lodging rooms are exactly ſimilar, and having a court belonging to each, are diſtinct kennels ſituated at the oppoſite ends of the building. In the centre of the boiling-houſe and feeding-yard, a leſſer kennel, either for hounds that are drafted off, hounds that are ſick and lame, or for any other required purpoſe, is on each ſide; at the back of which, it being but half the depth of the two larger kennels, are places for coals, &c. for the uſe of the kennel. There is alſo a ſmall building in the rear for hot bitches.

The inner-court floor ſhould be bricked or flagged, 216 Inner court.
and ſloped towards the centre like thoſe of the lodging-room; and water brought in by a leaden pipe, ſhould run through the channel in the middle. In the centre of each court is a well ſufficiently large to dip a bucket for the purpoſe of cleaning the kennel. To keep theſe from wanting repair, they ſhould be faced with ſtone, and to that of the feeding-yard a wooden cover ſhould be fixed. The benches, which muſt be open to let the urine through, ſhould have hinges and hooks in them all, that they may fold up when the kennel is waſhed. They ſhould be made as low as poſſible, that when a hound is tired, he may have no difficulty in jumping up, and at no time be able to creep under them. Recollect that if, owing to the ſmallneſs of the hound, as in beagles, it ſhould be difficult to make the benches ſufficiently low, it will be proper to nail a ledging projecting downwards in the edge, or the benches may be faced with boards at bottom, to prevent the hounds from creeping under.

A large bricked court in front, having a graſs court adjoining, and a brook running through the middle of it, completes the kennel. This court ſhould be planted round, and alſo have ſome lime trees and ſome horſe cheſnuts near the centre for ſhade. Some poſts bound round with ſtraw, rubbed with galbanum, may be placed ſo as to prevent the hounds from making water againſt the trees. The brook may be uſed as a cold bath for hounds lamed, in the ſtifle, in ſtrains, or for other purpoſes for which the cold bath is required. A high paling ſhould incloſe the whole, and which, to the height of four feet, ſhould be cloſe, the remainder being open, with an interval of two inches between the pales. At the back of the kennel ſhould be a thatched houſe, fenced at the ſides, to contain at leaſt a load of ſtraw, Hygeiology a pit for receiving the dung, and a gallows for the flesh. If a piece of ground adjoining to the kennel can conveniently be enclosed, for keeping such horses as may be brought alive for the use of the hounds, it would be of great service, as the disorders of condemned horses are not always ascertained; and an opportunity may thus be offered of investigating their nature and progress, which may prove advantageous in future similar cases. The hounds may also be brought into this field, to empty themselves after feeding; and the draught for the next day's hunt can be here made with greater accuracy than when they are confined to the kennel.

Stoves are used in some kennels; but a good feeder, and the mop properly applied, render them unnecessary. Should ticks prove troublesome at any time, the walls of the kennel should be well washed; and if that should fail to destroy the ticks, they must be white-washed with lime.

217 When the hunting season is over, one kennel will be sufficient, and the other with the grass-yard adjoining to it may be allowed to the young hounds. This separation, which should continue till the season commences, is necessary for preventing many accidents that might otherwise happen at this time of the year. Should there be conveniences, it will be proper to keep the dogs separate from the bitches during the summer months. When hounds are very riotous, the feeder may sleep in a cot in an adjoining kennel; if the dogs are well chastised at the first quarrel, his voice will afterwards be sufficient to keep them quiet *.

* *Daniel's Rural Sports*, vol. i.

Chap. II. *Of Diet.*

218 Diet. In preserving the health of domestic animals, much will depend on the quantity and quality of their food, and on the manner in which they are supplied with it. This subject, therefore, requires some share of our attention. We have already, in the article Agriculture, treated pretty much at large on the different kinds of food that are most proper for horses, sheep, and cattle; and have here little to add on that head. Our principal object in this chapter will be, to consider the best means of dispensing food to the different classes of domestic animals, and to describe what are considered the most beneficial methods of preparing the food in those cases where its preparation appears to be necessary.

219 Food of horses. The natural food of the horse is the simple herbage of the field, and on it alone he can be constantly kept in a high state of health and vigour, so long as he shall not be required to labour; and whilst he is employed in labour, grass in some form, either dried or green, seems absolutely necessary to his maintenance in a healthy state. Hay, straw, and corn of various kinds have been, from the earliest time, the common food of horses; but in Britain, and indeed in France and Germany, during later periods especially, they have rejected all other species of horse-corn; from a well-grounded preference in favour of oats and beans; the latter for draught-horses chiefly, or as substantial auxiliaries to the oats, imparting as strong a nourishment as the constitution of the horse will properly bear, and at the same time of a cleansing nature; and are, moreover, the best and cheapest in-door fattening for almost all domestic animals.

220 The species of corn usually given to horses in many countries is barley, the bulky provender is straw, both of which in warm climates, are said to be nearly equal in nutriment to our oats and hay. With us, barley is apt to scour horses, and make their urine red, especially at its first being given. Wheat is often given to horses of the great upon the continent; it is said when Philip of Spain was in this country, his jennets were fed upon wheat during the time of scarcity, and this gave great umbrage to the people.

There seems to exist no particular difference of quality between the white and the black oats, they being equal in weight and thinness of husk: these criteria, and their being short, are the best marks of their goodness. It is equally well known that they should be some months old when used, as new oats are apt to swell the belly and produce gripes.

221 Beans. New beans are improper for horses, for the same reason. The best remedy is to dry them in a kiln. Old beans should be split, and given either with bran or chaff; or the best way would be to break them in a mill. Mr Lawrence fed cart-horses with beans for nearly seven years, without experiencing any ill effect from such food; but the horses laboured very hard. Beans contain more solid nourishment than oats, but of a less salubrious nature.

Grains constantly loosen a horse, and impoverish his blood; bran scours and weakens the entrails; both of them are good occasional dietetic alteratives.

222 Carrots. Carrots are said to purify and sweeten the blood, to amend the wind, and to replenish after the wastings occasioned by disease or inordinate labour. Mr Lawrence informs us that he has been accustomed to use them for years in all forms, and to all descriptions of horses. They are either given in spring or autumn to high-fed horses, as a change of diet, at the rate of one feed per day, in lieu of a feed of corn, or as full subsistence to others. They ought to be washed clean, and, if large, cut into flat and sizeable pieces. The quantity of carrots for a feed is from half a peck to a peck.

223 Times of feeding. The usual periods of feeding with corn are in this country, morning, noon, and night. The quantities each time either a quarter or half a peck, with or without about two handfuls of beans, according to the horse's state of body. Much greater care than is common ought to be taken in sifting the oats clean from dust, and the dung of mice. Water should be allowed without fail twice a-day. There is an error not unfrequent among stable people, who suppose water to be at best but a kind of necessary evil to horses, and therefore think it a point gained whenever they can find an opportunity to abridge the quantity. But how well soever a horse may shift with little or no water while in the field, and while feeding on succulent meat, much mischief may ensue from its being withheld; and this may produce costiveness, gripes, inflammation of the bowels, perpetual longing, and a danger of drinking to excess on every opportunity.

224 Hay. The well-known use of hay is to dilate the body of the horse, to satisfy his appetite with bulk and quantity, as corn does with compact and solid nourishment. British hay, the best in the world, contains great nourishment,

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nouriſhment, and will keep a horſe and even fatten him; but he is unable to labour upon hay alone, and experience has ſhewn that Bracken's obſervation of the conſtant uſe of hay injuring the ſight of horſes, particularly if ſuddenly put on ſuch food after good keeping, is very juſt. Hard upland hay is the beſt for race and coach horſes; and it ſhould be of a fine, greeniſh colour, fragrant ſcent, and full of flower. It is ſaid that horſes and cattle prefer ſuch hay as has been ſweated, or which has undergone a partial fermentation: and it is even thought that they grow much ſooner fat on heated hay than on ſuch as has been gotten up dry and cool. There can be no doubt that ſweated hay contains a conſiderable quantity of ſugar, formed during its ſtate of fermentation; this may render the hay more pala table to the beaſts, but we have ſome doubt whether it be ſo wholeſome as freſh well-coloured hay. Clover-hay, and hay of artificial graſſes, from its groſsneſs, is appropriated to cart-horſes. Without attempting to aſcertain the preciſe quantity, it may be ſaid that hay ſhould be given as often as a horſe has a keen appetite for it; but great care ſhould be taken that ſo much be never allowed at once, as that he ſhall leave it, and blow upon it. At night a conſiderable quantity of hay is uſually left in the rack, and this is no doubt abſolutely neceſſary for horſes who are hard worked during the day, as night is their moſt leiſure time for feeding; but it admits of doubt whether horſes who live in a ſtate of luxury, and are but little worked, ſhould be indulged in much hay at night *.

* *Lawrence on Horſes*, vol. ii.

225 It will obviouſly occur to moſt people, that the quantity and quality of a horſe's food ſhould be proportioned to his labour; that horſes who are lightly worked, will not in general require ſo much or ſo nouriſhing food, as thoſe who are conſtantly kept to hard labour. It is evident that when horſes ſtand idle, and are at the ſame time high fed, they are expoſed to many dangerous diſeaſes, as inflammation, ſtaggers, ariſing from a too full habit of body; and theſe diſeaſes will be more likely to come on when a horſe that has been thus fed is ſuddenly put to hard labour, or obliged to make any unuſual or violent exertion. But this muſt not be carried too far. Horſes ſhould not, becauſe they have little work at the time, be entirely confined to graſs, or graſs and hay, unleſs they are at paſture, and are never worked. For while a horſe ſtands in the ſtable, and is liable to be called upon on any emergency, his diet ſhould be ſo regulated, as that he ſhall neither be ſo fat and full of blood, as not to perform occaſional work without difficulty and danger, nor on the other hand, ſo poor and weak, as to be incapable of ſupporting exertion without injury to himſelf or rider. All horſes that are fed on graſs and hay alone, are too weak to perform a good day's journey without ſtumbling. A moderate quantity of corn or other hard food, ſhould therefore be allowed to ſuch horſes as ſtand conſtantly in the ſtable, or who, while at paſture, are occaſionally worked.

226 Mr Clark obſerves, that throwing great quantities of clean grain before horſes at one time is very improper; as they eat it too greedily, and ſwallow whole mouthfuls of it almoſt dry. The moiſture in the ſtomach, or water drunk immediately after eating, cauſes the grain to ſwell, and thus the ſtomach is greatly diſtended, and loſes its contracting power on the food. By the preſſure of the full ſtomach on the inteſtines, the paſſage of the food backwards is obſtructed, and the confined air, ariſing from the indigeſted food, not having a ready paſſage backwards, and horſes not poſſeſſing the power of belching, the air becomes rarefied to a great degree, the horſe is ſeized with colic pains; as theſe increaſe he becomes convulſed, and in many caſes the ſtomach burſts. Out of a number of caſes where the above was diſcovered on diſſecting the bodies, Mr Clark mentions the two following.

"A young draught-horſe was fed in the morning with too great a quantity of barley mixed with peaſe, and had been allowed to drink water immediately thereafter. He was yoked to a two-wheeled chaiſe, in order to travel a few miles, and was obſerved about the middle of the day to be very uneaſy, frequently attempting to lie down. As ſoon as he was unyoked he lay down and tumbled about, frequently lying on his back, ſtarting up ſuddenly and turning his head towards his belly. He continued thus in great agony till towards next morning, when he died. Upon opening his body, the ſtomach was found burſt, the barley and peaſe moſtly entire, only greatly ſwelled, and the whole contents of the ſtomach ſpread through the abdomen.

"The other caſe was a horſe who had been fed with too great a quantity of oats and barley, and had been allowed to drink water freely afterwards. He was ſeized with griping pains, ſo that he frequently lay down and tumbled, ſeemingly tortured with the moſt acute pains. He died next day. Upon opening his body, the ſtomach was found diſtended to a moſt enormous ſize, but was not burſt. Its coats were ſo very thin, from the great diſtention it had undergone, that its coheſion was almoſt deſtroyed, and had more the appearance of a coat of mucus, or ſlime, than the ſtomach. The oats and barley were for the moſt part entire as they were ſwallowed, only greatly ſwelled from the moiſture they had imbibed.

"From the caſes now related, it will appear how neceſſary it is not to allow horſes to eat too great a quantity of clean grain at a time, but to give it in ſmall quantities, and repeated the more frequently. At the ſame time, it will ſhow the propriety of mixing with it a little chopped ſtraw, or hay, in order to make them chew it the more thoroughly before they ſwallow it. This proceſs alſo prepares the food for being properly digeſted, and not a ſingle grain of it is loſt *."

* *Clark on Prevention.*

The method of feeding horſes with bruiſed grain and cut ſtraw is recommended by the earl of Pembroke, in his excellent treatiſe on horſes, as exceedingly proper.

227 Cut ſtraw.

"Every grain (ſays he) goes to nouriſhment: none is to be found in the dung; and three feeds of it go further than four as commonly given which have not been in the mill. But wheaten ſtraw, and a little hay ſometimes mixed with it, is excellent food. To a quantity of corn, put the ſame quantity of ſtraw. It obliges them to chew their meat, and is many other ways of uſe †."

† *Military Equitation.*

Mr Lawrence diſapproves of the uſe of ſtraw, as containing no nouriſhment. In this he probably goes too far, as both horſes and cattle are in ſtraw-yards often fed with little elſe. He prefers chaff, or cut clover hay, to mix with the corn, eſpecially for cart-horſes. Mr Lawrence, however, allows that cutting up

Hygeiology up unthrashed oats for food is a good practice, particularly when hay is scarce; as thrashing and dressing of the oats are thus saved, and it is an economical expenditure of the oats, which are moreover very fresh, and agreeable to the horse.

228
Of grinding corn for horses.

It has of late been recommended to bruise the corn in a mill, before giving it to the horse, and it is certainly a good practice, as there is thus little danger of its passing through the bowels undigested. It is usual only to bruise the corn, but Mr Lawrence thinks that it is better to grind them as fine as possible. Whole corn, with whatever it may be mixed, will, much of it, be swallowed in that state; a great deal only half masticated, which will elude the digestive powers of the animal, and be ejected from his body crude and unbroken. This is particularly the case with brood-mares and young stock, the bellies of which are full of slippery grass; such should ever have ground corn, and mashes should always be made with it. Ground buck-wheat agrees well enough with horses, but that species of corn is the least substantial.

229
Lawson's food for horses and cattle.

Mr Lawson, a merchant of London, has lately published an essay, on the use of Mixed and Compressed Cattle Fodder, intended as food and fattening for horses, oxen, sheep, and hogs. His plan is, to grind, cut, mix and compress, all the articles in present use, as food for cattle, with some additional ones of his own recommending; and to keep the mass stowed in casks, or other close stowage. He gives a detailed account of all the instruments necessary in the process, the most commodious methods according to his own practice, and various tables of expence and quantities.

With respect to the drink of horses, we have little to remark. Their water should be as pure as possible, as muddy and hard water is not only very unpleasant to the horse, but probably lays the foundation of gravelly complaints. It is a very absurd custom, which is however very prevalent, to gallop the horse after watering, with the view, according to the groom's idea, of warming the water in his belly; for if the horse has drunk heartily, as he is very often improperly allowed to do, any violent exertion immediately after cannot but occasion great uneasiness. It is, however, a good practice to ride the horse moderately before watering; but care should be taken, not to throw him into a perspiration, as drinking cold water in this state is attended with considerable danger.

230
Food of cattle.

The feeding of cattle is of considerable importance to the farmer, and has of late been much improved. Both the food and the manner of administering it must be different according to the age of the cattle, the season of the year, and the purposes for which the cattle are fed.

It has been well observed in a late useful practical work, that in the winter the yearlings should "be fed with hay and roots, either turnips, carrots, or potatoes; and they should be thoroughly well fed, and kept perfectly clean by means of litter. At this age it is a matter of great consequence to keep such young cattle as well as possible; for the contrary practice will inevitably stop their growth, which cannot be recovered by the best summer food. If hay is not to be had, good straw must be substituted; but then the roots should be given in greater plenty, and with more attention. To steers and horses two years old, the proper food is hay, if cheap, or straw, with baits of turnips, cabbages, &c.*"

Mr Donaldson thinks the advantages of green winter food for live stock, so great, that there is no way in which it can be applied with greater benefit than "by giving the young cattle a daily allowance during the first two or three winters." Whenever straw is employed as fodder for young stock, without the above sorts of food, if it be not very good, or slightly mixed with some grassy material, a little hay should always be blended with it, in order that it may be preserved in proper condition. It is also of consequence that the animals be served with this sort of fodder, in a regular manner, as where too much is given at a time, Mr Marshall has remarked, that they do not thrive so well.

* *Dickson's Agriculture*, vol. ii.

The following observations of Sir John Sinclair merit every attention.

231
Sir John Sinclair's remarks.

"Some intelligent graziers recommend the following mode of feeding and fattening cattle. Suppose there are four inclosures, of from six to ten acres each, one of them should be kept quite free from stock till the grass has got up; and then the prime or falling cattle, should be put into it, that they may get the best of the food: the second best should then follow; and the young store after all, making the whole feed over the four inclosures in succession, as follows.

1st Inclosure.	*Free from stock, till ready for the best cattle.*
2d ditto.	*For the best cattle, till sent to N° 1.*
3d ditto.	*For the second best, till sent to N° 2.*
4th ditto.	*For the young cattle, till sent to N° 3.*

N° 4. is then kept free from stock till the grass gets up, and it is ready for the prime cattle. The proper size of inclosures has never yet been ascertained by experiment; probably from 10 to 30 acres is the best; but the size should be various, as small ones are better calculated for grass, and large ones for corn. Probably the best plan to adopt is, to feed cattle entirely in the house, or *soiling* them as it is technically called. In that case, small inclosures must be preferred, as the shelter they afford is extremely favourable to the growth of the herbage.

The larger a bullock is, he must take the more food 232
to support him. It is desirable to change his food often, and to give him frequently, but little at a time, which makes him more eager to eat. After his kidneys are covered with fat, he will take less meat every week. It is better, therefore, to ascertain the quantity he eats, by the week, than by the day.

Fatting cattle, to be sold immediately from the farmer's house, and not sent to market, should be kept 233
moderately warm. If kept too hot it makes them perspire, and their skins to itch: this vexes them, and they rub themselves against any wall or post within their reach, which is much against quick feeding. Currying and combing them are useful practices; and washing them, at least once a-week, is of great service. Bleeding is now exploded, as an old and unnecessary practice.

In some parts of the kingdom, the whole attention 234
of the farmer is dedicated to suckling, or, in other words, to feeding calves, for supplying the market with veal. In Essex, this plan is reckoned more profitable than the dairy, and next to grazing. But the profit there must depend much upon the immediate neighbourhood of

Hygeiology of that country, to so great and certain a market as London.

235 Essex mode of rearing calves.

The particulars connected with this branch of rural economy, will, it is probable, be fully detailed, in the improved Agricultural Survey of Essex, in so far as regards that and the neighbouring districts. But as the mode of suckling, adopted in some parts of Scotland, is extremely different, it may not be improper to give a short account of it in this place. As soon as the calf is dropped, it is put into a box made of coarse boards, four feet and a half or five feet long, and four feet, or four feet and a half high, and about two feet wide, according to the size of the calf. The boards are not put so close but that a sufficient quantity of air is admitted; light is, however, carefully excluded; and the box has a cover for that purpose. The box stands on four feet, which, at one end, are four inches high, but at the other, only two inches; and, as there are holes at the bottom, all wetness is drained off. The bottom is also covered with straw or hay, which is changed twice a-week. For seven or eight days, milk is but cautiously given, for unless a calf is fed moderately at first, it is apt to take a loathing to its food. It should be bled in about ten days; and afterwards, as much milk given it fresh from the cow, either twice or thrice a-day, as it will take. The bleeding should be repeated once a-week; and at all times when a calf loathes its milk, and does not feed well, bleeding ought to be repeated. These frequent bleedings prevent diseases from plethora, to which calves are subject, even when not fed so high, and still more so when they are. A large piece of chalk should be hung up in the box, which the calf will lick occasionally: this contributes nothing to the whiteness of the veal; but it amuses the animal, and corrects that acidity in the stomach which might otherwise be engendered, and which certainly often takes place. A cow calf is reckoned the best veal; if a bull calf is suckled, he ought to be cut when about a week old, otherwise the veal will neither be so good nor so white. By this mode of treatment, calves are kept clean, quiet, warm, and dry; the veal they furnish is excellent, and they are soon ready for the market; and, on the whole, it seems to be preferable to the practice of stupifying them with spirits, or with laudanum, so common in other places where a different system is pursued.

The supposed necessity of beginning to feed oxen at an early age, is a great objection to their being generally used, as they are hardly trained properly to work, before it is thought necessary to fatten them, after which they do very little work; but, in consequence of the improved mode of fattening by oil-cake, &c. there is no difficulty to fatten oxen, even at twelve years of age, which is a material circumstance in their favour *."

* Farm. Mag. vol. iii. 163.

236 Mr Hunter's feeding byre.

It is now very generally understood, that the more cleanly and comfortably cattle are kept, and the cleaner and better the order in which their food is presented to them, the better they will thrive, and consequently the sooner they will fatten, and the heavier they will be. With these views, and with the additional view of saving a greater proportion of the dung and urine of the cattle than is usually done, so as to increase the quantity of manure as much as possible, a byre has been constructed by Mr Hunter of Blackness in Forfarshire, which has been found on trial, completely to answer the ends proposed. The byre consists of two apartments, an inner apartment, or byre for feeding the cattle, and an outer apartment or barn for containing the turnips and fodder.

At the proper season when the turnips are completely ripened; and the turnip feeding commences, the turnips are gathered together on the field in large quantities, and two or three men with coarse turnip knives made from old scythes, cut off the whole of the roots, carefully cleaning the turnips at the same time, from any earth which may adhere to them. The turnips are then carted to the turnip barn, the door of which is wide enough to allow the carts to back in, and throw them down. Here the men with their turnip knives are again ready immediately to cut off the whole green tops or shaws of the turnips, and these green tops are immediately given to cows, young winterling cattle, sheep, &c. who readily eat them when fresh. The turnips, now quite clean, are piled up in one end of the barn like cannon balls, and will keep in excellent order for months together. Should the winter storm set in, a small quantity of clean dry straw laid over them, will effectually preserve them from being injured by the frost. The other end of the barn receives the straw and litter for the use of the byre. The advantages proposed to be derived from this method of treating the turnips are, 1. The preservation of a great many of the best turnips, which, if allowed to remain on the field during winter, are unavoidably spoiled by the effects of the weather, and the alternate operations of snow, rain, and frost. 2. The green tops being cut off fresh and good, are immediately consumed, in place of being entirely lost if allowed to remain on the field. 3. It saves much labour and trouble, both to men and horses, to lay in a stock of turnips at once, in place of going to the field every day, whether good or bad, and when, as the fields are necessarily wet and soft, the horses, carts, and harness, are severely strained, and the fields poached and cut up.

Lastly, By having a couple of months supply of turnips in the barn, you are never under the necessity of using frosted turnips, which are often little better than lumps of ice. And even if you should not incline, or find it convenient, to lay in so large a stock of turnips at once, still you can take the advantage of any good fresh day, as it occurs, to add to your stock of turnips in the barn.

At right angles to the turnip barn, stands the feeding byre, constructed as follows. At the distance of about three feet and a half from the great side wall of the byre, there are constructed on the ground, in a straight line, ten troughs for feeding ten large cattle; these are of hewn pavement on all sides, and at the bottom; and they are divided from each other by divisions or bridges, likewise of hewn pavement. These troughs are so constructed, that there is a small and gradual declivity from the first or innermost, to the last and outermost one; and the bridges separating them, being made with a small arch at the bottom, a pail or bucket of water poured in at the uppermost, runs out at the undermost one, through a stone spout passing through the wall, and a sweep with a broom, carries off the whole remains of the turnips, &c. rendering the whole troughs quite clean and sweet. The whole food of the cattle is thus kept perfectly clean at all times.

In a line with the feeding troughs, and immediately over-

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over them, runs a large ſtrong beam of wood, from one end of the byre to the other, which is ſtrengthened by two ſtrong upright ſupporters to the roof, placed at equal diſtances from the ends of the byre, and the main beam is again ſubdivided by the cattle ſtakes and chains, ſo as to keep each of the ten oxen oppoſite to his own feeding trough and ſtall.

The three and a half feet of ſpace betwixt the feeding troughs and outer wall of the byre, lighted at the farther end by a glazed window, is the cattle-feeder's walk, who paſſes along it in front of the cattle; and, with a baſket, depoſits before each of the cattle the turnips into the feeding trough of each.

To prevent any of the cattle from choaking on ſmall turnips, or pieces of large ones, as they are very apt to do, the chains at the ſtakes are contrived of ſuch a length, that no ox can raiſe his head too high when eating; for, in this way, it is obſerved, cattle are generally choaked. However, in caſe it ſtill ſhould happen, that an ox choaks on a turnip, the cattle-man, or feeder is provided with a ramrod, made of a piece of ſtrong ſtiff rope, with a ſmall round poliſhed wooden head at the end of it; this he introduces into the mouth of the ox, and ſo gently knocks the turnip down his throat, without either difficulty or danger to the animal. That the cattle-feeder may be always at hand to attend his cattle, a ſmall apartment with a window in it, in which his bed is placed, is conſtructed immediately off the corner of the byre, ſo that he is ready, even in the night-time, in caſe of any accident happening, to give aſſiſtance.

At the diſtance of about ſix feet eight inches from the feeding troughs, and parallel to them, is the dung groop and urine gutter, neatly and ſubſtantially built with hewn ſtone. Here, too, like the troughs, there is a gradual declivity from the inner and upper to the outer and loweſt end; ſo that the moment the urine paſſes from the cattle, it runs to the loweſt end of the gutter, whence it is conveyed through the outer wall of the byre in a large ſtone ſpout, and depoſited in the urinarium outſide of the wall. At this place is a large incloſed ſpace, occupied as a compoſt dung-court. Here, all ſorts of ſtuff are collected for increaſing the manure; ſuch as, fat earth, cleanings of roads, ditches, ponds, &c. rotten vegetables, &c.; and the urine from the byre being cauſed to run over all theſe collected together, which is done very eaſily by a couple of wooden ſpouts moved backwards and forwards to the urinarium at pleaſure, renders the whole maſs in a ſhort time, a rich compoſt dunghill; and this is done by the urine alone, which in general is totally loſt. The dung of the byre again is cleaned out ſeveral times each day, at the two front doors of the byre oppoſite to the groop, and depoſited in the dung-court; ſo that, in this way, too, the byre is kept in as good order as any ſtable, and the cattle as clean as horſes. Along the edge of the dung-court, a few low ſheds are conſtructed, in which young beaſts, ſheep, or ſwine, &c. are kept; and theſe conſume the refuſe and remains of the turnips from the great feeding byre.

In the ſide wall of the byre, and oppoſite to the heads of the cattle, there are conſtructed three vents, or ventilators; theſe are placed at the diſtance of about two feet four inches from the ground in the inſide of the byre, and come out immediately under the eaſing of the ſlates on the outſide. The inſide openings of theſe are about 13 inches in length, ſeven in breadth, and nine in depth in the wall; and they ſerve two good purpoſes. 1. The breath of cattle being ſpecifically lighter than atmoſpheric air; the conſequence is, that, in ſome byres, the cattle are kept in a conſtant heat and ſweat, becauſe their breath and heat have no way to eſcape; whereas, by means of the ventilators, the air of the byre is kept in proper circulation, which conduces as much to the health of the cattle as to the preſervation of the walls and timber of the byre, by drying up the moiſture produced from the breath and ſweat of the cattle, which is found to injure thoſe parts of the building *.

*See *Farm. Mag.* vol. iii. p. 8.

237 London mode of feeding cows.

The method of giving cows their food by the milk-farmers in the vicinity of the metropolis, where this buſineſs is carried on upon the moſt extenſive ſcale, is thus ſtated in the valuable Agricultural Survey of that diſtrict. "During the night, the cows are confined in ſtalls; about three o'clock in the morning, each cow has a half-buſhel baſket of grains; when the milking is finiſhed, a buſhel baſket of turnips is given to each cow; and very ſoon afterwards they have an allotment in the proportion of one buſs to ten cows, of the moſt graſſy and ſoft meadow hay, which had been the moſt early mown, and cured of the greeneſt colour. Theſe ſeveral feedings are generally made before eight o'clock in the morning, at which time the cows are turned into the cow-yard. About twelve o'clock they are again confined to their ſtalls, and ſerved with the ſame quantity as they had in the morning. When the afternoon milking, which continues till near three, is finiſhed, the cows are again ſerved with the ſame quantity of turnips, and about an hour afterwards with the ſame diſtribution of hay, as before deſcribed. This mode of feeding generally continues during the turnip ſeaſon, which is from the month of September to the month of May. During the other months of the year they are fed with grains, cabbages, tares, and the other foregoing proportion of ſecond cut meadow hay, and are continued to be fed with the ſame regularity until they are turned out to graſs, when they continue in the field all night; and even during this ſeaſon they are frequently fed with grains."

As the grains employed in feeding cattle cannot always be procured freſh as they are wanted, it becomes a deſirable object to preſerve them for a length of time. They are preſerved in ſome places by putting them into pits dug in the earth, into which they are trodden down, and afterwards covered to a moderate depth with dry earth. In this way being defended from the action of the air, and thus prevented from fermenting, they may be kept for a conſiderable time during the months of ſummer, when brewing is not carrying on; they may alſo be kept by preſſing them down into caſks placed upon ſtands, ſo as to elevate them a little from the ground, and having their bottoms pierced with holes, to carry off the ſuperabundant moiſture.

Food of Dogs.

238 Food of dogs.

A good feeder is very eſſential. He ſhould be young, active, induſtrious, and good tempered, for the ſake of the animals entruſted to his care, who, however they may be treated by him, cannot complain. He muſt ſtrictly obey any orders that his maſter may give, both

Hygeiology both with regard to the management and to the breeding of the hounds, and he must not consider himself as solely under the direction of the huntsman. This is a necessary hint, as it has sometimes happened that a pack of hounds apparently belonged entirely to the huntsman, when the master had little more authority over them than if he were a perfect stranger.

239 Cleanliness. On the exquisite sense of smelling so peculiar to the hound, our sport entirely depends; care must therefore be taken to preserve it, and the surest method of doing so is, to observe the utmost cleanliness; to keep the kennel sweet, is a point that cannot be too much recommended, and which must on no account be neglected. This must therefore be inculcated on the feeder, and the proprietor should see that his orders in this respect are carefully observed.

240 Of vegetable food. 241 Oat meal. Oat meal is by far the heartiest and best food; for hounds will run more stoutly with that, than on any other meal, or than even on oat meal mixed with any other. In point of expence, as well as for the greater benefit of the hounds, the most advantageous method is to grow one's own oats, and have them properly dried, and broken at the mill into meal that is not too fine. A sufficient quantity should be ground, to serve for 12 or 18 months consumption; the older the meal, so much the better; but unless it is kept by one, there is scarcely any mode of procuring it sufficiently old. It should be kept in bins, in a dry granary, and the meal should be trodden into the bins as closely as possible. Should there be no granary near, sugar hogsheads will answer the purpose, but the meal must be pressed into them very firmly, and it must be kept dry. These hogsheads should be placed upon stands, like beer stands, by which means vermin will be prevented from getting at the meal unobserved.

242 Barley meal. Barley meal is used in many kennels, being cheaper than oat meal, but it is said to be much more heating, and less nourishing; or as the huntsmen express themselves, there is less proof in it.

243 Mode of preparing the food. It is well known that the principal animal food given to hounds, is the flesh of horses, which should be boiled. The boiler employed for this purpose should be made of cast iron, and its size should be in proportion to the number of hounds in the kennel. The flesh must be thoroughly boiled, and must then be taken out of the broth with the strainer, and a proper quantity of oatmeal must be put into the broth. When this has been boiled sufficiently, which will require from three quarters of an hour to an hour, the fire may be withdrawn. As it cools, it thickens into a pretty firm jelly, and for hunting hounds it cannot be too strong. Five or six pecks of good oat meal will be sufficient to make a boiler of broth that will furnish 30 couple of hounds for two feeds sufficiently thick. Some are of opinion that oat meal and barley meal in equal quantities make the best food for hounds. The oat meal is to be first boiled for half an hour, the fire is then to be extinguished, and the barley meal put into the copper, and both mixed together. The reason for not putting both kinds of meal into the boiler at the same time is, that the boiling which thickens the oat meal, makes the barley meal thin. When barley meal alone is used, it should not be put into the boiler at all, but should be scalded with the hot liquor, and mixed up in a large tub, capable of containing at least half a hogshead. We must however remark, that barley meal should never be given by itself to hunting hounds during the hunting season, as its heating quality renders them exceedingly thirsty; and when out, they take every opportunity to lap water. Hygeiology

The meat should never be given to the dogs too hot, and should be mixed up to as thick a consistence as may be. The feeding troughs should be wide at the bottom, and have wooden covers, and they should not be made too long; five or six troughs that are easily moved, are better than two or three that are unwieldy. 244

The boiling for the hounds, mixing of the meat, and preparing it for them at proper hours, will of course be taken care of by the huntsman. He must constantly attend the feeding of the hounds, who should be draughted according to the state they are in at the time. Some hounds are better feeders than others, and some require less meat than others; a nice eye and great attention are required to keep them all in equal flesh. This is what constitutes the merit of the huntsman, and shews him to be well qualified for his office; but few are sufficiently attentive to this. The hounds are fed in a hurry, without examining them before they begin. To ascertain properly the condition of a pack of hounds requires no small circumspection.

The huntsman should call each hound by name, letting him in to his food as he is called; this uses them to their name, and teaches them obedience. A hound should always approach him who calls on him; and if he touches him with a stick, he should follow wherever he is led. 245 Mode of administering it.

The thin and tender feeding hounds being first turned out to the feeding room, will have the opportunity of picking where they choose. Such hounds as are in low condition, had better be drafted off into a separate kennel. Thus selecting those that are poor, we proceed to the feeding of the rest with less trouble and more accuracy; but those that are drafted off, when more flesh is mixed with the meat, must be let in to feed one by one as they answer to their names; or they may be better fed than taught. Thus the hounds who want flesh, will all have a share of it; and if any of them be much poorer than the rest, they should be fed again, as such hounds cannot be fed too often. Unless peculiarly good, a soft washy constitutioned hound will scarcely ever be worth the attention that is given him; and after a hard day is frequently unserviceable for some time. It must be recollected, however, that such hounds as are tender, or lean feeders, cannot be fed too late, or with too rich meat. Should any hounds appear to get too fat, they must not be suffered to eat their fill, but the rest may eat as much of the meat as they please.

Once a week, or fortnight at most, during the hunting season, the hounds should have a pound of sulphur given them in their meat; and when the season is over, they should have half a pound of antimony added to the sulphur, and well mixed with the meat. On these days, the hounds should all be let in to feed together, and such as require flesh, have it given to them afterwards. Greens boiled in their meat once a week, is likewise proper. A horse killed and given to hounds whilst warm, after a very hard day's hunting, will make an excellent meal, but they should not hunt again till three days after it. The bones broken are good food for poor hounds, as there is considerable nourishment in them. 246

Sheeps

Hygeiology

Sheeps trotters are alſo very ſweet food, and in a ſcarcity of horſe fleſh, bullocks paunches may be employed with advantage.

247 It is cuſtomary with ſome to ſhut up the hounds for two hours after they have returned from hunting, before they are fed, and the other hounds are ſhut up with them to lick them clean; but probably this practice does more harm than good, as the idle hounds will diſturb the tired dogs more by their licking, than this will make amends for. Beſides, hounds ſhut up on their return from hunting, will not afterwards readily quit their benches, as, if much fatigued, they will ſeek repoſe rather than food. It is therefore a better way when the hunt is nearly over, to ſend forward a ſervant to ſee the meat prepared, that the dogs may be fed immediately on their return. If they have had a ſevere day, they ſhould be fed again afterwards. When hounds are fed twice, they ſhould be kept ſeparate from the hounds that were left at home, till after the ſecond feeding, and it will be ſtill better if they are not put together till the next morning. It is the beſt plan to feed the hounds that have been out twice. Some hounds will feed better the ſecond time than the firſt, and beſides, the turning them out from the lodging houſe refreſhes them, and allows them to ſtretch their limbs; and if the kennel is cleaned out, and the litter well ſhaken up, they will afterwards ſettle themſelves better on their benches. It is at all times proper, after feeding, to turn out the dogs into the graſs court, as this contributes very much to the cleanlineſs of the kennel.

Chap. III. *Of Exerciſe.*

248 Exerciſe.

Nature dictates the neceſſity of exerciſe to almoſt every animal, and a greater or leſs proportion of it is neceſſary to enable them to perform their functions with health and activity. The proportion requiſite for this purpoſe is, however, not the ſame in all animals. Sheep and cattle require but little exerciſe, much of which, indeed, appears to be incompatible with the manner of their eating; for, as they require a ſecond maſtication of their food by rumination, a conſiderable time is neceſſary for this proceſs, which cannot be properly performed, unleſs the animal be entirely at its eaſe. It is found, however, that ſuch of theſe animals as are kept without exerciſe, or are wholly cooped up in houſes, for the purpoſe of fattening them more ſpeedily, are neither ſo healthy, nor afford ſuch fine and wholeſome meat, as thoſe which are permitted to rove at large in their native paſtures. It is to the horſe and dog that exerciſe ſeems the moſt eſſential. Theſe animals require the greateſt proportion, and are moſt injured by the want of it. The obſervations we are about to make will chiefly apply to the horſe.

Such horſes as are conſtantly employed in active labour have, of courſe, ſufficient exerciſe; but it often happens that thoſe which are kept by gentlemen, for their pleaſure or convenience, are, when their labour is not required, permitted to ſtand whole days in the ſtable, without any other exerciſe than being ridden perhaps twice a day to a neighbouring pond. In cities and large towns, even this exerciſe is often not permitted them. They are in the mean time plentifully fed with rich, hard food, and thus pampered, they are rendered liable to the attacks of many acute diſeaſes; and when their exertions are required, they cannot perform their uſual labour with their uſual eaſe. It is therefore neceſſary that ſuch horſes as are not regularly worked ſhould receive daily a moderate proportion of exerciſe, and ſhould be accuſtomed to ſuch a degree of labour as may counterbalance the effect of high feeding, and enable them to undergo occaſional exertion. A horſe who is kept in the ſtate of regular labour is ſaid to be in *wind*. The exerciſe of a horſe that is not conſtantly worked ſhould not, however be exceſſive, or be carried beyond the commencement of fatigue, as this would wear out the horſe without neceſſity. It is an abſurd practice which ſome people purſue, to ſend out their horſes every day to be galloped and rattled along the roads, or perhaps over the ſtreets, for the purpoſe of keeping them in wind. This is wrong, even where the horſe is in good health and ſound condition; but when it is practiſed with ſinew-ſtrained, or foundered horſes, as is not uncommon, it muſt be productive of conſiderable miſchief.

In general, two hours a-day will be ſufficient for the purpoſe of preſerving the health of the horſe, and this may be taken at once or twice in the day, as may be moſt convenient. If poſſible, the owner ſhould ride his own horſe on theſe exerciſing jaunts, for the groom will probably do the horſe more injury than benefit.

Some horſes require more exerciſe than others. Gentlemen's horſes that are merely kept for light riding, will do with but little; but hunters and racers require a greater proportion, and ſhould ſeldom have leſs than three hours a-day. This, however, muſt depend in a great meaſure on the quantity and quality of their food, as the food and exerciſe muſt in general be proportioned to each other; but in all caſes care muſt be taken that the horſe's labour do not exceed his ſtrength. Young horſes are not equal to much exertion, and ſhould therefore be exerciſed but lightly. Many horſes have been deſtroyed by the neglect of this precaution, eſpecially in the army, where it is not unuſual to receive horſes as recruits of four or even three years of age. Theſe horſes, when they reach the regiment, to which they are probably brought from a conſiderable diſtance, are in general weak and in low condition, and are probably ſuffering from ſome acute diſeaſe, brought on them by expoſure to cold and wet during their journey. They are of courſe very unfit for labour, and require at leaſt three or four weeks reſt, before they can with propriety be brought to go through their exerciſes in the riding ſchool. According to Mr White, however, they are ſeldom allowed the half of that time, but are brought too haſtily into the ſchool, without reflecting that, as they are unaccuſtomed to ſuch exerciſes, or indeed at that early age to any kind of work, it muſt become exceedingly fatiguing to them; and to young horſes in a ſtate of debility, eſpecially if they are not immediately attended to, when brought ſweating from the riding ſchool, ſuch labour muſt often be followed by the worſt conſequences.

Where a horſe cannot be conveniently taken out to the fields or roads, for the purpoſe of exerciſe, expedients have been thought on to exerciſe them within the ſtable, or in a yard adjoining. The ſtable can anſwer for this purpoſe only when it is very large, and he may then be made to trot backwards and forwards till

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till he begins to ſweat, with ſome advantage. We have heard of the governor of a certain town, who fell on a good expedient to exerciſe the horſes of a large body of cavalry that had been received into the town, juſt before the enemy laid ſiege to it. As there was no poſſibility of riding out the horſes, he cauſed a number of the troopers to ſtand about the horſes, two or three at each horſe, and whip them ſo as to make them fly from one ſide of the ſtall to the other, till both men and horſes were ſufficiently heated. It is ſaid that by this means the horſes were kept in a pretty good ſtate of health, whereas they would otherwiſe have been much diſeaſed.

When a horſe comes in from work in a profuſe perſpiration, he ſhould not be ſuffered to ſtand to cool at the ſtable door, but ſhould rather be walked gently about, if the weather will permit of it, or elſe be tied up in his ſtall with a cloth thrown over him. If he is in a violent ſweat, it is a good practice to ſtroke off the ſweat with a ſharp-edged ſtick, as is uſually performed on race-horſes immediately after running the courſe. If he is much fatigued, it will alſo be not amiſs to give him a little ſtrong beer, a ſmall draught of which will conſiderably refreſh him. The French commonly give wine in theſe caſes; but their wine is very weak, and is probably not ſo wholeſome for horſes as our ale.

It is very common with the drivers of coaches, and many grooms, to throw cold water over the legs of horſes, when they come to the end of their journey, ſweating and fatigued. Some even ride them into the water on theſe occaſions, or throw it over a great part of their body. This is a very dangerous practice, and gives occaſion to ſeveral diſeaſes of the legs, joints, and feet. It is more eſpecially to be avoided when the horſe has been long ſweating, as when in this ſtate he is too much weakened to bear the ſhock of the cold water with impunity. When a horſe is overheated without much ſweating or fatigue, the practice would probably not be attended with danger, and bathing him with cold water at that time would perhaps be even beneficial, eſpecially if he were immediately rubbed dry, and covered with a light cloth. But as it is difficult to hit this nice point, this practice muſt be employed with caution, and ſhould never be truſted to the indiſcriminate prudence of a groom or coachman. The inſtances of horſes having been plunged into cold water when overheated, without ſuſtaining any injury, are eaſily explained from the above remark.

M. Laſoſſe makes the following remarks on the exerciſe of horſes. "A horſe on a journey may travel five hours at a time, if not hurried onwards; a manege horſe one hour; a cavalry horſe may manœuvre two hours; a coach horſe, at a ſlow pace, ſix hours. But it is proper that ſaddle horſes ſhould not be overloaded, and that the load of a horſe in harneſs ſhould be in proportion to his ſtrength, in order to perform thoſe proportions of labour, to eſtabliſh which is a difficult point; all depends on quickneſs. We will ſay generally, that a ſaddle horſe, well formed, and muſcular, may thus carry at a ſlow rate, two-thirds of his own weight, and run in a chaiſe, with double and one-half of his weight. It is eaſy to ſee from this, that the load of a ſaddle horſe ſhould be leſs if he is put on the trot, and leſs ſtill if he is made to gallop. The draught horſe, on the contrary, lightens his load by ſpeed, which, however, he cannot long continue without tiring, and being out of breath.

"The diſorders which proceed from hard work are, founder, fret, and moſt inflammatory diſeaſes. There are others that proceed from ſudden tranſitions from heat to cold, or, on the contrary, ſuch as inflammation of the lungs, colds, glanders, rheumatiſms, and dropſy of the breaſt. Theſe are particularly frequent and dangerous to cavalry horſes. They have exiſted at all times; but the preſent ſyſtem of manœuvres renders them much more common than formerly; they are a ſpecies of endemial diſorders, which alarm many regiments, and make them dread the conſequences. But there can be no doubt they may be avoided in a great degree.

1. By taking no horſe into a regiment under four years old, and thoſe only which are well formed.
2. By giving them forage of good quality.
3. By airing them in the ſtable, and
4. By avoiding to put them in a ſweat, which is a ſtate contrary to nature. This forced perſpiration dries up and impoveriſhes the blood, ſpoils the finer fibres, the veſſels loſe their re-action; hence the ſtagnation of the humours, which produce tumours and farcy. It would be adviſeable then to avoid accidents after a repetition of military exerciſes by walking the horſes quick, and afterwards ſlowly, until they have regained their natural warmth. By this means a repercuſſion of the humours may be avoided. For the ſame reaſon, a horſe ſhould neither be watered, fed, or dreſſed while ſweating; on the contrary, if he muſt be put into the ſtable, take off the ſaddle, rub him down with ſtraw, and cover him with a cloth *."

* *Veterinarian's Pocket Manual*, p. 11.

PART V. VETERINARY MATERIA MEDICA.

249 IN treating of the ſubſtances employed in the cure of the diſeaſes that affect domeſtic animals, we ſhall firſt deſcribe the uſual forms in which they are adminiſtered, with the moſt approved methods of exhibiting each, in the various caſes to which they are applicable. We ſhall then enumerate the remedies themſelves, arranged under certain heads or claſſes, as is uſually done by writers on the materia medica; for the ſake of bringing together under one view, thoſe articles which are ſuited to the ſame purpoſes. We ſhall not at preſent, however, deſcribe the articles made uſe of, as moſt of them are employed in general medicine, and a particular account will be given of them in the article MATERIA MEDICA. Our object here will be to point out the doſes required for the animals of whoſe diſeaſes we are about to treat; and the particular caſes to which they are adapted. To each claſs we ſhall ſubjoin a number of receipts to which we ſhall have occaſion to refer, when we come to the treatment of the diſeaſes.

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250 Forms. The moſt uſual forms in which medicine is exhibited, to horſes and cattle, are thoſe of powder, ball, drench, clyſter, ointment, poultice, and fomentation.

Powders.

251 Powders. There are not many ſubſtances which admit of being adminiſtered in the form of powders; for as it is neceſſary to mix theſe with the food of the animal, they muſt of courſe be compoſed of ſuch articles as do not impart to the food any very ſtrong or diſagreeable taſte. The ſubſtances chiefly given in the form of powders are antimony, ſulphur, nitre, and ſome of the aromatic ſeeds, &c. They ſhould be reduced to the fineſt powder, and ſhould be thoroughly mixed with the corn or bran that is placed before the animal. Thoſe powders which do not readily diſſolve in water, ſuch as antimony, ſulphur, and the powder of ſeeds, ſhould be moiſtened before mixing with the food, as in this way leſs of the medicine will be waſted. Emetic tartar, and all articles that require to be given in a ſmall determinate doſe, cannot properly be adminiſtered in this form.

In giving powders mixed with the food of horſes, much will depend on the delicacy of the animal's taſte, and on the ſtate of his ſtomach at the time. Some horſes will readily take their food mixed with medicinal powders, while others refuſe every article offered to them in this form. When this is the caſe, or when the medicine thus adminiſtered appears to diſagree with the animal's ſtomach, this mode of giving it muſt not be repeated; but the medicine muſt be adminiſtered in ſome other form.

Powders are alſo ſometimes uſed externally either to ſores and ulcers, or blown into the eyes.

Balls.

252 Balls. The form of ball or bolus is one of the moſt common in which internal medicines are adminiſtered in farriery. It is extremely convenient, as there are very few articles that do not admit of being given when mixed up into a ball; as they are, from the peculiar conformation of the animal's throat, more eaſily adminiſtered than any other form that can be given by the mouth. Some articles, however, eſpecially ſuch as eaſily evaporate at the uſual temperature of the air, as ether and volatile alkali, and ſuch as ſpeedily liquefy or deliqueſce by expoſure to a moiſt atmoſphere, are not ſo properly given in the form of balls. Subſtances, too, which require a very large doſe, do not eaſily admit of this form, and are beſt given in infuſion, or mixed with water in the form of a drench.

It is beſt to prepare balls as they are required, or at leaſt not many days before they are needed, as by expoſure to the air they become hard, and do not eaſily diſſolve in the ſtomach; they may even paſs through the bowels nearly unchanged. But what is of ſtill more conſequence, giving a hard ball may endanger the animal's life, by its ſticking in his throat. Mr White ſays, that he has known ſeveral inſtances of horſes being deſtroyed in this way. Sometimes the horſe's jaws are ſo narrow as not to admit of introducing the hand between them. In this caſe, the ball may be fixed lightly on the end of a ſtick or cane, moderately pointed; or, what is ſtill better, placed looſely in a kind of cup fixed on ſuch a ſtick or cane; and thus thruſt to the back of the tongue.

The ball ſhould be made not round, but nearly of the ſhape of an egg, and rather leſs in ſize. The mode of adminiſtering balls to horſes requires ſome dexterity. To give a ball with eaſe, the operator ſhould extend his fingers ſo as to ſurround one end of it, while the whole hand and the thumb oppoſite to the finger that ſurround the ball muſt be contracted into as ſmall a ſpace as poſſible, as the ſmaller the hand, the greater will be the eaſe with which the operation is performed, both to the farrier and the horſe. The animal's mouth is uſually kept open by means of an inſtrument called a *balling iron*, that is formed like a ring, with an opening ſufficiently large to admit the hand, and which is covered with cloth, and placed between the horſe's jaws; thus preventing him from ſhutting his mouth, or hurting the operator with his teeth. When the ball is held in this way, in the right hand, the tongue of the animal is to be drawn out with the left hand towards the left ſide, and the ball is to be adroitly placed beyond the root of the tongue, and immediately on quitting the ball, the tongue is to be let go, and the horſe allowed to raiſe his head. The ball is now in ſuch a ſituation that it cannot be thrown back, and will be gradually ſwallowed. In holding the tongue, it is proper to keep it pretty firmly againſt the lower jaw, as this poſition greatly facilitates the operation. Balls are uſually wrapt up lightly in paper, to prevent their diſagreeable taſte, but the paper ſhould be very thin and delicate, that it may eaſily give way when the ball enters the ſtomach. Wafer paper, which is employed for adminiſtering boluſes in the human ſubject, would be an improvement in farriery, which may be eaſily adopted, as it is by no means expenſive. 253 Mode of adminiſtering balls.

When the balls are compoſed of very hot or ſtimulating ingredients, it is proper to give the horſe drink before adminiſtering them. It is beſt to give the drink firſt, as horſes in particular will not readily drink after receiving a ball. If the ball has been compoſed of any medicine that poſſeſſes a corroſive quality, or is otherwiſe very irritating, as arſenic, corroſive ſublimate, blue vitriol, or the like, it is neceſſary to give the animal, previous to the operation, a conſiderable quantity of ſome mucilaginous drink, as of water-gruel, or linſeed tea.

When a ball is properly adminiſtered, it gives the animal very little fatigue, and may be repeated much more frequently than any other form of medicine. It is therefore extremely convenient.

The ingredients compoſing a ball ſhould be mixed up with ſome ſugary ſubſtance, as molaſſes, honey, or extract of liquorice ſoftened in water, rather than with any gummy or mucilaginous ſubſtance, as theſe latter ſoon become hard by expoſure to the air.

When a number of balls of the ſame kind are made at once, great care ſhould be taken in mixing the ingredients in the moſt accurate manner, otherwiſe a much greater quantity of the active part of the medicine will be found in ſome of the balls than in others.

Though we have mentioned the uſe of the balling iron, in adminiſtering balls to horſes, ſome grooms and farriers are very expert in giving the ball without this inſtrument.

Materia Medica. inſtrument. Where this can be done, it is certainly preferable, as the uſe of the iron is very apt to alarm a horſe.

Drenches.

254 Of drenches This form is chiefly ſuited to thoſe remedies that are eaſily ſoluble in water, or which readily mix with that fluid, and which have not any very diſagreeable taſte. Hence all mucilaginous ſubſtances, ſome reſins, and many of the aromatics, may be given in this form. It is proper, in compounding a drench, that the ſubſtances compoſing it be thoroughly mixed with each other. It not unfrequently happens, that oils or balſams are given by way of drench, without any pains having been taken to combine them fully with the watery part of the medicine; and when ſubſtances that would admit of being finely powdered, are adminiſtered in this way, the careleſſneſs of grooms or farriers is too often ſuch as to give them in a very coarſe ſtate. In the former caſe the oil or balſam ſwimming in the liquid hangs about the mouth and throat of the animal, and by its unpleaſant taſte renders him averſe to the repetition of the medicine; in the latter caſe, it is evident that the remedy is not reduced to that ſtate in which it is capable of exerting its full effect.

255 Mode of adminiſtering. Drenches are uſually adminiſtered by means of a horn, which is that of an ox or cow, with the larger end cut into the form of a ſpout. Sometimes when a horn is not at hand, a bottle is employed; but this is very improper, as in the horſe's ſtruggling, which often happens in adminiſtering a drench, the neck of the bottle may be broken, and occaſion much miſchief.

In giving a drench by means of the horn, the animal's tongue is to be held down with the left hand, as in giving a ball; and when his head is ſufficiently raiſed, the drench is to be poured cautiouſly into his mouth. Every ſtable ſhould be provided with a drenching horn.

In preparing drenches, farriers almoſt always make uſe of ale or beer, as the menſtruum or diluent; but this is often very abſurd, and can be proper only in the preparation of cordial drenches. Thoſe of a cooling nature ſhould be mixed, either with common water, or with ſome mucilaginous infuſion.

Drenches are ſeldom given with dexterity, and thus a conſiderable quantity of the medicine is frequently ſpilt. This circumſtance renders them often very inconvenient, particularly in caſes where there is any ſwelling or painful affection either of the mouth or throat. Under ſuch circumſtances it is ſcarcely adviſable to adminiſter medicine in the form of a drench; as, independently of the reſiſtance given by the horſe, which will certainly waſte much of the medicine, the forcing of a drench down his throat, when it is in an inflamed or irritable ſtate, may be followed by very unpleaſant conſequences. Mr Clark ſays that he has frequently obſerved a ſimple ſolution of nitre in water, ſweetened with honey or molaſſes, when given in caſes ſuch as we have deſcribed, to occaſion violent coughing, trembling and panting, inſomuch that the poor animal was like to drop down, merely from the acute pain he ſuffered, from a medicine being adminiſtered to him in the form of a drench at ſuch a critical period.

Even the poſition in which the horſe's head is placed to receive a drench may, in theſe caſes, excite the moſt violent pain, from the diſtention which the muſcles of the throat undergo, when the head and tongue are held in ſo awkward a ſituation.

The great advantage of a drench is, that remedies exhibited in this form produce their effect much more ſpeedily than when given in the form of a ball, which may take a conſiderable time to be diſſolved in the juices of the ſtomach. Drenches are therefore particularly ſuited to urgent caſes, in which it is neceſſary to give immediate relief.

Clysters.

This form is ſuited to a great variety of purpoſes, and is not adminiſtered ſo often as with propriety it might be given. Not only purges, which are very commonly adminiſtered in this way, but alſo every claſs of remedies, may be exhibited in the form of a clyſter. The clyſter ſhould be compoſed of no ſubſtances that are not either entirely ſoluble in water, or may be ſo thoroughly mixed with any watery fluid, as to paſs readily through a ſlender tube. 256 Of Clyſters.

The inſtrument employed for adminiſtering a clyſter is, as in the human ſubject, a pipe and bladder, but the bladder ſhould be that of an ox, and of the largeſt ſize; to the extremity of which muſt be fitted a pewter pipe about a foot long, and about half an inch in diameter, having the extremity which is to enter the gut made completely ſmooth, that it may not injure the internal coat of the bowel.

Previous to adminiſtering a clyſter, it is often neceſſary to free the great gut from a quantity of hardened excrement which it may contain. This is beſt performed by means of the hand, and the operation is called *raking*, or *back-raking*. The hand is eaſily introduced, as the diameter of the great gut is in the horſe very large. Care muſt be taken before introducing the hand, to greaſe it well with oil or hogs lard, and to have the nails cut perfectly cloſe, for fear of injuring the gut. This mode of extracting the hardened excrement is frequently required, and will ſucceed when medicine would probably only ſerve to increaſe the animal's diſtreſs. 257 Back-raking.

Large ſyringes are frequently employed for the purpoſe of adminiſtering clyſters; but ſuch imſtruments are exceedingly improper, as their tubes are very ſhort, and they are very difficult to manage, eſpecially if the animal ſhould prove reſtleſs from pain, as frequently happens in caſes of colic; where, as we ſhall ſee, clyſters are very frequently required. 258

Clyſters are peculiarly requiſite in thoſe caſes where medicine cannot be conveniently given by the mouth; as in locked-jaw, or when there is any obſtruction in the throat, or wound of the tongue. In ſuch circumſtances horſes may frequently be kept alive for many weeks, by the frequent exhibition of nouriſhing clyſters.

Ointments.

Ointments are employed in farriery, merely as an application to ſores, or in ſome caſes of eruptions of the ſkin. They cannot be employed as in the human body, to introduce remedies into the ſyſtem; as on account of the hair that covers the body of quadrupeds, 259 Ointments.

Materia Medica. long-continued friction in this way cannot easily be employed.

Poultices.

260 Poultices. Poultices are frequently employed, either for the purpose of maintaining a long-continued heat and moisture about a part in which we are desirous to produce suppuration, or for correcting the unpleasant smell that sometimes arises from foul ill-conditioned ulcers; or lastly, they are applied to check inflammation. In the first case they are always applied warm, and should be renewed repeatedly, till the proper effect is produced; as if old poultices are suffered to remain long on a suppurating part, they tend to check the suppuration instead of assisting it. In the two latter cases poultices are usually applied cold.

Poultices should always be composed of such substances, as admit of being reduced to a soft mass, either by boiling or pounding, as otherwise they would fret and irritate the parts to which they are applied. This must be particularly attended to in such poultices as are laid over large open ulcers, or any part that is highly sensible.

Fomentations.

261 Fomentations. These are intended to relax and soften the parts to which they are applied, and in this circumstance they nearly resemble the first kind of poultices, only that fomentations are always in a liquid form, being composed of some infusion or decoction of herbs. The mode of applying a fomentation is, by wetting a large flannel cloth in the warm liquor, wringing it slightly, and then applying it as warm as can easily be borne over the part to be fomented.

262 In the following list of the articles of the veterinary materia medica, we shall call the substances by those names by which they are usually known to the common people; but we shall add by way of synonyms the scientific names, as derived from the modern systems of natural history and chemistry. In fixing the doses of each article, we shall, unless particularly mentioned to the contrary, only specify the dose proper for horses and cattle; but it would be proper for the reader to keep in remembrance, that the dose for a sheep or a dog will be about one-half or one-third of that for a horse or cow.

In classing the remedies we shall adapt the arrangement given in a late compendium of the materia medica. Most writers on the materia medica of horses, have arranged their articles in alphabetical order. Mr White has done this, in his excellent veterinary materia medica and pharmacopeia. Such an arrangement does very well, if intended to answer the purpose of a dictionary; but for practice, it is better to have the articles classed according to the sensible effects which they appear to produce in the system; as in this way the practitioner has before him all those remedies that are of the same nature, and may select from among them such as he thinks will best suit the particular case that he has in hand.

It may be necessary to observe, that the weight intended in this part is troy weight divided according to the apothecaries, and the measure English wine measure.

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1. Emetics.

263 Emetics. It will have appeared from our description of the stomach of the horse, that this animal is in general incapable of vomiting. Emetics, therefore, as calculated for him, form no part of the veterinary materia medica. We do not know that emetics are given either to sheep or cattle, but to dogs they may be often given with advantage. A few substances, however, will answer this purpose, as in general a little grass, or a little mustard mixed with warm water, will be sufficient to vomit a dog. The following substances may be ranked in this class for dogs.

a. Antimony. *Sulphuret of Antimony.*
Emetic Tartar. *Tartrate of Antimony and Potash.*
Dose from two to four grains.

b. Antimonial Powder. *Oxide of Antimony with Phosphate of Lime. James's Powder.*
Said to have been given with success in the distemper.
Dose from eight to ten grains, repeated every three or four hours, according to the evacuation produced.

c. Mercury.
Turbith Mineral. *Yellow Sulphate of Mercury.*
Used also for the distemper, and in cases of recent poisoning.
Dose about half a drachm. Also recommended in canine madness.

Receipt. 264

1. Take of turbith mineral, five grains;
And emetic tartar, one grain.
Give in a little milk after bleeding.

2. Expectorants.

These are remedies that are calculated to produce or keep up a discharge of mucus from the lungs, or windpipe, and are thus suited to relieve coughs and thickness of wind, or asthma. 265 Expectorants.

a. Ammoniac. *Gum Ammoniac.*
A gum-resin, Dose from three to five drachms, in the form of ball. Commonly combined with squill, or some other powerful expectorant, preceded by a purging medicine. Particularly suited to chronic coughs.

b. Asafoetida. *Ferula asafœtida.* Lin.
A gum resin; dose about half a drachm, in a ball.

c. Balsam of Peru. *Myroxilon Peruiferum.* Lin.
Dose from one to two drachms in combination in a ball, assisted with other expectorants. In chronic coughs.

d. Balsam of Copaiva. *Copaifera balsamum.* Lin.
Dose about an ounce, in the same form and cases as the last.

e. Balsam of Sulphur.
Dose from half an ounce to an ounce.

f. Barbadoes

Materia Medica. *f.* Barbadoes Tar. *Petroleum Barbadenſe.* Lin.
Employed ſometimes in chronic cough; but not ſo good as other expectorants.

g. Garlic. *Allium ſativum.* Lin.
The cloves of the root beaten to a paſte; doſe from one to two ounces; made into a ball with liquorice powder, or boiled in water into a drench. In ſimilar caſes.

h. Squill. *Scilla maritima.* Lin.
Dried root powdered; doſe about a drachm, in a ball, with other mild expectorants.

i. Storax. *Styrax officinale.* Lin.
Strained ſtorax. Doſe two drachms, in a ball. As a ſubſtitute for balſam of Tolu, in obſtinate coughs.

Receipts for Expectorants.

266 Receipts. 2. Take of gum ammoniac, three drachms;
Caſtile ſoap, two drachms;
Powdered ſquill, a drachm.
Mix with honey or molaſſes into a ball.

3. Take of camphor; powdered ſquill, each a drachm;
Balſam of copaiva, half an ounce;
Aromatic powder, two drachms.
With honey, mix into a ball.

4. Take of balſam of ſulphur, four ounces;
Barbadoes tar, two ounces;
Oil of aniſeſeed, two drachms;
Powdered liquorice root, enough to make a maſs, to be divided into balls, each weighing about an ounce and a half, for a doſe.

5. Take aſafœtida, half an ounce;
Powdered ginger, a drachm and a half;
Prepared ammonia, half a drachm;
Honey, &c. enough to make a ball.

3. Sudorifics.

267 Sudorifics. Theſe are ſuch medicines as are intended, either to keep up or bring back the inſenſible perſpiration, or to excite profuſe ſweating. They are alſo called diaphoretics. See Materia Medica.

Few medicines are employed in farriery with a view to excite ſweat. In the dog, it is well-known that this effect can ſcarcely be produced by any means; and in the horſe it is found extremely difficult to produce any ſenſible ſudorific effect by means of medicine. This may indeed be excited by violent exerciſe and warm clothing; but theſe are ill ſuited to the caſes in which ſweating would be moſt deſirable. The inſenſible perſpiration may, however, be gently encouraged by ſome powerful ſweating medicines; and in cattle theſe may not unfrequently be given with advantage.

a. Ammonia.
Mindererus's Spirit. *Acetate of Ammonia.*
Recommended by Mr White as a gentle diaphoretic. Doſe from eight to ten ounces in form of a drench. In febrile complaints.

b. Camphor. *Laurus camphora.* Lin.
Doſe from one to two drachms, in form of a ball. In fevers.

c. Antimony. *Sulphuret of Antimony.*
Very commonly given to horſes for the purpoſe of improving the fineneſs of their coat. Doſe about an ounce, in powder mixed with the food.

d. Emetic Tartar. *Tartrate of Antimony and Potaſh.*
Doſe from one to two drachms; in a ball or drench.

Antimonial Powder. *Oxide of Antimony with Phoſphate of Lime.*
Doſe about two drachms.

e. Unwashed Calx or Oxide of Antimony.
Doſe two or three drachms, in compoſition as below.

f. Nitre. *Nitrate of Potaſh.*
Doſe about one ounce in a ball, with one or two drachms of camphor; or alone in a drench.

g. Opium. *Papaver ſomniferum.* Lin.
Seldom given alone, though it might probably be adminiſtered with great propriety, in doſes of two ſcruples to a drachm.

Receipts for Sudorifics.

6. Take of nitre half an ounce; 268 Receipts.
Camphor, a drachm and a half;
Calomel, powdered opium, a ſcruple;
Molaſſes, enough to make a ball. In fever.

7. Take of unwaſhed calx of antimony, two drachms;
Camphor, a drachm;
Opium, half a drachm;
Compound powder of tragacanth, two drachms.
Honey enough to make a ball.
In fever. To be repeated occaſionally.

8. Take of emetic tartar from one drachm to two;
Compound powder of tragacanth, three drachms;
Honey enough to make a ball.

9. Take of emetic tartar, a drachm and a half;
Ginger, two drachms;
Camphor, half a drachm;
Opium, a ſcruple;
Oil of caraway, ten drops.
Molaſſes enough to make a ball.
For horſes that are hide-bound, and have unhealthy looking coats.

10. Take of antimonial powder, two drachms;
Caraway ſeeds powdered, half an ounce;
Ginger, a drachm;
Oil of aniſeſeeds, twenty drops.
Honey enough to make a ball.

11. Take of unwaſhed calx or oxide of antimony, two drachms;
Prepared ammonia, ginger, of each a drachm;
Opium, half a drachm;
Powdered aniſeſeeds, half an ounce;
Molaſſes, enough to make a ball.

4. Diuretics.

Theſe are remedies that are intended to produce a more than ordinary diſcharge of urine. See Materia Medica. 269 Diuretics.

Diuretics

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Diuretics are frequently given to horfes, not only in cafes of dropfical fwellings, efpecially of the legs, but in greafe, and in many eruptive difeafes; in running thrufhes, crack, or ulcers about the heels; in baldnefs of different parts of the body; and in fome cafes where there appears to be a difficulty in ftaling.

They are ufually given in the form of balls, but fome of them by way of powder mixed with the food. Before exhibiting diuretics, bleeding is fometimes requifite. Thefe cafes will be ftated in their proper place. It is alfo proper, during the ufe of diuretics, that the animal fhould take regular exercife; and occafional drink fhould be given, to promote their operation. The ufe of them fhould not be continued too long, as they are found to produce confiderable weaknefs.

a. Balsam of Copaiva. See *Expectorants.*

This medicine, when given as directed under expectorants, frequently acts as a diuretic.

b. Camphor. See *Sudorifics.*

Dofe about two drachms, mixed with nitre in a ball. In fpafmodic difficulty of ftaling.

c. Nitre. *Nitrate of Potafh.*

Dofe about one ounce, in the form of powder, ball, or drench. In fevers and ftrangury.

d. Potash. *Subcarbonate of Potafh, or Vegetable Alkali.*

Dofe a drachm or two.

e. Rosin.

Dofe from two to four drachms repeated occafionally, in the form of powder with the food.

Rofin is a good diuretic in cafes of fwelled legs and greafy heels, but is feldom given, except to cart-horfes.

f. Soap. *Caftile Soap.*

Dofe from two to fix drachms, in compofition.

g. Tobacco. *Nicotiana tabacum.* Lin.

Sometimes given by grooms for fining a horfe's coat.

h. Turpentine.

a. Common turpentine.
b. Venice turpentine. Dofe from half an ounce to an ounce; in the form of emulfion.

i. Oil or Spirit of Turpentine.

Dofe from one ounce to two.

Receipts for Diuretics.

12. Take of Caftile foap, powdered rofin, of each three drachms;
Nitre, half an ounce;
Oil of juniper, a drachm.
Firft beat the foap and oil of juniper together, and then add the other ingredients, to make a ball.

13. Take of nitre in powder, half an ounce;
Camphor, oil of juniper, of each one drachm;
Caftile foap, three drachms.
Rub the camphor and oil together, then add the foap and nitre, and as much flour as is fufficient to make it into a ball.

Take of rofin and nitre, each half an ounce.
Mix into a powder, to be taken with the food.

5. Purges.

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Thefe medicines are well known. They are generally confidered of two kinds; laxatives, or fuch as gently move the bowels, and are intended merely to empty them of excrement; and purges, or fuch as, befides this effect, are intended to ftimulate the exhalent veffels of the inteftines, and produce a confiderable difcharge of liquid ftools, (See Materia Medica. As either order may in general be given fo as to produce either of thefe effects, according to the quantity in which it is adminiftered, we fhall confider them together. 270 Purge.

Purgative medicines are given with confiderable advantage to all the domeftic animals, in many cafes of difeafe, which will be pointed out hereafter. They are very commonly, however, given to horfes, by grooms and ordinary farriers, by way of alterative or preventive of difeafe; or in order, as they think, the better to prepare them for fome unufual exertion. The reafon given for this practice is, that the horfe is foul in the body, or full of humours, and the purgatives are given to expel this morbid accumulation of humours.

271 Impropriety of indifcriminate purging in horfes.

"This fort of evacuation (fays Dr Bracken, who is one of the firft that pointed out the abfurdity of this practice), feems very much to quadrate with the outward fenfes, and makes the ignorant part of mankind, whofe heads are fuller of humours than their horfes, imagine that purging medicines carry off the offending matter in moft diforders; never confidering the general rule, which ought ftill to be kept in mind, viz. that in proportion to any one evacuation being heightened or increafed, moft or all of the other natural evacuations are proportionally diminifhed.

It muft be remembered that the inteftines of the horfe are exceedingly long, and the large inteftines are fo conftructed as in many cafes to retain the food or excrement for a very confiderable time. Purgative medicines given to a horfe are often retained for 24 or 30 hours; and if thefe have been of an irritating quality, it is evident that the unneceffary exhibition of them may often produce confiderable mifchief. Mr Blaine fays, that when horfes die after the exhibition of ftrong purges, which according to him is not unfrequently the cafe, he has always found the large inteftines more or lefs inflamed.

It is found that after giving a horfe a ftrong purge, he is often incapable of returning to his ufual work for many days; it is even faid for a month. Hence it will eafily appear how abfurd is the practice of thofe who phyfic their horfes without neceffity. Mr John Lawrence is, however, ftill an advocate for purging horfes now and then, and is of opinion that the mifchief done by purges is to be attributed to the coarfenefs of the medicine, rather than to its purging effect. He declares, that after 30 years experience, he has never known purging do harm, if the aloes employed was of the finer fort.

Veterinary practitioners differ with refpect to the time of adminiftering a purge. Mr Blaine recommends it to be given in the morning, when the horfe is to be allowed to faft from 9 or 10 o'clock to 12 or 1. Then a lock or two of hay, or about two handfuls, is to be given him, and after this he is to have the ball, with a horn

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horn full of warm ale, or water-gruel, immediately after it. He is then to fast for another hour, when he is to be allowed the moderate use of hay. He should have all his drink a little warm; should be walked about gently during the remainder of the day, and should have a warm mash at night. Next day he is to be again moderately exercised at intervals, till the purge begins to operate; but if the weather is severe, he must be covered with body clothes, and care must be taken not to have the stable too warm when he returns. Mr Clark recommends a mash of bran to be given about an hour before the ball, and says that in this way he has always found the medicine to operate in a gentle and easy manner.

272 Strong exercise before purging, improper.

It is a common practice with many people to ride their horses very hard before giving them a purging medicine, with the view, as they term it, to stir up the humours, which being thus set afloat, will more easily be carried off by the purge. To say no more with respect to the absurdity of the doctrine, we may remark that the practice itself is highly dangerous, as a purge administered after such violent exercise, will seldom fail to produce inflammation in the bowels, fevers, or some other disorder, which, though it may not at the time prove fatal, may lay the foundation of blindness, incurable lameness, or some other disorder that may render the horse useless. Violent exercise, after administering a purge, is equally to be avoided, as it may produce sweating, and thus counteract the purgative effect; or, what is as bad, it will tend to increase the weakness that seldom fails to be brought on by purging.

We have been the more particular in our observations on purging horses, as it is a matter of considerable consequence, and as the effect of indiscriminate purging in this animal is little understood.

273 *a*. Aloes. *Aloe perfoliata*. Lin.

a. Socotorine aloes. Dose from five to nine drachms.
b. Barbadoes aloes. Dose from half an ounce to an ounce.

Of these the latter is commonly employed for horses. It is best given in form of a ball, mixed with soap, as prescribed at present. In most cases where purges are required.

b. Castor Oil. *Ricinus communis*. Lin.

Dose from a pound to a pound and a half. In fevers and worms. Though Mr White says, he has given it in the latter case without effect.

c. Epsom Salt. See Sulphate *of Magnesia*.

d. Gamboge. *Stalagmitis cambogioides*. Lin.

Seldom employed in horses, though recommended by Mr White as a useful medicine in worms.

Dose from two to three drachms, in a ball with Castile soap.

e. Jalap. *Convolvulus jalapa*.

Dose in the dog twenty to thirty grains.

f. Common Salt. *Muriate of Soda*.

Dose from four to six ounces in a drench, or in a larger dose by way of clyster.

g. Soap.

Chiefly used to combine aloes and other purgatives into a ball.

h. Mercury, or *Quicksilver*.

i. Calomel. *Sub-muriate*, or *mild muriate of mercury*.

Dose from one to two drachms, usually mixed with other purgatives.

In liver complaints, obstinate cases of grease, chronic inflammation of the eyes, and dropsical swellings of the hind-legs.

k. Glauber's Salt. *Sulphate of Soda*.

Dose about a pound. Best given in the form of a clyster. In fevers, and inflammatory complaints.

l. Epsom Salt. *Sulphate of Magnesia*.

As the last.

Receipts for Purges.

14. Take of Socotorine aloes, five drachms; 274 Receipts.
Castile soap, half an ounce;
Oil of caraway, ten drops;
Molasses enough to make a ball.

A moderate dose for young or delicate horses.

15. Take of Socotorine aloes, an ounce;
Castile soap, half an ounce;
Calomel, a drachm and a half;
Oil of mint, twenty drops;
Molasses enough to make a ball.

16. Take of Barbadoes aloes, half an ounce;
Compound powder of tragacanth, two drachms;
Salt of tartar, a drachm and a half;
Syrup enough to make a ball.

This is given as a laxative by Mr White, who declares that he never saw any ill result from giving Barbadoes aloes, though Mr Blaine and Mr Lawrence are of opinion, that Socotorine aloes is always to be prefered.

17. Take of water-gruel, a gallon;
Glauber's salt, half a pound;
Oil of olives, or linseed oil, a pint.

To be given warm by way of clyster. In fevers and inflammations of the bowels.

18. Take of powdered jalap, a drachm;
Powdered ginger, half a drachm;
Syrup of buckthorn, enough to make a ball.

For dogs.

6. Errhines.

These remedies are suited to produce a considerable discharge from the nostrils, and with this view are sometimes prescribed to horses in cases of staggers or violent headaches. They must, however, be given with caution, and not till after bleeding and other evacuating means have been used. They are always administered in the form of powder, which is blown up the nostrils, usually through a quill. 275 Errhines.

a. Asarabacca. *Asarum Europæum*. Lin.

The dried leaves in powder.

The snuff, usually sold by the name of cephalic snuff, is chiefly composed of asarabacca mixed with some aromatic

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aromatic herbs, and will anſwer the purpoſe of an errhine pretty well.

b. TOBACCO.
Common ſnuff.
In affections of the eyes.

7. SIALOGOGUES.

276 Sialogogues. Theſe remedies are given with a view of increaſing the flow of ſaliva or ſlaver. They are ſeldom employed in veterinary medicine, though it is probable that ſalivation might be productive of good effects in the locked jaw, ſo fatal to horſes, and in the *diſtemper* in dogs.

a. GINGER. *Amomum zingiber.*
Sometimes tied about a horſe's bit by way of a maſticatory, as it is called.

b. MERCURY.
Calomel is the only mercurial that can properly be employed to excite ſalivation in the horſe and dog; and it will ſcarcely produce this effect, if given by the mouth. It is beſt to rub the gums with it twice or thrice a day, till the proper effect is produced. See STIMULANTS.

8. EMOLLIENTS.

277 Emollients. Theſe are ſuch remedies as are calculated, either to relax the body, or to abate acrimony. The former are ſometimes divided into diluents and relaxants; the latter are uſually called demulcents, although diluents are alſo commonly given to obviate acrimony.

a. BARLEY. *Hordeum diſtichon.* Lin.
The uſe of barley as an article of food, has been already noticed. A decoction of it forms a part of moſt emollient drenches and clyſters.

b. CHAMOMILE. *Anthemis nobilis.* Lin.
The dried flower. In infuſion or decoction by way of fomentation.

c. GUM ARABIC. *Mimoſa nilotica.* Lin.
In powder. Doſe two or three ounces or more, by way of a drench.

d. GUM DRAGANT. *Aſtragalus tragacantha.*
In infuſion, ſo as to form a mucilage. In inflammatory affections of the lungs, bowels, or bladder.

e. HOG'S LARD.
An ingredient in moſt ointments and liniments.

f. LINTSEED. *Linum uſitatiſſimum.* Lin.
In infuſion, by way of drench or clyſter. In purging or ſcouring.

g. LIQUORICE. *Glycyrrhiza glabra.* Lin.
The root in infuſion, or the powder.
Seldom employed except to render drenches more palatable, or in powder to mix up balls.

h. MARSHMALLOWS. *Althea officinalis.* Lin.
The dried root in decoction, by way of drench or clyſter. In internal inflammations, or irritation from ſtrong purges.

i. OLIVE OIL.
A principal ingredient in ointments and liniments, and alſo frequently given by way of drench or clyſter.

k. STARCH.
Very ſerviceable by way of clyſter diſſolved in warm water, either to obviate acrimony in inflammation of the bowels, and ſcouring; or by way of nouriſhment, combined with a little opium, in caſes where food cannot be given by the mouth.

l. WARM BATH.
Seldom employed, on account of its inconvenience, although it would be probably one of the beſt remedies in ſpaſmodic complaints.

Receipts for Emollients.

19. Take of lintſeed, four ounces; 278 Receipts.
Boiling water, three pints.
Infuſe for ſome hours, and add to the ſtrained liquor of nitre an ounce, honey ſufficient to make a palatable drench. For two doſes.

20. Take of marſhmallow root ſliced, four ounces;
Water three pints.
Boil together till the liquor be reduced to a quart, and to the ſtrained decoction add of
Powdered gum arabic an ounce;
Lintſeed oil two ounces;
Honey ſufficient to make it palatable. For two doſes.
The above decoction, before the other ingredients are added, forms a good emollient fomentation.

21. Take of ſtarch, two ounces;
Water-gruel, two quarts;
Mix for a clyſter.
To be given frequently in ſcouring or purging.
If they are not kept up for a ſufficient time, two or three drachms of laudanum muſt be added.

9. COOLING REMEDIES.

Theſe are called refrigerants by medical writers, and it is ſuppoſed that they act by diminiſhing the temperature of the body. See MATERIA MEDICA. They are peculiarly ſuited to caſes of fever and inflammation. 279 Cooling remedies.

a. NITRE.
Frequently employed in fevers and inflammations, except thoſe of the kidneys, and in catarrh. Doſe about an ounce, diſſolved in water-gruel, or ſome mucilaginous decoction, by way of a drench.

b. SAL AMMONIAC. *Muriate of Ammonia.*
Externally, as a lotion againſt inflammation.

c. SPIRIT OF Salt. *Muriatic acid.*
May be employed as a refrigerant in fevers, when largely diluted with water, or water-gruel.

d. SUGAR OF LEAD. *Acetate of Lead.*
Employed externally, diſſolved in ſoft water; by way of lotion or embrocation, for ſtrains or bruiſes; and in the form of a poultice with oat-meal, to check inflammation.

e. GOULARD'S

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e. Goulard's Extract, or *Vegeto-mineral water.*
Is merely another form of the same remedy.

f. Vinegar. *Acetous acid.*
Employed externally in similar cases.

g. Vitriolic Acid. *Sulphuric acid.*
Useful in similar cases with the muriatic acid, but requires to be largely diluted.

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Receipts for Cooling Remedies.

22. Take of nitre, one ounce;
Emetic tartar, two drachms.
Dissolve it in a sufficient quantity of water-gruel, for a drench.

23. Take of sugar of lead, half an ounce;
Vinegar, two ounces;
Rain-water a quart.
Dissolve for a lotion.

24. Take of sal ammoniac, an ounce;
Vinegar, four ounces;
Spirit of wine, two ounces;
Soft water, half a pint.
Dissolve for a lotion.
Both these lotions are employed in external inflammation.

25. Take of cream of tartar, two drachms;
Nitre, an ounce;
Water-gruel, a quart.
For a drench in fevers.

26. Take of emetic tartar, a drachm;
Glauber's salt, eight ounces;
Water-gruel, a quart.
In similar cases attended with costiveness.
To be repeated every six hours.

27. Take of extract of lead, half an ounce;
Distilled vinegar,
Olive oil, of each two ounces.
Mix well together, into a liniment.
For sore backs.

28. Take of marshmallow ointment, half a pound;
Sugar of lead rubbed fine, an ounce.
Mix for an ointment.

281 Astringents

10. Astringents.

Astringents are such medicines as are supposed to produce a degree of rigidity in the muscular fibres, and thus to increase its power of action, or to prevent morbid discharges. Such as are intended to prevent unusual discharges of blood are called styptics. For the action of astringents, see Materia Medica.

a. Alum. *Supersulphate of Alumina and Potash.*
In powder, from half an ounce to an ounce, in the form of drench or ball.
In purging, diabetes, &c. Externally by way of lotion, or in a fine powder sprinkled on the part. In grease.

b. Bistort. *Polygonum bistorta.* Lin.

The root in powder, from half an ounce to an ounce; or in a larger dose, in the form of decoction, for a drench.

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A powerful astringent in cases of purging, and recommended in hemorrhages.

c. Galls. *Quercus cerris.* Lin.
Nut galls.
In powder, infused in boiling water as an external application.

d. Iron. *Muriate of Iron.*
A powerful astringent, though rarely employed in veterinary practice. It may be given in cases of obstinate purging, or diabetes, in doses of a drachm or two, by way of drench.

e. Japan Earth. *Mimosa catechu.*
Improperly called an earth, as it is a vegetable extract. Given in powder, from two drachms to four, in purging and diabetes.

f. Kino.
An extract similar to the former, and adapted to similar purposes.

g. Logwood. *Hæmatoxylon Campechianum.* Lin.
Extract of logwood. Dose from two to four drachms in a ball.

h. Oak Bark. *Quercus robur.* Lin.
In powder. Dose about two ounces, in the form of a ball. Externally by way of decoction.

i. Pomegranate. *Punica granatum.* Lin.
The dried fruit in powder. Dose from half an ounce to an ounce. Chiefly given in the scouring incident to horned cattle.

k. Tormentil. *Tormentilla erecta.* Lin.
The root in the form of decoction, by way of a drench. An ounce or an ounce and a half in three pints of water, boiled to a quart. In similar cases with the last.

l. Vitriolic Acid. *Sulphuric Acid.*
Diluted Vitriolic Acid.
Used externally by way of lotion, in obstinate cases of grease, and to foul ulcers. Not given to the horse internally.

m. Zinc.

White Vitriol. *Sulphate of Zinc.*
Chiefly employed externally, in inflammations of the eye, and as a lotion to foul ulcers, and to check inflammation. Seems to have little effect on the horse, but may probably be given to cattle with some advantage in cases of debility.

Receipts for Astringents. 282 Receipts.

29. Take of powdered oak bark, an ounce;
Powdered ginger, two drachms;
Opium, a drachm;
Solution of glue, enough to make the mass into a ball.
In profuse staling, with a drench of oak-bark decoction after it.

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30. Take of kino, two drachms;
Alum, half an ounce;
Ginger, a drachm;
Castile soap softened with water, two drachms;
Powder of oak-bark, enough to make a ball.
In scouring or purging.

31. Take of white vitriol,
Sugar of lead, each one drachm;
Soft water, half a pint.
Mix.
For eye-water, in inflammation of the eyes.

283 Strengthening remedies.

11. STRENGTHENING REMEDIES.

These are commonly called tonics by medical writers. Many of them are astringents, and have been already enumerated.

a. GALANGAL. *Maranta galanga.* Lin.
The root in powder; dose about an ounce. In weakness of the stomach.

b. GENTIAN. *Gentiana lutea.* Lin.
The root in powder; dose from half an ounce to six drachms.

EXTRACT OF GENTIAN. Dose, a drachm or two, in a ball in composition. In indigestion and weakness of the stomach.

c. HORSE CHESNUT. *Esculus hippocastanum.* Lin.
The bark in powder, or its decoction. Dose of the powder about an ounce.

d. IRON.

SALT OF STEEL. *Sulphate of Iron.*
Dose about half an ounce. Generally in composition. In similar cases.

e. MYRRH.
A gum resin. Dose in powder, from two to four drachms, in a ball. In weakness of the stomach, and general debility.

f. OAK BARK. *Quercus robur.* Lin.
Dose in powder about an ounce.
In general debility, succeeding to violent diseases.

g. PERUVIAN BARK. *Cinchona officinalis.* Lin.
Dose of the powder from one ounce to two. Seldom employed in veterinary practice on account of its expence. Said to be inferior to many other tonics in the horse.

h. QUASSIA. *Quassia excelsa.* Lin.
The wood and the bark of the root. Dose in powder two or three drachms, in a ball, or infused in water by way of a drench.

i. BLUE VITRIOL. *Sulphate of Copper.*
Recommended as a powerful tonic, but requires caution in its use. Dose about half a drachm, gradually increased according to its effects. A considerable quantity of drink should be given, either before or after it.
In cases of debility that resist other tonics.

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284 Receipts.

Receipts for Tonics.

32. Take of powdered gentian, half an ounce;
Ginger, two drachms;
Honey or molasses, enough to make a ball.

33. Take of powdered horse chesnut bark, an ounce;
Myrrh, in powder,
Castile soap, each a drachm;
Water, enough to make a ball.

34. Take of powdered cassia buds, a drachm;
Extract of gentian, a drachm and a half;
Honey, enough to make a ball.

35. Take of powdered oak bark, an ounce;
Aromatic powder, two drachms;
Salt of tartar, a drachm;
Molasses, enough to form a ball.

36. Take of salt of steel, two drachms;
Infusion of quassia, (2 drachms to a quart of water) a quart;
Dissolve for a drench.

285 Stimulants.

12. STIMULANTS.

These are such remedies as are suited to increase the action, either of the whole circulating system, or of some particular part or organ. They are at present usually divided into *diffusible* and *permanent*, the former being such as produce a considerable stimulating effect, which is soon followed by a degree of quietness or torpor, proportioned to the quantity that had been administered; as wine, alcohol, ether, and probably opium; the other sort being such as produce no very considerable effect, unless repeatedly exhibited for some considerable time.

Most of the stimulants are called *cordials* or *aromatics;* and under this class, we rank those medicines which have been called *carminatives*, or which are calculated to expel wind from the stomach and bowels, *epispastics* or blistering substances; and under this class we may also reckon most of those remedies that are called *alteratives*, or such as are supposed to produce some change in the constitution or habit of body. The stimulating remedies employed in farriery, as in human medicine, are very numerous.

a. AMMONIA, or *Volatile Alkali. Prepared Ammonia. Carbonate of Ammonia.*
Dose from half a drachm to two drachms, in a ball newly prepared. In the latter stages of fever, attended with great debility.

b.——— *Spirit of Sal Ammoniac. Water of Carbonate of Ammonia.*
Chiefly used externally.
Caustic Volatile Alkali. Water of Ammonia.
Used externally mixed with oil into a liniment, in cases of strains, bruises and swellings of the back sinews.

c. ANISESEED. *Pimpinella anisum.* Lin.
The seed in powder. Dose about an ounce, in a ball.
Essential oil of aniseed.
Dose from half a drachm to a drachm, in the same form. In flatulency and indigestion.

d. BALSAM

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d. BALSAM OF COPAIVA. See *Expectorants.*
In flatulent colic or gripes.

e. BARBADOES TAR.
Externally mixed with oil of turpentine or ſweet oil into an embrocation. In ſtrains and bruiſes.

f. CANTHARIDES, or *Spaniſh fly. Lytta veſicatoria.*
Tincture of cantharides. Externally by way of embrocation in ſimilar caſes.

Bliſters are well known to be thoſe remedies that irritate the ſkin to which they are applied, ſo as to raiſe the ſcarf-ſkin into a bladder containing a watery fluid, which is the ſerous part of the blood. By abſtracting this from the general maſs of circulation, they produce an evacuation, proportioned to their extent, from the part to which they are applied, and are thus extremely uſeful in producing a determination of blood from ſome neighbouring and more important part.

Bliſters are of conſiderable uſe in veterinary practice. According to Mr White they are very efficacious in diſperſing callous ſwellings, the effects of ſtrains, bruiſes, &c. Their beneficial effects are very great in removing the inflammation of ſuch parts as are remote from the ſurface. In inflammations of the internal parts of the foot, they generally give relief when applied to the paſtern, eſpecially if the auxiliary remedies are not neglected, ſuch as raſping the hoof, paring the ſole, ſoaking the horny part of the foot in warm water, or by the application of a poultice to it, and adminiſtering a purging medicine. For curbs, wind-galls, ſpavins, &c. no remedy is more efficacious than bliſtering. It is alſo productive of ſalutary effects in inflammation of the internal organs. For inſtance, when the lungs are inflamed, the determination of blood to the diſeaſed part is leſſened by extenſive bliſtering of the ſides, and conſiderable relief is afforded in this way.

By the unſkilful treatment of broken knees, a callous ſwelling is often left in the part, for the removal of which it is always neceſſary to have recourſe to bliſtering. If bliſters are freed from all cauſtic ingredients, and properly made, no injury to the hair will reſult from their application; and if one ſhould fail of producing the deſired effect, the practice may be followed without danger till that object is attained.

g. BLUE VITRIOL. *Sulphate of Copper.*
Employed externally to foul ulcers, either in ſolution, or by touching their edges with a cryſtal of it; to produce healthy granulations. Alſo in ſome inflammations of the eye by way of lotion.

h. BURGUNDY PITCH.
As an ingredient in ſtimulating ointments and plaſters.

i. CAPSICUM, or CAYENNE PEPPER. *Cap. annuum.* Lin.
The dried pod in powder.
Doſe about a drachm, in a ball, with milder ſtimulants. In flatulence and indigeſtion,

k. CARAWAY. *Carum carui.* Lin.
The ſeeds and their eſſential oil.
Doſe of the oil from half a drachm to a drachm, in a ball, as preſcribed preſently. In weakneſs of the ſtomach, flatulence, and indigeſtion.

l. CASSIA. *Laurus caſſia.* Lin.
The bark and flowering buds in powder.
Doſe, from one to three drachms. Uſed as an ingredient in many cordial medicines. Chiefly for affections of the ſtomach.

m. CLOVES. *Eugenium caryophyllata.* Lin.
The flowering buds.

n. OIL OF CLOVES.
Doſe, 20 or 30 drops. In gripes and ſickneſs of the ſtomach.

o. CUMMIN. *Cuminum cyminum.* Lin.
The ſeeds and their eſſential oil.
In a doſe of from half a drachm to a drachm, in ſimilar caſes.

p. OIL OF CUMMIN.
Doſe, from half a drachm to a drachm. In flatulent colic.

q. FENNEL. *Anethum fœniculum.* Lin.
The ſeeds in powder.
Doſe, an ounce or two.

r. GINGER. *Amomum zingiber.* Lin.
The root in powder. One of the moſt uſeful ſtimulants, and preferable to moſt others in veterinary practice.
Doſe, a drachm or two. In weakneſs of the ſtomach, indigeſtion, and flatulent colic.

s. GRAINS of PARADISE. *Amomum grana paradiſi.* Lin.
The ſeeds. Chiefly employed as a ſtimulant for cattle, as a cordial.
Doſe, from three to ſix drachms.

t. WHITE HELLEBORE. *Veratrum album.* Lin.
The root in powder. Chiefly uſed externally in bliſters, and for diſeaſes of the ſkin. Formerly employed as a purge for horſes, but now deſervedly exploded, as by far too violent.

u. HORSE RADDISH. *Cochlearia armoracia.* Lin.
The freſh root in infuſion or diſtilled water. In flatulence and indigeſtion.

v. MERCURY.
Calomel. Doſe, from 15 grains to half a drachm. In farcy, glanders, &c.

Wherever calomel or other mercurial preparations are given, the animals ſhould be kept warm, ſhould drink their water a little warmed, and ſhould take regular exerciſe in dry weather.

w. CORROSIVE SUBLIMATE. *Muriate of Mercury.*
Employed internally in ſolution, in doſes of about 15 grains, gradually increaſed. In farcy and glanders. Externally by way of lotion, to foul ulcers and eruptions of the ſkin.

No preparation of mercury ſeems to produce ſo great a degree of weakneſs in the horſe as this. Its effects muſt therefore be carefully watched; and beſides the regulations laid down above; the horſe muſt be kept on a more nouriſhing diet than uſual.

x. RED PRECIPITATE. *Nitrated Oxide of Mercury.*
Externally to ulcers, either ſprinkled on their ſurface, or

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or mixed into an ointment; in which latter form it is very useful in chronic inflammation of the eyes.

y. NITRATE OF MERCURY. See *Receipts*, N° 49.

z. MINT. *Mentha sativa*, Lin.
The essential oil.
Dose, about a drachm. In weakness of the stomach, &c.

a a. MUSTARD. *Sinapi nigrum*. Lin.
The seed in powder.
Externally mixed with water into a paste, or sinapism, in cases of internal inflammation.

b b. PEPPERMINT. *Mentha piperita*. Lin.
The essential oil.
Dose, about half a drachm. In similar cases with mint.

c c. PEPPER. *Piper nigrum*. Lin.
Dose, from half an ounce to an ounce, in powder. In flatulent colic.

d d. SPIRITS. *Whisky, Gin, or Brandy*.
Dose, from a gill to half a pint. To cattle in the flatulence proceeding from eating too much green food.

e e. SALT. *Muriate of Soda*.
Given with good effect to sheep in the rot.

f f. TAR.
Commonly given by country farmers to cattle when hoven from clover.

g g. TURPENTINE.
Oil of Turpentine.
Dose, an ounce or two. In flatulent colic. Externally by way of embrocation. In cases of indurated swellings, strains, and bruises; and for cattle after the bite of the gad-fly.

286 Receipts.

Receipts for Stimulants.

Cordial Balls.

37. Take of caraway seeds powdered, six drachms;
Powdered ginger, two drachms;
Oil of cloves, 15 drops;
Treacle enough to make a ball.

38. Take of powdered anisefeeds, half an ounce;
Turmeric, an ounce;
Powdered cassia, two drachms;
Treacle enough to form the ball.

39. Take of caraway seeds, and grains of paradise, each in powder, three drachms;
Ginger, a drachm;
Oil of mint, 30 drops;
Honey enough to form the ball.

Stimulating Ointments and Liniments.

40. Take of yellow basilicon, half a pound;
Red precipitate finely ground, two ounces;
Mix well together.
For foul ulcers.

41. Take of hog's lard four ounces;
Oil of turpentine, an ounce.
Melt together on a slow fire.
In similar cases.

42. Take of oil of turpentine,
Oil of olives, each two ounces.
Mix for a liniment.
For strains and bruises.

43. Take of verdigrise finely powdered, an ounce;
Venice turpentine, half an ounce;
Olive oil, an ounce.
Melt the turpentine and oil together, and when nearly cold, add the verdigrise.
For foul ulcers.

44. Take of hog's lard, four ounces;
Bees wax, an ounce;
Venice turpentine, three ounces;
Red precipitate finely ground, two ounces.
Melt the three first together, and when nearly cold, sprinkle in the powder.

This is Mr White's receipt for the digestive ointment, commonly employed by farriers for dressing rowels and ulcers.

45. Take of camphor, an ounce;
Oil of turpentine, two ounces;
Rectified spirit, four ounces.
Dissolve. For old strains.

Stimulating Lotions.

46. Take of blue vitriol, an ounce;
Water, four ounces;
Vitriolic acid, 10 drops.
Mix.
For similar cases, and for the mange.

47. Take of blue vitriol, half a drachm;
Water, half a pint.
Dissolve for a lotion.
In inflammation of the eyes.

48. Take of tincture of opium, two ounces;
Water, six ounces.
Mix for an eye water.
In similar cases.

49. Take of aquafortis, two ounces;
Quicksilver one ounce.
Dissolve in a gentle heat, taking care to avoid the fumes.

This forms a *nitrate of quicksilver*, and when diluted with a proper quantity of water, is one of the best applications for the foot-rot in sheep.

13. ANTISPASMODICS.

287 Antispasmodics.

These are such remedies as are calculated to remove spasmodic affections of the muscles, or convulsive affections, and are therefore frequently employed in cases of locked jaw, epilepsy, &c. Few remedies of this class are used in veterinary practice. Such as are more peculiarly of this nature are mentioned below. They generally consist of stimulants or of anodyne remedies.

a. CAMPHOR.
Dose, about two drachms, in a ball combined with opium and stimulants. In locked jaw.

b. ETHER. *Sulphuric Ether*.
One of the most powerful antispasmodics.

Dose,

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Dose, about an ounce, mixed with a pint of water. This should be given as expeditiously as possible, otherwise much of the ether will evaporate. In obstinate cases of flatulent colic.

c. Opium.
Dose a drachm or two. The latter quantity generally in clysters.

Tincture of Opium.
Dose, from half an ounce to an ounce, repeated occasionally, in most spasmodic complaints.

Oil of Turpentine.
Dose, about two ounces. In flatulent colic.

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Receipts.

50. Take of camphor, a drachm;
Essence of peppermint, two drachms.
Grind together, and add
Of water, a pint;
Ether, half an ounce.
Mix.
To be given immediately.
In violent cramp of the stomach.

51. Take of tincture of opium, an ounce;
Oil of juniper, two drachms;
Dulcified spirit of nitre, a drachm;
Water, a pint.
Mix.

52. Take of tincture of opium, two ounces;
Cold water-gruel, a quart.
For a clyster.
To be repeated frequently.
In locked jaw.

289 Anodynes.

14. Anodynes

Are those remedies which are given for the purpose of procuring sleep, or alleviating pain. They are commonly called *narcotics*, and many of them are by most medical writers denominated *sedatives*.

a. Fox-Glove. *Digitalis purpurea*. Lin.
The leaves in powder.
Dose, half a drachm, increased gradually according to its effect. In violent internal inflammations and swelling of the legs.

b. Hemlock. *Conium maculatum*. Lin.
Leaves in powder.
Dose, about a drachm, gradually increased.

Extract of Hemlock.
Dose, about a drachm.
In obstinate coughs attended with irritability.

c. Henbane. *Hyoscyamus niger*. Lin.
The leaves in powder, or the seeds.
Dose, about a drachm.

Extract of Henbane.
Dose, about a drachm.
A solution of this extract has been found useful, applied to the eye, in chronic inflammation.

d. Hop. *Humulus lupulus*. Lin.
The dried cones in powder.
Dose a drachm or two, in a ball.
The hop has been shewn to be a powerful narcotic, and has succeeded in producing sleep in some cases where opium has failed. It has not yet been introduced into veterinary practice; but we think it deserves a trial, as being much cheaper than opium.

e. Opium.
Dose, about a drachm by the mouth, and two drachms in a clyster.

f. Poppy. *Papaver somniferum*. Lin.
The dried heads boiled in water, by way of fomentation.

290 Receipts.

Receipts.

53. Take of opium, a drachm;
Powdered anisefeeds, half an ounce;
Castile soap, two drachms;
Molasses, enough to make a ball.

54. Take of camphor, a drachm and a half;
Opium, a drachm;
Ginger, two drachms;
Honey, enough to form the ball.

55. Take of tincture of opium, two drachms;
Decoction of poppyheads, a quart.
Mix for a clyster.

56. Take of extract of hemlock, two drachms;
Peppermint water, half a pint;
Ether, half an ounce.
Dissolve the extract in the water, and add the ether at the moment of exhibition.
For a drench.
In putrid fever, or gangrene.

57. Take of bruised poppyheads, four ounces;
Hemlock leaves green, a large handful.
Boil gently in a gallon of water for about an hour, and strain the decoction.
In wounds and bruises attended with considerable irritability.

15. Worm Medicines. 291 Worm medicines.

There are few cases in which worm medicines are given in veterinary practice. In the horse they are seldom required, and do not often prove effectual. In the dog, indeed, they have been employed more frequently, and may be used with more probability of success. The remedies of this class are generally of two kinds, either such as are violent purgatives, and in this way expel the worms by the violence of their operation; or, they are such as act mechanically on these animals, irritating and tearing their tender bodies, and thus forcing them to relinquish their situation.

a. Castor Oil.
Dose, about half a pound.

b. Gamboge.
Dose, two or three drachms in a ball.

c. Mercury. *Calomel.*
Dose for a horse, two or three drachms; for a dog, about half a drachm, in a ball with purgatives.

d. Salt.

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Dose, from four to six ounces, in a drench, or double the quantity by way of clyster.

Said to have proved frequently successful in expelling worms, when followed by a brisk purgative.

e. Sal Indus.

A salt lately procured from the East Indies, said to be successful in expelling bots from horses; but Mr White thinks that other worms have been mistaken for bots, in the cases where it has been successful.

Dose, about four or five ounces in a drench.

f. Tin. *Powder of Tin.*

Dose, about an ounce, mixed with honey.

This promises to be one of the most effectual medicines in cases of tape-worm, that are so common to dogs.

292 Receipts.

Receipts.

58. Take of calomel, jalap, each half a drachm;
Honey enough to make a ball.
For dogs.

59. Take of tin powder,
Quicksilver, of each two drachms.
Grind together till they be thoroughly mixed; then add enough of sugar to form a powder, to be made up into a ball with castile soap, softened with water.

60. Take of sal indus, four ounces;
Alum, half an ounce;
Water, a pint.
Dissolve for a drench. For the botts in horses.

293 Chemical remedies.

16. Chemical Remedies.

Many remedies are given internally, or applied externally, which seem to act merely chemically, either by combining with an acid or alkali, and thus neutralizing it, by checking putrefaction, or correcting the ill smell that is produced by it; or, in external applications, by destroying or corroding the parts to which they are applied. This class will therefore comprehend,

1. All those medicines that have been called *antacids* or *absorbents*, which are given to correct acidity in the stomach and bowels.

2. *Antalkalines*, or those acid substances that are given more rarely to correct alkalescence.

3. *Antiseptics*, or those that are supposed capable of obviating putrefaction.

4. *Caustics* or *escharotics*, which are intended to corrode the skin, or to take down fungous or proud flesh in ulcers.

a. Alum.
Burnt Alum.
Sometimes applied to ulcers, to wear down proud flesh.

b. Ammonia.
Spirit of Sal Ammoniac. Water of Ammonia.
Dose, a drachm or two, in a drench, for acidity in the stomach and bowels.

c. Antimony.
Butter of Antimony. Muriate of Antimony.
Sometimes applied to foul ulcers. A violent caustic.

d. Charcoal.

Given internally in powder, to correct the bad smell in violent purging; and when powdered fine, may be sprinkled on large stinking sores, with the same intention.

e. Lime.
Lime-water. Dose about a quart, in acidity of the stomach.

f. Chalk.
Carbonate of Lime.
Dose, an ounce or two.
In violent purging attended with acidity.

g. Silver.
Lunar Caustic. Nitrate of Silver.
Employed to eat down proud flesh, or destroy horny excrescences.

h. Spirit of Salt. Dose about two drachms, mixed with a quart of water by way of drench.

i. Vinegar.
Given internally as an antiseptic, diluted with an equal quantity of water, or used externally to wash foul ulcers.

k. Vitriolic Acid.
Dose, a drachm or two, as under spirit of salt.

l. Yeast or Barm.
Employed to make fermenting poultices in cases of stinking ulcers.

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61. Take of prepared chalk, an ounce;
Powdered ginger, two drachms;
Honey enough to make a ball.
In purging attended with griping.

62. Take of purified soda in powder,
Powdered gentian root, each two drachms;
Powdered cassia, a drachm;
Treacle enough to form a ball.
In indigestion, with acidity of the stomach and bowels.

63. Take of charcoal in powder,
Powdered oak bark, each an ounce;
Treacle enough to make a ball.
In violent purging, producing very fetid stools.

64. Take of oat meal,
Powdered charcoal, of each four ounces;
Thin yeast, a sufficient quantity to make a poultice.
To be applied to foul ulcers.

65. Take of aquafortis, an ounce;
Filings of copper, half an ounce.
Dissolve in a gentle heat, taking care to avoid the fumes.
For a caustic, in canker of the foot. It may be made into an ointment for the same purpose, by mixing with hog's lard.

66. Take of fresh burnt quicklime powdered,
Soft soap, of each equal parts.
Mix at the time of using.
A mild caustic, useful in destroying parts of the skin where necessary.

67. Take

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67. Take of corrosive sublimate, half a drachm;
Ardent spirits, two ounces.
Dissolve for a lotion.
Useful as an application to the callous edges of ulcers.

295 Miscellaneous remedies.

17. Miscellaneous Remedies.

a. Eggs. The Yolk.

Sometimes employed among the common farriers as a remedy for broken wind, but appear to be useful only for the purpose of combining oily substances with water.

b. Elecampane. *Enula helenium.* Lin.

The root in powder. In the form of ointment for the itch or mange.

c. Glass.

Powdered glass is sometimes blown into the eyes of horses, to remove specks on the cornea.

d. Lead.

White Lead. White Oxide of Lead.

Sometimes used by way of ointment in some diseases of the skin.

e. Diachylon Plaister. *Litharge Plaister.*

Employed in making charges or strengthening plaisters.

f. Bays. *Laurus nobilis.* Lin.

Oil of Bay.

Sometimes used in ointments for the mange.

g. Stavesacre. *Delphinium staphisagria*, Lin.

The seeds in powder. Employed to destroy vermin, being sprinkled on the skin.

h. Zinc.

White flowers of Zinc. White oxide of Zinc.

In ointment, to sores and ulcers.

Calamine. Impure Carbonate of Zinc.

Employed to make the common brown cerate.

296 Receipts.

Receipts.

68. Take of sulphur vivum finely powdered.
Powdered elecampane root, each two ounces;
Hogs lard, enough to form an ointment.
For the mange.

69. Take of sulphur vivum powdered, four ounces;
Salt butter, six ounces;
Train oil,
Oil of turpentine, each one ounce.
Mix well together into an ointment.

These two ointments are useful applications in the mange.

70. Take of hogs lard, four ounces;
Tar, two ounces.
Melt together into an ointment.

Employed to anoint the backs of sheep or cattle, when bitten by the gad-fly.

71. Take of burgundy pitch, four ounces;
Barbadoes tar, six ounces;
Bees wax, two ounces;
Red lead, four ounces.
Melt the pitch, tar, and wax together, and when the mixture is nearly cold, stir in the red lead, and continue stirring till it is firm.

This is Mr White's receipt for making charges, or strengthening plasters.

In cases of wind-galls and old strains.

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297 Impropriety of giving medicines to horses unnecessarily.

Before concluding this part, it will be proper to make a few observations, on the custom that prevails so much among grooms and farriers, of administering medicine to horses, by way of preservatives of health, or preventives of disease. It is very common among these gentlemen to bleed or physic a horse at least twice a-year, viz. in the spring and fall, though he be in never such good health, or good condition; to give him sulphur and antimony now and then *to keep his coat fine;* and to administer a cordial ball, or a dose of *diapente* occasionally to *improve his appetite.* If he is to undergo any unusual exertion, as riding or hunting, it is judged necessary by these sagacious practitioners to prepare him for the work, by bleeding, purging, and sweating below a load of body clothes in a close, hot stable. In pursuing this custom, they indeed only imitate what they practise on themselves on similar occasions. As they deem it necessary to have themselves bled every spring and fall, or once a quarter, to take physic once a month, and to sweat themselves to make them ride or run more lightly in a jockey match, they naturally conclude that their horses should be treated in the same manner, and should undergo the same preparation.

If an animal is in a perfect state of health, nothing more is required to render him capable of performing the functions for which he is intended. It is only when there appears some derangement of the system, or when the state of the body is such as to threaten the attack of some dangerous disease, that it is necessary to call in the assistance of medicine. We shall soon have occasion to mention cases of this kind, and to shew how the threatened danger is to be avoided. It must be remembered that those substances that are called medicine, are such as produce some effect on the body, that is in general either unnatural, or is greater than what commonly takes place in a state of perfect health. If then we give medicines to an animal in this healthy state, we either excite the organs to some unusual exertion, or we check those exertions that are natural and healthy; and in either case, we must do harm. Besides the custom of giving medicines when they are unnecessary, renders them less efficacious when they are absolutely required, to ward off or obviate any disease. It is found that most remedies, when employed habitually, require to be increased in quantity in order to produce the same effect, and if continued too long they sometimes cease to produce their effect at all. With respect to some remedies, it is found that their habitual use is attended with dangerous consequences. Frequent bleeding tends to produce fatness, and a plethoric state of the body; the frequent use of cordials and astringents stimulates the circulation too much, and produces such a rigidity of the fibres, as lays the foundation of apoplexy, palsy, and other dangerous disorders. It is well known, too, that when the action of the stomach is too much excited by the habitual use of stimulants, it in time loses its tone, and becomes incapable of healthy digestion, unless roused by a greater quantity of its accustomed stimulus. It is therefore obvious that when an animal is in perfect health, all that is required to keep him so, is the proper regulation of diet, exercise, cleanliness, and other circumstances that have been mentioned in the fourth part of this article.

298 Case.

We cannot better illustrate the absurdity of the usual methods

Diseases. methods of preparing horses for a race, than by the following case, which fell under the observation of Mr Clark of Edinburgh. "Two military gentlemen betted their horses to run against each other on the sands of Leith for a considerable sum, and this was to take place three weeks after the bet. The horses were to be ridden by their own grooms. Captain R's was a poney about 13½ hands, Captain M's was a gelding about 15 hands high. Both grooms were bred at Newmarket, and were keen advocates for bleeding and purging, though both the horses had been kept on dry food, and in the best order, and the interval of time for such treatment was very short. This bleeding and purging was in order to prepare them the better for running. Captain M's horse was bled once, and purged twice. Captain R's was bled once, and purged once. Both were sweated in the stable with a great load of clothes; and their stables, though separate, were kept uncommonly hot, and closely shut up day and night, though it was in the midst of summer. From this treatment the horses soon lost their appetite, and in the course of eight or ten days their strength was so much exhausted that they were scarcely able to go through their usual exercise on the sands. In this situation Captain R. considered his bet as lost, and expected nothing less than the loss of his poney, on which he set a high value. Luckily, however, the groom, who was rather corpulent, had put himself under a course of physic, to bring himself down to the proper weight, and was unable to proceed in his plan of purging and sweating the horse. The poney was therefore provided with another groom, and was put under the care of Mr Clark, who, seeing the absurdity of the plan which had hitherto been observed, ordered his clothing to be reduced to a single rug, and the stable windows to be thrown open, to admit the fresh air. The poney soon recovered his appetite; and his activity, strength and spirits were in a great measure restored. Captain M's horse in the meantime was continued under the debilitating regimen. When the race came to be decided, though at starting the odds were considerably in favour of Captain M's horse, yet his opponent won the race with considerable ease.

PART VI. OF THE DISEASES INCIDENT TO DOMESTIC ANIMALS.

299 IN treating of the diseases of domestic animals; we shall class them in two great divisions: in the first of which we shall consider most of those morbid affections which are usually called *local* and *symptomatic*, or in general those simple affections of the several functions, that are most easily understood, and require the least complicated mode of treatment. In the second of these divisions we shall treat of the more complicated diseases, or those in which the whole system is more or less affected, and of which the treatment is more difficult, and in general more precarious.

300 Classification of symptoms. When an animal is diseased, he is affected with some or other of the following symptoms.

301 Of sensation.

1. *Of Sensation.*

He labours under too acute sensibility; or,
He is affected with pain or itching.
His sensibility is unusually diminished.
His sense of smelling is more or less impaired.
He hears with difficulty, or not at all.
His vision is more or less impaired.
He is unusually watchful.
His sleep is disturbed; or,
He is unusually heavy and drowsy,

302 Of motion.

2. *Of Motion.*

He is either affected with irregular, involuntary motions or spasms; or,
His moving powers are impaired.

303 Digestion.

3. *Of Digestion.*

His digestive organs perform their functions too quickly.
His digestion is impaired; or,
He does not digest at all.
He is affected with sickness,
with flatulence, or wind in the stomach and bowels.

304 Of absorption.

4. *Of Absorption.*

He is unusually *fat*; or,
unusually *lean*.
He is affected with some watery swelling.

305 Of circulation.

5. *Of Circulation.*

His circulation is too rapid; or,
It is too slow; or,
It is irregular.
He has some effusion of blood.

306 Of respiration.

6. *Of Respiration.*

His breathing is hurried; or,
It is difficult.
He is affected with cough;
with sneezing,
hickup.
His breath is hot; or,
It is cold.
His skin is unusually hot; or,
It is unusually cold.

307 Of secretion and excretion.

7. *Of Secretion and Excretion.*

His secretions and execretions are either unusually copious.
He stales profusely.
He has a purging; or,
His skin is unusually moist.
The secretions and excretions are morbidly diminished.
He stales with difficulty, or not at all.
He is costive.
His skin is unusually dry.

8. *Of*

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8. *Of Generation.*

308 Of generation. His venereal appetite is excessive; or,
It is morbidly impaired.
He is impotent.

When a practitioner comes to examine one of these animals whose health is deranged, he will naturally inquire into all or most of the above particulars, and they will in general apply to all the four animals of which we are treating. There are some other questions which peculiarly relate to horses, and which it more especially becomes a farrier to ask; as, Whether his flanks work. Whether his ears are cold; or are in constant motion.

309 Enquiries proper to be made by a farrier.

In what manner he walks.
Whether he looks earnestly at his sides.
Whether his eyes appear drowsy.
In what manner he carries his head.
Whether he kicks his belly.
Whether he appears desirous to lie down, but afraid to do so.
Whether he sometimes lies down on one side, and then immediately turns to the other.
Whether he lies down and flies up again repeatedly.
Whether he leans upon the manger.
Whether he stands off from the manger.
Whether he paws his litter.
Whether his nose runs.
Whether or not he passes much wind.

It will also frequently be of consequence to ascertain the following particulars.

Whether the horse is usually in a poor condition.
How did the disorder begin?
How long it has continued.
How long it is since he ate or drank.
Has he ever had the disorder before?
If he has, What was usually given him on these occasions?
Does the disorder come on at any particular times?
Has he been observed to pass any worms?
How long he has been bought, and what price was paid for him.
Was he bought of a horse-dealer, or of a private person?
Of a friend, or at the public market?

310 Having ascertained the necessary particulars, it is proper to consider whether the disease is of such a nature as has in general been easily removed; or whether the expence and time of cure will be sufficiently compensated by the value of the horse; for it must be remarked, that in general a horse or other domestic animal is worth no more than the price he would fetch at the public market. Unless, therefore, the animal is a favourite, or has some particular good quality which greatly enhances his value, it may happen that the expence and trouble of cure may amount to more than the animal is worth. In such a case it would be both prudence and mercy to kill him, unless we wish to attempt his cure for the sake of experience. These observations of course equally apply to cases that are generally deemed incurable.

Having found that the disease is of such a nature as to give hopes of a speedy or perfect cure, it will next be proper for the practitioner to consider what is the speediest, safest, and cheapest method of treatment. In particular, he ought to consider whether any immediate remedy be necessary, in order to check the violence of the distemper; more especially whether any immediate evacuation is required, as bleeding, purging, blisters, rowels, &c.

He must also be particular in examining whether the disease be of a contagious or infectious nature, that the affected animals may be kept in a separate place from those which have not been attacked.

As the general nature and theory of disease will be considered at large under the medical department of this work, we have only in this article to detail the symptoms as they occur in the domestic animals; to point out the causes and seat of the disease, as far as they have been ascertained by observation and dissection; and to lay down the most approved methods of treatment adapted to these animals. Observations with respect to the theory of diseases would here be out of place, and we shall seldom hazard them, except in some of those specific complaints which appear to attack solely the animals of which we are treating. 311

It may not be improper to remark, that diseases, like the objects of natural history, have been arranged in two methods. One of these is the natural method, in which they are classed according to their seat or causes. The causes of diseases are the foundation of Dr Darwin's system. In the first section of this part we shall attempt to class the morbid symptoms according to their seat, or the functions which they attack. The other method of arrangement, or the artificial method, is that in which diseases are arranged according to some obvious and remarkable symptoms. This is best calculated for the purpose of recognizing the disease when seen, and is the method employed by most nosologists. The diseases in the second section of this part will be arranged in this way. 312 Classification of the diseases.

SECT. I.

Chap. I. *Of Morbid Affections of Sensation.*

Most animals are occasionally subject to a morbid increase of sensibility, either of the whole nervous system, or of some particular organ. This morbid sensibility is generally called by medical writers, *irritability;* but this name is improper, as it implies an affection of the muscular parts; whereas the symptom we are now considering is an affection of the nervous system. 313 Morbid sensibility.

Some horses naturally possess a morbid degree of sensibility, which appears by their starting on the sudden approach of any object, by the peculiar tenderness of their skin that makes them wince and tremble under the currycomb, and by the extreme sensibility that they evince at the least touch of the whip or spur. Such horses are in general very active and spirited; but they require a cautious and prudent rider, who must rather endeavour to soothe and encourage them, than use any harsh or violent means.

This increased sensibility is not easily removed by art, but

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but generally decreases as the horse grows older. It is best counteracted by living in a large well-aired stable, by being kept on hard coarse food, and by lying with as little litter below him, as is sufficient to prevent him from injuring himself against the pavement of the stable. In dressing him the currycomb should not be too sharp, and should not be employed too freely.

When excessive sensibility arises from a delicacy and weakness of habit, strengthening medicines will be of use, and cordials may occasionally be employed.

There is a symptom nearly allied to this, which sometimes appears. The animal affected gathers himself together, and brings his four legs as close as possible below him, and creeps as it were all on a heap. This symptom often attends nervous diseases, and severe affections of the bowels. It is generally considered as a sign of great danger, and is not unfrequently the forerunner of mortification.

At the commencement of several acute diseases, especially those of the brain, animals betray an unusual sensibility to the effects of light and sound. When this happens, the place where they are kept should be darkened, and they should be as little as possible disturbed with noise.

314 Restlessness, or anxiety.

There is a peculiar *restlessness and anxiety* with which animals are sometimes affected. This is not unfrequently their only complaint, or at least we cannot perceive that they are affected with any obvious or well-marked disease, but it is most commonly a symptom attending violent disorders, especially of the inflammatory kind; and generally preceding the fatal termination of dangerous chronic diseases. Animals thus affected are continually moving about, and often lie down; if they are at liberty, they seek out the most sequestered and gloomy parts of the pasture, and frequently change their place: if they are tied up, they appear to listen to, or observe, every thing that passes round them; they are restlessly attentive to the various objects near them; but although their eyes appear fixed, and wide open, they do not stedfastly regard any object; they are perpetually turning from side to side, and if they feel pain in any part, they often turn their heads mournfully towards it, sometimes groaning or panting. If this state has continued long, the animals become still more restless, are perpetually shifting about, scraping with their feet and pawing the litter; their ears become cold, and their hairs bristle up.

These latter symptoms are considered as denoting great danger, especially when the animal looks stedfastly at his sides, or stares with his eyes without appearing to take particular notice of any object.

When anxiety appears to be the only symptom, without any signs of inflammation or convulsive affection, it is generally a mark of nervous weakness, and requires cordial and strengthening remedies, nourishing diet, and gentle exercise without labour: but if it is a symptom of some violent disease, it can only be removed by the general treatment of that disease; and in this view, will come to be considered hereafter.

315 Depression of spirit.

316 Fatigue.

Animals are sometimes affected with dejection or loss of spirit. This is not unfrequently the attendant of fatigue brought on by excessive labour or unusual exertion; and is therefore most commonly seen in horses. It appears by the animal's leaning his head on the manger, standing still in the same place, and appearing to move with pain or difficulty. His limbs are stiff, his skin hard and dry, his eyes look sad, he has no appetite for meat; if he lies down, he remains immoveable, or if obliged to rise, immediately falls again when left to himself.

Diseases.

In general, if the fatigue produced be not extremely great, it gradually goes off with rest and quiet, especially if it has been found practicable to employ the means that are presently to be recommended; but if the exertion to which the animal was exposed, has been too great for its strength, the consequent depression may prove highly dangerous, or even fatal. In this state his urine is crude and watery, and, if a male horse, he seems scarcely to have the power of *drawing* for the purpose of making water; and his excrements are dry and scanty. If taken out in this condition he moves with pain and difficulty, trots slow, or lifts his feet very little above the ground, carries his head very low and his ears depressed over his forehead; he often stumbles, and not unfrequently falls on his knees, and appears very little sensible of the whip or spur. If a horse in this state has any sores or ulcers about him, they become hard, or flabby, assume a dull appearance, and the matter proceeding from them becomes thick and viscid. Rowels very frequently dry up; and if he is affected with any eruption of the skin, this commonly disappears.

To prevent the bad consequences that are likely to follow the state which we have now described, it is proper, as soon as we find a horse much fatigued, to spread a bed of litter for him to rest on; and as soon as possible give him a cordial ball, or drench. The strength of this must not, however, be in proportion to the degree of fatigue or depression; as experience has shown, that when a powerful cordial is given in a state of excessive weakness, it proves too much for the animal, and frequently excites fevers or inflammation. The horse's limbs should be bathed with warm water, and then rubbed thoroughly dry. After this he should be left to his repose, and if it be not too late at night, he may in a few hours have a warm bran mash. When a little recovered, he must be gently rubbed all over, but especially his limbs, without currying; he should be put upon a nourishing diet, and exercised but little. These means, varied according to circumstances, will in general bring the horse round, unless the symptoms are extremely violent; when they will commonly terminate in fever, or in some chronic disease, especially dropsy.

The train of symptoms which we have been describing, are most commonly the effect of fatigue; but they may arise from other causes. They are more or less the attendants of decay, and they are generally the forerunners of fever or inflammation of the brain.

317 Insensibility, drowsiness.

Sometimes these animals are affected with a great degree of insensibility or torpor; they are heavy and listless; lie much; are not easily disturbed; are inattentive to the objects around them; seem to be insensible to pain, and move heavily and unwillingly. These symptoms require particular attention, as in most cases they denote some dangerous affection of the brain, and are very commonly followed by apoplexy or *staggers*; or by epilepsy; or they are the attendants (especially in sheep) of water in the head. Wherever they are observed to take place in an animal that has been full fed, with little exercise, especially if he appear fat and full of of blood, and the pulſe be found full and ſtrong, the eyes red or heavy, there is danger of apoplexy; and the animal ſhould immediately be bled and purged, be gradually put on a lower diet, and uſe gradually more exerciſe. Theſe changes muſt be made by degrees, becauſe too ſudden changes may produce the very effects againſt which we are guarding.

A great degree of torpor and inſenſibility is often produced by exceſſive cold, or by being kept long in an impure atmoſphere. Where they have taken place from either of theſe cauſes to a dangerous degree, the application of heat muſt not be too ſudden, as it will tend to extinguiſh the ſmall remaining ſpark of life, and produce apoplexy, or mortification, where any external part has ſuffered from cold.

318 Giddineſs, or turn-ſick. The head may be affected with dizzineſs, or giddineſs, commonly called *turn-ſick*, from various cauſes. It may ariſe from great weakneſs, or it may be the conſequence of plethora, or fullneſs of blood. In the latter caſe, it is a pretty ſure mark of approaching apoplexy or ſtaggers; and the animal muſt immediately be bled, and put on a lower diet, with gentle exerciſe. In ſheep, dizzineſs is a common ſymptom of ſturdy, or water in the head, a complaint which will be conſidered hereafter. It will be evident that when this affection appears in animals that are lean, meagre, and in low condition, it ſhows the neceſſity of a more full and nouriſhing diet.

319 Blindneſs. The only morbid affection of the external ſenſes, that we ſhall here conſider is blindneſs, a defect which is of moſt conſequence in the horſe, though it may occur in all the domeſtic animals.

320 Marks of a ſound eye. The eyes of a horſe, when perfectly ſound, have the cornea or outer covering, and the humours that are ſeen through it, perfectly clear and tranſparent; there ſhould be no ſpecks, or *dragons* as they are called, in either; no greenneſs or glaſſy appearance of the pupil, and this ſhould readily contract when ſuddenly expoſed to a clear light. Buffon obſerves, that in a ſound eye, two or three ſoot-coloured ſpots appear through the cornea above the pupil.

321 Partial blindneſs. When a horſe has a defect in his viſion, without being perfectly blind, he appears dull, fearful, and reſtive, ſtarts at ſuddenly approaching any object, carries his head high, or to one ſide; moves his ears alternately, or turns one forwards, while the other is turned backwards; and uſually hangs back on his bridle or halter, and lifts his legs up very high.

Partial blindneſs is a ſymptom of ſeveral diſeaſes in the horſe: it uſually attends great weakneſs, eſpecially when this has been brought on by hard work and low feeding; it is a common attendant on locked jaw, and generally precedes the ſtaggers. It of courſe is one of the effects of old age.

When proceeding from debility, it generally goes off in proportion as the ſtrength is reſtored by reſt and proper nouriſhment; when it is a ſymptom of other diſeaſes, it goes off when they are removed. The blindneſs of old age is incurable, and in the horſe we believe no method has yet been diſcovered of relieving the defect by art.

It is generally allowed, that it is better to have a horſe totally, than partially blind; as when quite blind, he is not liable to ſtart, or be ſhy; and when ſure footed, well ſhod, and managed by a careful rider, there is little danger of his ſtumbling or falling.

Total blindneſs either proceeds from a defect in the optic nerve, by which this is rendered incapable of receiving the impreſſion of light, or from an opacity or muddineſs in the cornea or humours, by which the tranſmiſſion of light through them is obſtructed. 322 Total blindneſs.

The firſt ſpecies of blindneſs, or that depending on a defect in the optic nerve, is generally called by farriers *glaſs eyes*, and by medical writers, it is termed *amauroſis*, or *gutta ſerena*. 323 Glaſs eyes.

It is known by the peculiar glaſſy appearance of the eye, which ſeems perfectly clear, ſo that an ordinary obſerver would not ſuppoſe that there was any defect in the horſe's eye. On examining the eye however more attentively, it will be found that the pupil is conſiderably dilated, and preſerves the ſame ſize in every change of light; not contracting, as uſual, when the light to which it is expoſed becomes ſtronger. There is alſo a greeniſh appearance of the eye in this diſeaſe.

The cauſes of glaſs eyes are not well aſcertained. It has followed a blow on the head, or inflammatory affections of the brain or its membranes, but it has come on ſometimes imperceptibly, and where theſe diſeaſes, or any other evident cauſe has not appeared.

This diſeaſe in the horſe has hitherto proved incurable.

The moſt common cauſe of blindneſs in the horſe, is an opacity of the lens, or cryſtalline humour of the eye. This diſeaſe is known by the name of *cataract*, and is ſometimes called by farriers, *moon blindneſs*, or a horſe that has a cataract is ſaid to be moon-eyed. 324 Cataract.

It is in general eaſily diſcovered that a horſe labours under a cataract, as, when the diſeaſe is confirmed, an obſcurity or muddineſs may be ſeen in the centre of the pupil, occupying more or leſs of the opening, according as the cataract is more or leſs extended. The opaque ſpot is generally of a dull white or yellowiſh colour. Sometimes the cryſtalline humour is ſo fixed to the iris, or that moveable coloured part in the middle of the eye, as to obſtruct its motion, and then the pupil retains the ſame ſize in every light; or if the adviſion is partial, the pupil of the eye aſſumes an irregular ſhape. It muſt be obſerved, that in this diſeaſe, the iris is not always ſo immoveable as in glaſs eyes; though when the cataract is fully formed, the pupil is generally enlarged, and contracts very little on the approach of a ſtrong light. Sometimes the lens comes through the pupil altogether, and floats in the watery humour, in the fore part of the eye.

The cataract in horſes is ſaid to be always a conſequence of inflammation in the eye, which will be conſidered in the ſecond ſection of this part.

The only method that appears likely to remove the cataract, is an operation by which the opaque lens may be thruſt down below the pupil, or entirely extracted from the eye; but neither couching nor extraction can be recommended in the horſe, as the removal of the lens would ſtill be attended with a defect of viſion that would render the animal of leſs uſe, than if he were totally blind.

Another cauſe of blindneſs, and alſo a conſequence of inflammation, is opacity of the cornea. There may be either a diffuſe whiteneſs or muddineſs in the cornea, that is more or leſs extenſive; or, there may be ſpecks 325 Opacity of the cornea.

 that

or warts growing on the outſide of this coat, ſo as to obſtruct the paſſage of the rays of light. Sometimes the opacity of the cornea is only ſlight, producing partial blindneſs; but frequently it is univerſal, and then the horſe cannot ſee at all. This univerſal opacity of the cornea is ſometimes, though improperly, called *cataract*. It ſometimes diſappears for a time, and the eye ſeems nearly as clear as ever; but it generally returns in no long time.

General opacity diffuſed through the ſubſtance of the cornea, does not readily yield to remedies. Attempts have been made, by ſcarifying the veſſels on the white of the eye, or by ſtimulating applications to the cornea, to rouſe into action the abſorbent veſſels of the eye, and thus remove the opacity; but theſe attempts ſeem to have been attended with little ſucceſs. Specks or warts on the cornea, if they are not too large, may generally be removed by the knife, or by repeatedly blowing into the eye a powder compoſed of powdered glaſs and white vitriol. But, if theſe ſpecks are attended with any general opacity of the cornea, little benefit is to be expected from theſe operations.

326 Warts. As the ſkin is ſo intimately connected with ſenſation, we ſhall here conſider ſome of the more ſimple affections of that organ, that are not generally attended with fever. It is not uncommon for excreſcences or warts to grow on the ſkins of domeſtic animals, particularly on horſes and oxen. Sometimes they are hard and firm; at others they are ſoft and ſprouting: in ſome their root is ſmaller than their head; in others the baſe is the largeſt part. The ſprouting kind of warts are called by the farriers *anger-berries*, *ambury* or *ambery*, and are not uncommon among oxen. As theſe are largeſt at the baſe, they can, like all of that deſcription, be removed only by touching them daily with ſome cauſtic, as lunar cauſtic, or butter of antimony. Where the wart has a ſmall root, it may be beſt removed by tying a ſtrong waxed thread round the root, tightening it now and then as it gets looſe till the wart drops off. It is in general not proper to remove warts by the knife, unleſs they are of ſuch a firm conſiſtence as not to bleed on being cut, and to admit of the application of cauſtic after cutting.

327 Mallenders and ſallenders. There ſometimes appears on the ſkin of the horſe, a ſcurfy eruption at the bending of the knee, or the bending of the hock. The eruption generally appears in both places at once, and is called by farriers, the *Mallenders* and *Sallenders;* a term which they have borrowed from the French. When conſidered ſeparately, the eruption of the knee is called the *mallenders*, and that of the hock the *ſallenders*.

Theſe eruptions may generally be traced to want of cleanlineſs, and are, in moſt caſes, eaſily removed, by waſhing the parts with ſoap and water, and applying an ointment, compoſed of mercurial ointment and camphor; or either of the ointments marked N° 41. and N° 70. in the receipts.

328 Hide-bound. When a horſe's ſkin is hard, dry, and unuſually tight about the body, the animal is ſaid to be hide-bound. This tightneſs about the ſkin is uſually the effect of hard work and improper food; and commonly attends lingering diſeaſes, in which the fat is gradually waſted or abſorbed. It muſt therefore be conſidered rather as a ſymptom of diſeaſe than as a diſeaſe itſelf: but, as is the caſe with moſt remarkable ſymptoms, it has often been regarded as a primary diſeaſe; to remove which, by ſweating and relaxing remedies, is the principal object of the practitioner.

The proper remedies for this affection, when it is not a ſymptom of ſome lingering diſorder, are nouriſhing diet, with plenty of green food, particular attention to cleanlineſs, by frequent dreſſing, and the occaſional uſe of boiled barley and warm maſhes.

329 Surfeit. Horſes that have a lean, unthrifty-like appearance, with their coats looking rough and ruſty, are ſaid by the grooms to labour under a *ſurfeit*. Whence has ariſen the application of this ſtrange term to an appearance that ſeems ſo oppoſite to what is generally underſtood by a ſurfeit, we are not aware; but an affection of the ſkin, under the name of ſurfeit, is thus deſcribed by Mr Lawrence: "Its confirmed ſtate is attended with eruptions, and ſometimes with ſwellings of the legs and joints, and in the latter caſe is uſually to be looked upon, as the termination of ſome chronic diſeaſe, or a conſequence of the improper uſe of mercurial phyſic. Surfeits are ſtyled *dry* or *wet;* in the former, the ſkin is covered with a thick dry ſcurf, with ſcabs, and ſmall hard tumours like warbles; in the latter, a ſharp briny ichor iſſues from the poll, neck, withers, quarters, and hinder legs, in the bend of the hock, cauſing great ſtiffneſs and inflammation; this is probably analogous with ſcurvy in the human body, and will often attend cart-horſes, with foul and unwholeſome blood, at ſtated periods. The too free uſe of beans will produce the wet ſurfeit.

"The cure of *ſurfeits* depends almoſt entirely upon internal alteratives, with a very ſmall attention to external applications. As to the latter, perhaps, frequent cleanſing, with a good ſtrong lather of ſoap is generally ſufficient, but where the eruptions are hard and fixed, and the ſcabs do not peel off, I know of nothing better than to rub them frequently with the ſtrong mercurial unction, keeping the horſe well clothed, and giving warm water in the interim. The warm bath if the animal is ſtrong *."

* *Lawrence on Horſes*, vol. ii.

330 Mange in horſes. One of the moſt common diſeaſes of the ſkin among domeſtic animals, is what is commonly called the *mange* in horſes, cattle and dogs, and the *ſcab* or *itch* in ſheep. Its ſymptoms differ but little in the different ſpecies of animals, and we do not remember to have ſeen the diſorder well deſcribed by any writer. The following deſcription of the mange in horſes by Mr Feron, is perhaps among the beſt that have been publiſhed. "The mange is a contagious chronical diſorder which manifeſts itſelf in the ſkin, on which ſenſible eminences of a roundiſh figure riſe up; theſe being ſcratched, a fluid oozes out, of a hot and corroding quality, that excoriates the ſound ſkin wherever it runs, in a little time forming a dry, ſcaly, cruſty eruption, which in its progreſs ſpreads over the whole ſurface of the body; and the ſkin becomes unequally thick, thin, hard, and ſoft. If the diſorder has been neglected, or ill-treated, the animal falls off from his food, grows lean, and the legs ſwell; in this ſtate the patient has frequent fits of ſhivering and trembling, and a ſlight fever ariſes, terminating in farcy or the glanders, by which he is eaſily deſtroyed †."

† *Feron's Farriery.*

331 In cattle. A diſeaſe ſimilar to this, if not of the ſame kind, affects cattle, eſpecially ſuch as are ill fed, and not kept clean. It is commonly called by herdſmen, the *ſcab* or

Diseases. or *scurf*; and is thus described in a popular treatise on cow-doctoring.

Skin stiff, and sits fast to every part of the carcase, as if too small for the body. It makes its first appearance about the head and jaws of the animal, with a scurfy, pale, and dry texture; and the beast begins to scratch against every thing that comes in its way: it then shews itself along the back, and behind the shoulders; and if timely aid be not procured, the animal will tear its skin till it bleeds violently, which ought to be prevented, if possible, as the scabs which are the consequence of bleeding, much retard the efficacy of the ointment, and the loss of time confirms the disorder.

332 In sheep.

This disease is incident to sheep in some particular pastures, situations, and seasons, more than to others. The predisposing cause seems to be a relaxed habit of body, produced by poverty or leanness, though some sheep are subject to it that are fat, and otherwise in good condition. The disease seldom seems to originate with such sheep, but to be conveyed to them by infection. *

* *Findlater's Survey.*

333 In dogs.

Dogs are exceedingly subject to the mange, and readily catch it from each other. The appearance of the disease in dogs, is familiar to every one, as there are few more common and disgusting sights than a mangy dog. A dog in this state is very unfit for any active exertion, as the affection of the skin renders him stiff and sore even in his limbs. A friend of ours had a greyhound, that, when he was clean, was one of the swiftest runners in the country, and had gained the prize in many a coursing match. This dog caught the mange, and while in this situation was several times, sent in pursuit of a hare; but now, puss generally escaped him.

This disease has sometimes been attributed to animalculæ, such as are found in the symptoms of the itch upon the human skin; and analogy seems to be in favour of this idea. It is, however, evidently connected with poor living, and want of cleanliness.

334 Treatment.

In the treatment of the mange, we are to rely chiefly on the use of external applications, such as ointments, composed of sulphur, of some preparation of mercury, or hellebore roots. The receipts marked N° 68 and 69 are well adapted to the cure of this disease. Sometimes internal remedies, such as sulphur and gentle laxatives, are required; and the greatest attention must be paid to cleanliness, diet, and exercise. It may be necessary in some cases, especially where the animals that have caught the disease, are very full of blood, to bleed and give cooling physic previous to the application of ointment; and in all cases the skin should be thoroughly washed with soap and water, both before and after anointing. The animals should always be confined till they are quite free from the disease.

Mr Feron, who considers the mange in horses as a general affection of the system, and not merely a local disease of the skin, strongly recommends the use of blisters, which he has seen act as a specific. "The local treatment, and the only one to be depended upon (says this gentleman), consists in a judicious application of blisters, used after the following manner; viz. if the whole body is affected, the one half must be blistered one day, and the other in three days after. This must be done at different times, in order to prevent the cantharides from operating too violently upon the kidneys and bladder; but if this happens, let the animal be bled, and clysters frequently injected. But the best way to avoid this, is to leave off all kinds of internal medicines, during the action of the blisters. When they begin to operate, the skin must be fomented with warm water three times a-day, in order to wash out a quantity of yellow matter, discharged by the action of the blisters, and to encourage the growth of new hair." We do not pretend to dispute the efficacy of Mr Feron's blistering practice in removing the mange, but we doubt whether the blistering one half of the body with cantharides may not be productive of more serious consequences than the disease which it is intended to remove. At any rate, the expence of the method, and the torment which it must occasion to the poor animal, must greatly prevent the general application of the remedy.

In Mr Findlater's survey, quoted above, are the following judicious observations on the treatment of sheep labouring under the scab.

"Sheep that are regularly tarred, or smeared, are seldom infected with this disease. If the disease be partial, perhaps the best remedy would be to clip the affected parts as bare as possible, and rub them occasionally with the common smearing ointment, to which may be added a little Venice turpentine. They should also be washed, once or twice a week, with black soap and water. But if this prove ineffectual, or if the disease has gone to a great extremity, the animal should first be washed as clean as possible, in a pond, or rill of water, to purge away all the accumulated virus, or infecting matter, from the wool. A little black soap may be of great use in washing. Then the whole body may be smeared with juice of tobacco; and after the animal becomes dry, may be rubbed with butter mixed with powdered brimstone; or brimstone mixed with the smearing ointment would answer better. A little of the sulphur may meanwhile be thrown down its throat. If this treatment, being twice or thrice repeated, after an interval of several days, should prove ineffectual, recourse must be had to the mercurial ointment, composed of three ounces of hogs lard, well rubbed in a mortar, with half a drachm of finely powdered corrosive sublimate; or the same proportion of corrosive sublimate, well mixed with three ounces of the common smearing ointment, will answer equally well. The animal being smeared with this ointment, will soon be effectually cured. Meanwhile the diseased animal should be invigorated or put upon substantial food."

In a note Mr Findlater mentions an observation of Mr Loch's of Rachan, that the matter discharged in the scab mixing with the wool, and drying, forms a hard impenetrable crust, which he has observed of half an inch in thickness; that it is vain to think of curing it by any external application, till this is removed; and that you might as well attempt to cure a man of the itch, by rubbing butter and brimstone upon his coat, instead of his naked skin; that the scurf thus formed, must be removed by soaking and washing it with warm lime-water and soap, and scraping it clean to the quick with a blunt knife. It may then be successfully cured by the ointment; or, what is more cleanly and more easily prepared, by means of a lotion made by dissolving half a drachm of corrosive sublimate in a quart (chopin) bottle of whisky and water. Mr Loch has always

Diseases. always found this lotion effectual, after two or three applications.

It has been proposed by a correspondent of the Farmer's Magazine, to inoculate sheep for the scab, in order to render it milder. Even should inoculation have this effect, which is by no means certain, it does not appear necessary, in a disease that is so easily cured.

Besides the several applications that we have mentioned, a variety of ointments and lotions are recommended by writers on dogs. Mr Beckford advises that as soon as a mangy spot appears on a hound, it should be well rubbed with a liniment composed of a pint (mutchkin) of train oil, half a pint of oil of turpentine, a quarter of a pound of powdered ginger, and half an ounce of gunpowder. It is also recommended that the dog should have a purging ball now and then, and should be kept from flesh meat. There is a variety of the mange in dogs, called the red mange, which it is said is best cured by mercurial ointments.

335 Lice and fleas.

Most of the domestic animals, especially when young, are troubled with lice. Calves are sometimes lousy, if they have been hard kept during winter, by being turned out in severe weather, fed on poor diet, and not kept clean. The best means of destroying these vermin is by rubbing their hide with an ointment composed of staves-acre, or cayenne pepper, mixed up with hogs lard.

Young whelps are very subject to lice; but they may be easily removed by washing with a lotion formed by steeping a pound of tobacco in three English pints of small beer, or by rubbing the skin well with train-oil.

Fleas are best destroyed by washing the dogs frequently with soft soap and water.

Sheep are often infected with vermin of various kinds, which harass the animals exceedingly; and not only do much mischief to the wool, but even eat into the animal's skin.

336 Fly.

The sheep fly abounds most in the southern parts of the island, and is chiefly troublesome to lambs. The most effectual means of protecting the lambs from the insect appears to be to smear the fleece with any kind of rancid oil.

337 Ticks.

Another species of insects that infest sheep is commonly called tick, or kedd, the *hippobosca ovina* of naturalists.

The smearing ointment generally prevents, or kills this insect. But if this should not happen, or if the sheep are not smeared, insects of every kind may be effectually killed, by slightly rubbing the parts affected with mercurial ointment, composed of three ounces of hogs lard, rubbed up with half a drachm of finely powdered corrosive sublimate. To this may be added, a little of the spirit of turpentine. Coal-oil is powerfully destructive to insects of every kind; but whether it may not prove injurious to the health or fleece of the sheep, has not yet been ascertained by experiment. A decoction or distillation from the gall-plant, which abounds in many mosses and muirs, is known to be very fatal to insects of every kind; and a sheep may be safely washed with this juice. The juice of tobacco is also much recommended as a poison for those insects which infest sheep.

The last species of insects are chiefly hurtful to sheep of a year old, or more.*

* *Findlater's Survey.*

Among the insects which prove most troublesome to horses, sheep, and cattle, are those of the genus *Oestrus*, some species of which are generally known by the name of *gad-fly*. The best account of these insects and their effects, that we have seen, is that of Mr Bracey Clark, published in the third volume of the Linnæan Transactions, from which the following account is chiefly taken.

Mr Clark describes five species of *Oestrus*, viz. *Oe. bovis*, *Oe. equi*, *Oe. hæmorrhoidalis*, *Oe. veterinus*, and *Oe. ovis*.

We shall at present describe the effects only of the first and last species.

The *Oe. bovis*, as its name imports, chiefly attacks cattle, through the skins of which it pierces, in order to deposit its eggs. The pain which it inflicts in depositing its egg, appears to be much more severe than what is excited by any of the other species. When one of the cattle is attacked by this fly, it is easily known by the extreme terror and agitation that seizes the whole herd. The unfortunate object of attack runs bellowing from among his fellows, to some distant part of the pasture, or to the nearest water, holding his tail, from the severity of the pain, extended straight from the body, in a line with his back, with a tremulous motion, and stretching out his head and neck to the utmost. The rest of the herd, infected with the like fear, though not attacked, fly also to the water, or disperse to different parts of the pasture. "Such is the dread and apprehension in the cattle, for this fly, says Mr Clark, that I have seen one of them meet the herd when almost driven home, and turn them back, regardless of the stones, sticks, and noise of their drivers; nor could they be stopped till they reached their accustomed retreat in the water." 338 Gad-fly, or Oestrus bovis.

When one of these flies happens to attack oxen that are yoked in the plough, there is often considerable danger, as the animals become quite ungovernable, and will often rush directly forwards with the plough, through hedges, or whatever opposes their career.

Heifers, steers, and the younger cattle, are in general most frequently attacked by this fly; the strongest and most healthy beasts seem constantly to be preferred by it, and this circumstance is said to be a criterion of goodness held in much esteem by the dealers in cattle. Tanners also have remarked, that their best and strongest hides have generally the greatest number of holes in them.

The larvæ of this species, as of most of those we are to mention, are generally termed *bots*, but this name is most frequently applied to the larvæ of the *Oe. equi*.

The complaint produced by the puncture of this insect in the skins of cattle, is called *puckeridge*, and is not unfrequently attributed to the bite of the goat-sucker. For the destruction of the larvæ thus deposited, it has been recommended to insert a red-hot wire into each of the holes made in the skin; but this is a formidable remedy, and will probably do as much harm to the skin as the bots themselves. A more rational practice that is sometimes in use, is to press the parts, and rub them well with a little oil of turpentine, or some other stimulating application, or a little oil of turpentine may be injected into each hole.

The

Diseases. The larvæ of the *Oe. bovis* are commonly known to the country people by the names of *wormils*, or *wormuls*, or *warbles*.

339 Oe. ovis. During the summer, sheep are often observed to gather together in clusters, endeavouring carefully to guard their heads. Mr Blaine says that this is to protect themselves against the attacks of this insect, which attempts to lay its eggs on the inner margin of the nose, which when it has effected, these eggs become larvæ, and creep up into the frontal and maxillary sinuses.

It is not easy to discover the manner in which this insect deposits its eggs, owing to its obscure colour and rapid motions, and to the great agitation into which the sheep are thrown by its attack; but the subsequent motion of the sheep, and the manner in which they attempt to defend themselves against their enemy, leave no room to doubt, that the eggs are deposited on the inner margin of the nostrils.

The moment the fly touches this part of the sheep, they shake their heads, and strike the ground violently with their fore feet, at the same time holding their noses close to the earth; they run away, looking about them on every side, to see whether the fly pursues: they also smell to the grass, as they go, lest one should be lying in wait for them. As they cannot, like horses, take refuge in the water, they have recourse to a rut, or dry dusty road, or gravel-pits, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly conveniently to get at the nostril.

Observations on these flies are best made in warm weather, and during the heat of the day, when by driving the sheep from their retreats to the grass, the attack of the fly, and the emotions of the sheep, are easily observed.

The nostril from repeated attacks, and the consequent rubbing against the ground, becomes highly inflamed and sore, which occasions their touch to be so much dreaded by the sheep.

It is said that this fly also deposits its eggs in the skin of the sheep, but we are not certain how far this has been proved by experience; although there is no doubt that there are sometimes found in the sheep's skin, maggots that must have been produced from eggs deposited by some insect. They prove extremely troublesome to the animal, eating into the skin, and producing ulcers. If not discovered in time they may even destroy the life of the sheep. The remedy is to clip the infected parts bare, wash them well with black soap and water, and apply the smearing ointment. If this does not succeed, recourse must be had to the method recommended, in N° 337.

340 Pelt-rot. When sheep have lain about for a long time in wet and marshy pastures, or have been kept in woods or copses in a starving condition, their fleeces become so completely soaked with water, that the wool rots off from the skin. This is what is called the *pelt-rot*. If sheep be suffered to continue long in this condition, they become heavy and low-spirited, and will sooner or later be destroyed. If, however, they be attended to in proper time, they may be saved by driving them to a good straw-yard, pulling off their ragged and rotten wool, and rubbing on a good coat of tar, grease, and turpentine. Care must also be taken, to provide them with plenty of good wholesome nourishment.

The skin of all animals, especially on the most delicate parts of it, is subject to excoriation or chafing. This is of most consequence in the backs of horses fretted with the saddle, and the udders of cows by rubbing against their thighs, when they are *cat-hammed*, and go close behind. Both the udder and thighs of the cow are sometimes quite raw, and ulcerated. The best remedy in these cases, is to wash the parts well with warm soap and water, and afterwards bathe them frequently with a mixture of Goulard, and camphorated spirits. Diseases. 341 Excoriations, chaps, &c.

The teats of cows are sometimes *chapped*, which is commonly owing to want of cleanliness in the milkers. When this happens, the treatment recommended above for *chapping* may be followed, or if this does not succeed, the teats may be anointed with what is called *unguentum nutritum*. If the teats are very painful, the cracks may first be bathed with a little laudanum, and afterwards filled up with finely powdered prepared chalk.

There are many other diseases that affect the skin of these animals; but some of them are so trifling as not to require particular notice, and others being intimately connected with some general derangement of the system, fall more properly to be considered in the next section of this part.

Chap. II. *Morbid Affections of Motion.*

The function of motion may be morbidly affected in various ways, but all these tend more or less to impede or disturb the natural motions of the animal. 342

The muscles are often affected with irregular motions, producing violent involuntary contractions, called convulsions or spasms. These are often symptoms of some dangerous derangement of the brain or nervous system, as locked-jaw, epilepsy, canine madness, &c. Convulsions of this nature, being intimately dependent on the primary disease, can only be removed by such means, as are calculated to carry off the disease, of which they are the symptoms. Irregular action of the muscles commonly attends great debility, whether it be brought on by hard work and low diet, or by disease. In either case, it is commonly a very dangerous symptom. We cannot properly consider the treatment of convulsion here; but it will be considered in the next section, when we come to treat of convulsive or spasmodic diseases.

The affection that we are chiefly called to consider in this chapter is lameness, a very comprehensive term, as it includes almost all the local affections of the extremities. Lameness is a complaint that is exceedingly common among horses and dogs, especially the former; in whom it more particularly demands attention, as it so materially affects the value of the animal. A knowledge of the nature of lameness, and the method of treating it, can only be acquired by an investigation of the causes by which it is produced. 343 Of lameness.

The causes of lameness are extremely numerous and various. We shall endeavour to class them, so as to render our inquiry as little tedious and difficult as may be.

1st, Lameness may be produced by a stiffness of some parts of the muscles, tendons, or ligaments, arising either from excessive labour, from bruises, wounds, or some diseased affection of the joints. 344 Stiffness.

It

Diseases.

It is well known, that when the muscles of an animal are exerted for any unusual length of time, or in a more than ordinary degree, they become fatigued, and cannot for some time perform their functions with their accustomed ease. In general, after proper rest and careful treatment, the stiffness gradually goes off; and in a day or two the animal is able to exert himself as usual; but if care has not been taken to rub him well down, and provide him with a well littered bed, and especially if he has been exposed to cold while sweating and fatigued, this stiffness may continue for many days, or may even degenerate into permanent lameness. Animals that have acquired this permanent stiffness of their limbs, always move with considerable difficulty, when first taken out; but in general when they have been long in exercise, and are become warm, the stiffness and lameness in a great measure disappear, but they commonly return again when the exertion is over.

Where the stiffness has not continued long, it may in general be easily removed, by frequent friction of the limbs, first with a wisp of hay and the brush, and afterwards with some warm liniment or embrocation, such as has been described among the stimulant receipts.

If it does not yield to this treatment, recourse may be had to warm fomentations, and gentle exercise must be persisted in. If the lameness should still continue, it will probably be occasioned by a strain of some ligament, or an injury done to some part of the limb.

345 Bruises.

Any of the muscular parts may be bruised by falls or blows; and if the bruise takes place on the limbs, or in their neighbourhood, lameness may be the consequence. A bruise is almost always followed by a swelling of the bruised part, occasioned by the rupture of small vessels, that pour out their fluids into the cellular membrane. If the bruise is slight, the swelling will soon subside; but if the injury has been considerable, and much blood has been poured out, inflammation and consequent suppuration will take place, and the part will become an abscess. If the injury has been still greater, and the texture of the parts has been destroyed, mortification will probably come on, and if the bruise be extensive, will be attended with considerable danger.

The treatment of bruises will be different according to the degree of the injury produced. In slight cases the object will be to promote the absorption of the effused blood; and this will be best answered by bathing the part with warm vinegar and water, or camphorated spirit. If there is considerable inflammation, and it is not judged proper to encourage a suppuration, the parts must be frequently bathed with a solution of sugar of lead, with a little vinegar; or, where the part admits of a bandage, it will be better to form a cold poultice of oatmeal mixed up with such a solution, and kept constantly applied to the part and frequently moistened with the solution to prevent its becoming hard and dry. If a suppuration should appear unavoidable, it will be proper to encourage it by a frequent application of warm poultices renewed as often as they become cool, or, where these cannot be applied, by repeatedly fomenting the part with flannel wrung out of warm water. When the suppuration is complete, the swelling must be opened with a lancet, or by means of a seton; and the sore must be treated as we shall presently describe with respect to ulcers. If mortification takes place, the parts must be frequently fomented with the fomentation directed in N° 57. of the receipts; and the animal's strength must be supported by nourishing food, and the occasional use of cordial and strengthening remedies. If the mortified part be very extensive, it may be necessary to make incisions towards the edges with a knife, to promote the separation of the slough; or firing may be employed, as directed for this purpose in N° 175.

It sometimes happens that after the inflammation which attended a bruise has subsided, a permanent hard tumour is left, that prevents the free motion of the muscles of the part. This may arise either from a thickening of some ligament, or the cellular texture, or it may proceed from an excrescence formed on the bone, in consequence of the bruise. The treatment in such cases will be presently described, when we come to consider splents, ring-bones, and other tumours that commonly produce lameness.

346 Tread, or overreach.

Horses are very liable to receive severe bruises in the back part of the foot, either from the tread of another horse, as often happens in the army, by a horse in the rear-rank treading on the heels of one in the front-rank; or, by a horse overreaching his hind foot, and thus bruising the heels of the fore foot. From the manner in which this accident is produced, it has received the names of *tread*, and *overreach*. Sometimes the bruise is so slight as to be productive of no farther ill consequence than a temporary lameness; but if the tread has been very violent, the edges of the part trodden on may be so much bruised as to produce considerable inflammations, or even a mortification. In ordinary cases it is sufficient to wash the part carefully with warm water, to clear it of dirt and gravel, then apply a pledget dipped in spirits, and bind up the foot, so as to exclude the external air; when the bruise, if slight, will probably soon heal. But in some cases matter is formed, which makes its way downwards towards the sole, forming what is called a *quittor*. Quittor may also take place from a puncture in the foot, by a nail or other pointed body, the effects and treatment of which will be presently described.

347 Quittor.

In a newly-formed quittor, it is of consequence to ascertain, whether it has been produced by a prick or a tread. In the former case the matter usually makes it way upwards from the punctured part towards the coronet; and here the practice generally followed by farriers is, to sear the upper orifice with a hot iron, which answers no other purpose than to confine the matter within the wound, where it must produce extensive ulceration and destruction of important parts of the foot. In the latter case, where quittor is produced by a tread, and where the sinus formed is very superficial, the use of the cautery may be very proper; and if it can be so applied as to inflame the whole extent of the wound, it may entirely carry off the disease. According to Mr Blaine, there are too general methods of curing quittor; one by removing a part of the hoof, cutting away the diseased parts, or suffering them to slough off or exfoliate. The other, to apply caustic to the diseased surfaces, introducing it within the sinuses, thus destroying the ulcerated parts, and allowing the healthy parts to throw them off. The latter is called by farriers *coreing out a quittor*, as they suppose that the

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the core or slough that comes away formed a part of the complaint. Mr Blaine objects to removing the hoof, as it would take up a considerable time before new horn can be formed; and it is probable that in the new hoof there will be a false quarter, which will render the horse unsound, besides that, during the formation of the new hoof, fresh sinuses may be produced. In the method of cure by caustic, he thinks that the disease may be completely removed in three or four weeks, whereas the other method may require as many months. The mode of applying the caustic is, to examine carefully the extent and direction of the sinuses, and then to fill them up with powdered blue vitriol, verdigrise, or corrosive sublimate. Mr Blaine has found that a paste made of corrosive sublimate, mixed up with flour and butter, forms a very good caustic for this purpose. Some of it is to be introduced by means of a probe, to which a piece of sponge is fastened, which must be carefully introduced in every direction, so as to touch all the diseased parts, after which the whole foot is to be bound up; but the bandage must not be applied too tightly. In two or three days the dressings are to be renewed, and this is to be repeated at intervals till the sloughs come away, when a healthy action of the parts will take place, and the cure soon be completed. Another method of introducing caustic, by which the sinuses may be completely filled, is to mix up the caustic with hogs lard, and roll the mass into small pellets within gause-paper, which may be easily introduced into the cavities.

Many farriers have fallen into a mistake with respect to the nature and treatment of *quittor*, that has been the ruin of many horses. They suppose, that during the progress of this disease, a bone is formed which they call a *quittor bone*; and they think it necessary to remove this bone, before a cure can be completed. This error seems to have arisen from an opinion of Lafosse, who conceived that the derangement which accompanied this disease originated in the cartilages being affected; which he affirmed were capable of being thus diseased, but incapable either of exfoliating like bone, or sloughing like ligament; and therefore that to promote a cure, the whole of the lateral cartilage on the affected side must be removed. But his first premises were erroneous, for cartilages are vascular, as we know by their being tinged with bile, and by their being at times absorbed; this is particularly the case with the lateral cartilages, which in almost all old horses are partly absorbed. As they are vascular, they must be capable of living action; though it is slow, and hence where disease exists, they will exfoliate like other parts. This practice of Lafosse has in this country been for some time tried among many of the more intelligent farriers, and was still further propagated by the late Professor St Bel. Many horses have been ruined by this injudicious practice; for the future elasticity of the foot, which is in a great measure dependent on these cartilages, must be lost; besides the necessary removal of the hoof to get at the cartilage, a false quarter almost always remains *.

* *Blaine's Outlines*, vol. ii.

348 Wounds.

Wounds are frequently inflicted in the soft parts of horses and dogs, and these are more common in the legs, feet, and joints, than in any other parts. The treatment of wounds must depend in a great measure on the part where they are inflicted, and the form of the instrument that produced them. A clean cut made in the muscular parts is easily healed, by applying slips of sticking plaster as soon as possible, so as to keep the edges of the wound close together; or where plaster cannot readily be applied, by taking a stitch or two through the edges of the wound, and tying the strings gently together. When the edges are found to adhere, the strings must be cut away, and the holes which they made will soon fill up. If any considerable blood-vessel has been wounded, it will be proper to secure it, if possible, by means of ligature, rather than by applying any styptic substance. All wounds should be made as clean as possible, before any attempt is made to heal them. Sometimes the wound is so situated that it will not admit of being sewed up; but in these cases we may in general pass silver or steel pins from the edges, at about an inch distance from each other, and twist a thread crosswise from one to the other, so as to form what is called the *twisted-suture*. In all cases where sutures are used, it will be proper to apply a sticking plaster over the edges of the wound. If the wound should not heal by these means, a formation of matter will take place, and then the sore is to be treated as a common ulcer, taking care that its edges be always kept as near together as may be, by sticking plaster or a bandage.

If the wound is very large, it may excite considerable inflammation and fever. In these cases, if the animal is plethoric, it will be proper to bleed him, or at any rate to administer cooling remedies. If, on the other hand, there has been much loss of blood, or if the wound shews no disposition to heal, and the matter formed is thin and ichorous, an opposite plan of treatment will be required. The animal must be supported by nourishing food, and strengthening remedies.

The most troublesome wounds are those of the feet and joints, as they are in general very difficult to be healed.

349 Wounds of the feet.

Wounds in the feet are not uncommonly produced by the horse treading on sharp stones, broken glass, sharp bones or nails. These are generally punctured wounds, and will be considered presently. Sometimes a deep wound is made on the coronet, by a sharp part of the heel of the shoe on the opposite foot, or any other substance penetrating downwards between the coffin-bone and the hoof, or between the lateral cartilages of the coffin-bone and the joint. Wounds of this kind are attended with much danger, from the difficulty of evacuating the matter that may be formed, or of producing that healthy action in the parts that is necessary to make them heal. In such cases Mr Feron recommends the application of a blister, extending from the fetlock to the foot, so as to produce external irritation, which may relieve the internal parts. In the mean time the foot is to be kept in a vessel of warm water all day, and a large warm poultice of bran and water is to be applied round it at night. The intention of this practice is to prevent suppuration, but if this should, nevertheless, take place, and if matter should be formed between the hoof and the sensible laminæ; the suppuration is to be encouraged, and we are to endeavour to prevent the formation of sinuses, by rasping the hoof very thin, just below the seat of the wound, so that we may be able to make an orifice for the evacuation of the matter downwards. Mr Feron advises

adviſes to delay this opening as long as poſſible, and when it is performed, to take care that the laminæ be properly preſſed after the operation, to prevent coming out through the hoof, and forming an incurable ſand-crack, or falſe-quarter. The bathing the foot in warm water, and the application of the bran poultice, muſt be continued till the foot is perfectly healed. If proud fleſh ſhould appear through the opening that has been made in the hoof, it is to be pared away with a ſharp knife, then fired, and covered with a ſmall pledget ſpread with ſoft ointment, on which is ſprinkled a little powdered blue vitriol. It is evident that, during the cure, the horſe muſt be kept perfectly at reſt; and it is recommended to adminiſter diuretics, and now and then a gentle doſe of phyſic, to keep the bowels moderately open.

350 Wounds of the joints.

Wounds in the joints are commonly attended with very ſerious conſequences, as it frequently happens that the capſular ligament is divided, and in this caſe the ſynovia or joint-oil conſtantly exſuding through the opening, prevents the diſpoſition to heal. A wound in the joints is common among horſes in the army, and ſuch as are employed in hunting; and a horſe that has received ſuch a wound in general becomes perfectly uſeleſs, from the improper method of treating theſe wounds that has in general prevailed among farriers. By their treatment, either an incurable ſinus is produced, or a ſecretion of bony matter takes place within the joint, forming what is called an *anchyloſis* or *ſtiff-joint*. The method generally practiſed by ordinary farriers is, to inject within the joint a mixture of turpentine and oil of vitriol, a ſolution of corroſive ſublimate and lime water, or ſome other corroſive ſubſtance. The more rational of them content themſelves with an injection of tincture of myrrh. All theſe ſubſtances produce ſuch a high degree of inflammation within the joint, as not unfrequently to deſtroy the animal.

Of late, a much more rational mode of treatment has been adopted by Mr Coleman, and is deſcribed in the firſt number of the Veterinary Tranſactions.

351 Mr Coleman's method of treating wounds of the joints.

The following is the method recommended by Mr Coleman for treating wounds of the joints and capſules.

"Where a joint, a mucous capſule, or the ſheath of a tendon is opened, the firſt application neceſſary is the actual cautery. The inſtrument moſt proper for the operation ſhould be made of iron, two feet in length, rounded at the extremity about the ſize of a ſmall button, with a wooden handle. The temperature of the iron ſhould be moderately red. If it be black, the heat will not be ſufficient to produce a proper diſcharge of lymph, to cloſe up the wound; and if it is white, it will deſtroy too much of the ſurrounding parts, and perhaps do miſchief to the ligament. Although the operation in itſelf is very ſimple, yet ſome knowledge of the ſtructure and economy of the parts, for the purpoſe of applying the cautery with the beſt poſſible effect, is neceſſary. The object in view is to produce a glutinous ſubſtance to cloſe up the cavity, and before the ſlough is removed, for granulations below to ſupply the place of the lymph; but if the ligament itſelf be deſtroyed by the cautery, it muſt, like other dead parts, ſeparate from the living and come away, and then the joint will ſtill be opened. It is, therefore, of importance not to deſtroy the ligament of joints with the hot iron, but confine its application to the external ſoft parts. In theſe caſes, it is generally proper to cauterize the whole external ſurface of the wound; and if the diſcharge is not immediately ſtopped, the iron has probably not been applied ſufficiently deep, or too cold, to produce a proper diſcharge of lymph. Where a cure is poſſible to be effected, the actual cautery will frequently cloſe the cavity and ſtop the diſcharge. Sometimes, however, in the courſe of one, two, or three days, the diſcharge appears again by the ſides of the lymph, and then the ſame operation ſhould be repeated. In ſome inſtances Mr Coleman has had occaſion to apply the hot iron five or ſix times, and nevertheleſs ſucceeded ultimately, without the leaſt lameneſs. The ſame treatment is likewiſe to be recommended for penetrating wounds into the cheſt and abdomen. The lips of the wound ſhould be cauterized, and, if requiſite, repeated in the ſame manner as is recommended for wounds of other cavities. When the cavities of veins become inflamed, ſome little variation is neceſſary in the treatment, as accidents of that nature are frequently attended with conſequences different from the opening of other cavities, and require a trifling alteration in the treatment. When a hemorrhage takes place, it may be very generally ſtopt by the application of the cautery; but if this fails, and the parts are too much ſwelled to admit of a pin, there is no other remedy than to take up the vein by a ligature above the diſeaſed parts; and there may be inſtances in which it may be adviſable to tie up the vein below. In general, however, the actual cautery will prevent the neceſſity of a ligature; and if it fails, tying up the vein will ſucceed only in thoſe caſes where the vein above is free from diſeaſe. In general, the vein is thickened and inflamed, and if a ligature be applied on a veſſel in a ſtate of inflammation, the diſeaſe will be formed, and the vein inflame above. In a caſe that occurred to Mr Goodwin, veterinary ſurgeon at Oxford, where the jugular vein was tied, an abſceſs took place over the occipital bone, commonly termed the *poll evil*. That diſeaſe, however, moſt probably did not originate in conſequence of the tube being obliterated, for in moſt ſucceſsful caſes of inflamed veins, the ſides of the vein unite and deſtroy the cavity. After the orifice of the inflamed vein, from the application of the actual cautery, is cloſed, a conſiderable degree of ſwelling frequently remains, and this may be removed by a bliſter. When abſceſſes form in the adjacent parts, they ſhould be treated in the ſame manner as common abſceſſes."

A puncture of ſome part of the lower ſurface of the foot is a frequent occurrence. It may ariſe from the prick of a nail in ſhoeing, from a nail picked up in travelling; or from glaſs, flint, or any other ſharp body. Injuries of this kind are proportioned in their effects, to the parts punctured, and not entirely to the depth of the wound. A puncture of the frog penetrating even to the fleſhy frog, is not uſually ſo ſerious, as that which penetrates the ſole; hence a wound any where at the hinder part may penetrate deeper with impunity than towards the centre, and likewiſe in the front, though conſiderable inflammation uſually follows from this laſt. When the capſular ligament is wounded in theſe caſes, the conſequence may be very ſerious, as a ſtiff joint is commonly produced. When it is found that the capſular ligament has been wounded, the external opening muſt be enlarged, and a hot iron muſt be applied to the

352 Punctured wounds.

the ſurface of the ſkin that covers the wounded part of the ligament, in order to heal up the internal opening. Conſiderable irritation commonly attends a punctured wound of the tendon, or its ſheath; and it is beſt removed by enlarging the wound that is made through the horny part, and keeping the feet for ſome time in warm water. When matter appears in either of theſe caſes, it muſt be let out, and the wound muſt be healed in the uſual manner.

The moſt uſual caſe of punctures is that which ariſes from a nail in ſhoeing taking a wrong direction, when inſtead of penetrating the outer ſurface of the cruſt, it turns inwards, and thus wounds the ſenſible laminæ. This is known to the ſmith at the time by a peculiar feel in the ſtroke he gives, and by the flinching; when, if the nail is immediately removed, and has not penetrated far, the wound heals by the firſt intention; but if it is ſuffered to remain, it produces inflammation and ſuppuration. As ſoon as this is diſcovered, a depending orifice ſhould be made for the matter, by making an opening in the line of the hole at which the nail entered. It is always prudent, when a nail has penetrated, and lameneſs follows without matter appearing, to remove the ſhoe, and enlarging the opening to apply a pledget of tow dipped in ſpirits of wine, which will frequently prevent any future effects: but whenever matter has formed, it is indiſpenſably neceſſary; for otherwiſe the matter will proceed upwards, and coming out at an opening on the coronet, it will form a quittor. When by this treatment the matter has gained a depending ſituation, and the inflammation has ſubſided, the part may be dreſſed with any mild ointment; but if the matter ſhould increaſe in quantity, it will be proper to pour a ſolution of white vitriol within to promote a ſtoppage of the diſcharge, and of the extenſion of the ulcerative proceſs. In every puncture, when the heat and inflammation appear conſiderable, bleeding at the toe is a prudent meaſure, as it unloads the veſſels.

Dogs are frequently wounded with thorns in their feet or knees, and the thorn may be ſo deeply lodged, that it cannot eaſily be extracted. When the foot is wounded with a thorn, the beſt application is a plaſter of black pitch, which is ſaid to have ſucceeded when every thing elſe has failed. If there is much inflammation, it will be proper to apply a poultice over the plaſter. When a dog is wounded in the knee, if there is reaſon to ſuppoſe that a thorn is left in the wound, the ſame applications will be proper; and when the thorn comes away, if there is ſtill an oozing of fluid from the orifice, a red-hot iron muſt be applied, as in the wounds of the joints in horſes. If no thorn is left in the wound, a little digeſtive ointment rubbed upon the part, and a ſubſequent application of a poultice made with Goulard and crumbs of bread, with proper reſt, will probably ſoon effect a cure.

Lameneſs is not unfrequently produced by a ſtiff joint, or what the ſurgeons call *anchyloſis*. This is generally the effect of an injury done to the articulating ſurfaces of the bones that compoſe the joint, cauſing the formation of new bony matter, which gets between the bones, and unites them together. A ſtiff joint may perhaps be ſometimes prevented by the timely uſe of bliſters and firing; but when completely formed, the lameneſs is incurable.

2. The ſecond head of cauſes that produce lameneſs will comprehend ſtrains, fractures, and luxations.

353 Strains.

Strains may take place in any of the muſcular parts or ligaments, but they moſt commonly happen in the fleſhy part of the ſhoulder, or in ſome of the ligaments of the feet.

354 Shoulder ſlip.

A ſtrain in the muſcles of the ſhoulder, has been generally called a ſhoulder-ſlip, under the idea that the ſhoulder-bone has been disjointed, or the blade-bone puſhed out of its place; but the ſtructure of the parts ſhews that the former of theſe accidents can ſcarcely happen, on account of the great ſtrength of the capſular and other ligaments that ſurround the ſhoulder joint; and a diſlocation of the blade-bone is, by the extent and ſtrength of the muſcles that unite it with the ribs, nearly impoſſible, unleſs by ſuch a force as is ſufficient to deſtroy the texture of the muſcles, and tear the limb from the body. A ſtrain of theſe muſcles, and of the ligaments that ſurround the ſhoulder joint, is, however, by no means an unfrequent occurrence, but affections of other parts are often miſtaken for a ſhoulder ſtrain, as we ſhall ſee preſently. A ſtrain in the ſhoulder, when firſt received, is generally attended with conſiderable inflammation and ſwelling of the part, which are uſually ſufficient to diſtinguiſh it from other affections. When the ſtrain has continued long, and the inflammation has ſubſided, the diſtinction is not ſo eaſy.

In caſes of recent ſhoulder ſtrains, it will be proper to draw blood from the plate vein, and if the inflammation is extenſive, to adminiſter a purge, and keep the animal rather low, to keep down the inflammation as much as poſſible; and it will be proper to bathe the parts frequently, with ſome aſtringent lotion, or with a warm fomentation, as directed under *bruiſes*. A rowel may alſo be placed in the cheſt, or a ſeton in the inſide of the fore-leg. Complete reſt is neceſſary; and to render this the more perfect, the horſe ſhould be fitted with a patten ſhoe, and ſhould have a bed of litter conſtantly below him. When the inflammation has ſubſided, gentle friction, and the occaſional uſe of aſtringent lotions, will in general ſoon reſtore the uſe of the limb; and as ſoon as the horſe can bear it, moderate exerciſe may be employed.

355 Injuries of the ligaments and tendons.

Injuries done to the ligaments and tendons, are alſo uſually called ſtrains; but if we underſtand by this term, an extenſion of the ſtrained part, the appellation is improper, ſince the tendons appear to be entirely without elaſticity, and the ligaments nearly ſo. Theſe parts cannot, therefore, be properly ſtrained, though by unuſual exertion, their texture may be ſo far injured as to produce ſtiffneſs, inflammation, and ſwelling, but will have the ſame effect in cauſing lameneſs, as a ſtrain.

Injuries of this kind are more dangerous then mere muſcular ſtrains, their treatment is more difficult, and the cure more tedious. The treatment uſually adopted by ordinary farriers, is to apply the ſame aſtringent and ſtimulating lotions, as in ſtrains; but here they commonly do harm, as they generally produce a greater ſecretion of coagulable lymph, which ſtill more obſtructs the motion of the part, and renders the lameneſs permanent.

One of the worſt caſes of theſe injuries, is what farriers

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riers commonly call a clap or ſtrain in the back ſinews. When a horſe trips or ſtumbles, and makes an unuſual effort to ſave himſelf from falling, or when the heels are lowered in ſhoeing too ſuddenly, or too much at once, ſo as to throw too great a weight upon them, there often happens ſuch a ſudden or violent contraction of the flexor muſcles as may produce a partial laceration, or even rupture of the flexor tendon, or its ſheath. This injury is attended with conſiderable inflammation, and the conſequent lameneſs is of the worſt kind. A great ſtiffneſs and ſwelling is produced, and there is commonly an effuſion of fluid, which is at firſt ſerous, and may again be taken up by the abſorbent veſſels; but if improper applications are employed, coagulable lymph may be poured out, ſo as to obſtruct the motion of the part, and produce that ſwelling, or permanent enlargement, that we ſometimes ſee in the neighbourhood of the tendon, after what is called a ſtrain of the back ſinews.

356 Clap or ſtrain in the back ſinews.

When a horſe is ſtrained in the back ſinews, he puts forward his leg and foot in a looſe, faint, and faultering manner. Mr Lawrence gives the following directions for aſcertaining whether or not a horſe is injured in the back ſinews. To try how far the horſe has been injured, let him be walked about for half an hour, when the ſwelling of his legs will in all probability ſubſide. If you then obſerve the *tendo achillis*, or main ſinew, diſtinct from the ſhank; if, on preſſing it with the finger towards the bone, you find it firm and tenſe; if you diſcover by the feel, no ſoft ſpongy ſinews between the ſhank and the tendon, no extraordinary pulſation, but that all is well braced and wiry, you may conclude the ſwellings not dangerous. A perſon of experience, with a nice diſcriminating finger, will ſcarce ever fail to detect lameneſs in the back ſinews.

Mr Feron is of opinion that the injury which we have deſcribed is not done to the flexor tendon, but to the ligaments of the neighbouring joints. He ſays, that "on the diſſection of a ſtrain ſuppoſed to be in the back ſinews, we diſcover no affection in the ſubſtance of this part, which on the contrary appears perfectly ſound. But on examining the ligaments of the fetlock, coronet, and foot, we find them to be the ſeat of the diſeaſe; we find alſo, that if the accident has been violent, and of long duration, the whole vaſcular ſyſtem of the leg is found affected, but never, or very ſeldom, the back ſinews; it is in this violent ſtate that we obſerve ſometimes one or two ſwellings along the tendons. It is alſo on this account that the pain is ſo great, and ſo hard to be cured, in conſequence of the conſiderable irritation which takes place in the ſurrounding parts. So the increaſe of thickneſs of the leg, is nothing more than the effect of the diſeaſe; but not the diſeaſe itſelf, as farriers, grooms, &c. ſuppoſe it to be. Nevertheleſs, we ſaid before that the back ſinews or tendons were void of feeling in a ſtate of health and incapable of extenſion *." It may be very true that this injury is not commonly ſeated in the tendon; but we cannot agree with Mr Feron, that this part is never the ſeat of it, eſpecially as he himſelf allows that a rupture of the tendon may take place, of which he has ſeen different inſtances. It is not difficult to conceive that the ſame exertion which when in a great degree is capable of rupturing the tendon, may in a ſmaller degree produce a partial laceration, or a ſtrain in the back ſinews.

* *Feron's Farriery*, p. 104.

A horſe labouring under this injury, even after the inflammation has ſubſided, is extremely weak and ſtiff in the joints of the foot; but when he has been for ſome time at work, the lameneſs in ſome meaſure goes off. This has led ſome perſons to ſuppoſe that a ſtrained horſe may be worked ſound; but this is a very erroneous opinion, and the practice of continuing to work a horſe that has been newly ſtrained, under the idea of removing the ſtiffneſs, is equally cruel and injudicious.

The treatment of ſtrains or injuries of the ligaments or tendons muſt be ſuch as will moſt effectually prevent inflammation, and promote the abſorption of the effuſed fluid. Local bleeding from the veins of the part, and warm fomentations frequently repeated, ſeem to be the moſt adviſable; and a bandage ſhould be always applied where the nature of the parts will admit of it, and ſhould be continued till the lameneſs is removed. Various ſtimulating applications have been recommended in theſe caſes, as ſoon as the inflammation has ſubſided, ſuch as oil of turpentine, camphorated ſpirit, verjuice, &c. but theſe muſt not be employed while any conſiderable inflammation remains. It is ſomewhat remarkable that Mr Feron recommends aſtringent and ſtimulating applications in the text of his work, and ſays there that they may be employed with ſafety; but, in a note at the foot of the page, he ſpeaks of having inſerted thoſe aſtringent preſcriptions for the purpoſe of ſatisfying the different opinions, but that he is fully convinced, by a long experience, that warm fomentations and warm poultices of bran and water, are infinitely preferable in ſtrains or contuſions, to theſe expenſive preſcriptions, and are always to be tried firſt.

It will be proper to elevate the heels of the horſe's ſhoe by calkins, and Mr Blaine recommends that the heels of the hoof be encouraged to grow, or that a thick-heeled ſhoe be uſed. If there ſtill remains much ſwelling, firing will prove one of the moſt effectual remedies, as it will both promote the abſorption of the effuſed fluid, and will produce ſuch a degree of conſtriction of the ſkin as will anſwer the purpoſe of a permanent bandage. In ſuch caſes the cautery muſt be applied, ſo as to make perpendicular lines on the ſkin.

Dogs are very ſubject to ſtrains; and where theſe are ſlight, a mixture of ſpirit of wine and oil of turpentine, or ſtrong Goulard, applied before a fire, is the moſt uſeful remedy. Sometimes from blows or other accidents, ſuch as ſlipping their hind-legs, or getting them entangled in the bars of a gate, hounds are lamed in their *ſtifle*, as it is called. In general the above applications and long reſt will remove the lameneſs; but when a conſiderable quantity of coagulable lymph has been effuſed, it is not eaſily re-abſorbed, and the lameneſs continues. When this happens, ſome huntſmen recommend the operation of cutting for the ſtifle, and Mr Daniel ſpeaks of a huntſman who uſed to perform this operation very dexterouſly in the following manner. The bone is laid bare by a tranſverſe cut, and upon it is found a ſubſtance like a ſtiff jelly, which is the cauſe of the lameneſs, and is in fact the coagulable lymph that has been effuſed. This jelly is taken away, and a wire is run through the ball of the hind-foot on the contrary ſide, and twiſted in ſuch a manner as to keep that leg from touching the ground, ſo that the hound may be compelled to uſe the ſtifled leg. In this way the dogs were always cured. The ſame huntſman recommended that

357 Strains of the ſtifle in dogs.

Diseases. that when a dog had been entangled in a gate or stile, he should, as soon as released, be taken by the hind-feet, and twisted round five or six times, turning with him; and it is said that this prevented any ill consequence from the bruises that he received in the stifle, while endeavouring to disengage himself.

358 Some of the ligaments or tendons of the extremities are now and then ruptured. This is not a common case, but it may happen, either to the suspensory ligament, or the back sinew.

359 Rupture of the suspensory ligament. A rupture of the suspensory ligament is found most likely to happen to young horses while breaking, and to cavalry horses while under training. The accident is generally called *breaking down*, as, when it happens the horse appears unable to support himself. The fetlock is brought almost to the ground, and the limb is evidently exceedingly weak; but the horse can bend his foot when he raises it. This circumstance distinguishes a rupture of the suspensory ligament from that of the flexor tendon or back sinew; as, in the latter case, the power of the flexor muscle being destroyed, the horse is unable to bend the foot.

It appears from the observations of Mr Coleman, and some experiments that have been made by Mr Feron, that the flexor tendon has little or no effect in giving support to the heels; but that this office is almost entirely performed by the suspensory ligament. Hence, when this is ruptured, the horse loses one of his principal stays, and the foot is of course unable to support its usual weight, whence the horse breaks down.

A perfect cure of this accident can seldom be expected; and the only way to relieve the animal will be to obviate the inflammation as much as possible, and to elevate the limb, and especially to raise the heels, in order to relax the injured parts. An intermediate substance will in time be produced between the two parts of the broken ligament, that will enable the horse to walk and perform some of his functions, but he can never afterwards be depended on for the road or the field.

360 Rupture of the back sinew. When it is ascertained that the back sinew has been ruptured, which is discovered by the inability of the horse to bend his foot backwards, it is generally recommended to kill the horse, as a cure is by most deemed impracticable. Mr Blaine recommends to bend the limb from the ancle downwards, and to keep it in that situation by throwing the animal, when he thinks that a perfect cure might be made. There would, however, be considerable difficulty in keeping the limb in such a confined situation for so long a time as would be necessary to unite the ruptured tendon; and after all, there is the greatest probability that a very slight exertion would produce a fresh rupture.

361 Fractures. Fractures of the bones may take place in any part of these animals, but they are most common in the feet of horses and the legs of dogs.

The navicular, coffin, and small pastern bones of a horse are not unfrequently fractured, and Mr Feron speaks of a small pastern bone being broken into seven pieces. It is not surprising that these bones should be broken, when we consider the immense weight that is generally sustained by them, and the great exertions which a horse sometimes makes to recover a false step.

These bones, when broken, will be united by a callus, provided that the limb be kept in such a situation as to prevent motion; but this can rarely be effected, even in cases where the bones of the foot are fractured, still less in these cases where a fracture of the larger bones has taken place.

One of the most common fractures of the bones in a horse is that of the ridge of the ilium, or haunch-bone. This bone, from the projecting angle formed by its ridge, is peculiarly exposed to injury; and when the ridge is unusually prominent, as sometimes happens, or when the horse is more than commonly lean, the probability of fracturing this bone is still further increased. 362 Fractures of the haunch-bone.

Fractures of the haunch-bone may be occasioned by falls, by blows, which are often given by brutal ostlers and carters, with the but end of a large whip, or perhaps a broomstick, and they are very commonly produced by striking the haunch violently against a post, or the edge of a wall, when the horse turns too sharply round a corner, or passes swiftly through a narrow gateway.

It may be ascertained that such an accident has taken place, by the pain the horse feels in the part, and where the fracture is considerable, by the cracking of the parts of the broken bone against each other, but still more certainly by an evident cavity of the haunch, from the depression of the ridge. The muscles of the belly in the upper part of the flank will appear sunk in, especially when the horse lies down, and will form a sort of hollow between the haunch and the ribs. The horse, when he attempts to move, will be as lame as if one of the bones of the leg were broken, owing to the extreme pain that motion excites in the muscles, that beside being severely bruised, have lost one of their principal attachments.

When an accident of this kind has happened, it is necessary to keep the animal perfectly at rest, as nothing but repose can produce a reunion of the fractured bone. The parts may be gently rubbed with some stimulating liniment, as in other cases of bruises, and some recommend the application of a charge, or strengthening plaster. It sometimes happens, where only a small part of the bone has been broken off, the horse completely recovers his former activity; but more commonly such a deformity is produced by the ridge of one haunch remaining lower than that of the other, and by the callus that forms between the end of the divided bone, as to render the horse more or less permanently lame.

When the legs of a dog are broken, it is easy, by means of splints, to keep the limb in such a situation as to effect a union of the broken bone; and we have not unfrequently met with cases of this kind, where a complete cure has been effected in the course of a few weeks.

The ribs of a horse are sometimes broken, either by falls, or from the brutality of their keepers, as by striking them with the heavy handle of a whip or cudgel. If the end of the fractured rib does not penetrate into the chest, so as to wound the lungs, a cure may in general be readily effected, by fastening a bandage round the body over the seat of the fractured rib, and keeping the horse at rest and on a low diet.

Luxations or dislocations of bones are exceedingly uncommon in the horse, owing to the great strength of the 363 Luxations.

Diſeaſes. the ligaments that ſurround the joints. Theſe may, however, ſometimes happen, and we are by no means of Mr Blaine's opinion, that the immenſe ſtrength of the muſcles in a horſe would prove any obſtacle to the complete reduction of ſuch a luxation. If, indeed, we endeavoured to reduce the luxation by pulling and hauling at the luxated limb, in order to overcome the power of the muſcles, and thus produce a counter extenſion, which is ſtill, we believe, the method generally employed by ſurgeons to ſet a diſlocated limb in the human body, we ſhall moſt certainly be diſappointed. But if, inſtead of this vain attempt, we place the limb in ſuch a ſituation as that the power of thoſe muſcles which are the antagoniſts of the muſcles that keep the limb in its diſlocated place, may be fairly exerted, there will probably be little difficulty in replacing the bone in its ſocket, as the very ſtrength of the muſcles will aſſiſt us in the operation.

364 3. Lameneſs is very commonly the effect of tumours of the mucous bags or capſules, or of excreſcences formed on the bones of the legs and feet, or on the hoof.

In moſt of the joints there are appendages or membranous bags, called *burſæ mucoſæ*, or mucous bags, that are filled with a mucous fluid ſecreted into their cavities, for the purpoſe of aſſiſting the motions of the muſcles and tendons near the joint. It often happens that theſe mucous capſules are enlarged, either from hard work, which is a very common cauſe of their enlargement, or from ſome injury done to the neighbouring parts. When the enlargement is but ſmall, it is of little conſequence, but when the bags become unuſually diſtended, their ſize impedes the motion of the joints. Theſe tumours have received different names among grooms and farriers, according to the place where they are ſeated.

365 Wind-galls. When the mucous bags that are ſituated near the paſterns become enlarged, the tumours are called *wind-galls*.

366 Bog-ſpavin. When the enlargement takes place in the mucous bags on the inner ſide of the hock, the diſeaſe is called *bog-ſpavin*.

367 Thorough-pin. When the tumours are ſeated in the upper and back part of the hock, between the gemelli muſcle and the tendons of the great flexor muſcle of the foot, the affection is called *thorough-pin*.

368 Capulet. When the ſwelling is ſituated at that part where the tendon of the gemelli muſcles is inſerted into the point of the hock, it is called *capulet* or *capped hock*.

Of all the various ſwellings, the wind-galls are the moſt likely to produce lameneſs, and next to them the bog-ſpavin. The capulet and thorough-pin are ſeldom of much conſequence.

369 Treatment. In the treatment of wind-galls and ſimilar tumours, the object is to remove the unuſual ſwelling, and to prevent its return. The ſwelling can be removed only by evacuating the contents of the tumour, or by promoting its abſorption. The former was recommended by Dr Bracken, and appears to have been ſucceſsful in a few caſes. The tumour is opened with a ſharp knife; and when the fluid has been evacuated, an eſcharotic ſubſtance compoſed of burnt alum, white vitriol, and red precipitate, is applied to the wound, to produce ſuch a degree of inflammation as may contract its cavity. Probably firing would have a better effect. Mr Coleman and the *eléves* of the veterinary college, are much averſe to this operation, and certainly where it can be avoided it is not deſirable. Abſorption of the accumulated fluid may often be produced by the application of bliſters, and other ſtimulating applications; but this is moſt certainly effected by producing preſſure on the tumour, by means of a bandage applied round the part, with a bolſter or compreſs immediately over the ſwelling. When the unuſual enlargement has been reduced, its return is beſt prevented by firing the ſkin, ſo as to produce a conſiderable degree of conſtriction.

Horſes are ſubject to various excreſcences on the bones, or *exoſtoſes*, as they are called, which, when they form near the joints, or below the tendons of the muſcles, generally produce lameneſs. Theſe excreſcences have received various names, according to their ſituation. When they are formed about ſome part of the knee or canon bone, they are generally called ſplents, though farriers often call the excreſcences at the knee *oſſeletes*; and when there are two ſmall bony enlargements near each other, they are called *fuzes*. The excreſcences at the knee are not very common, and when they occur, are generally the effect of a wound; but ſplents about the canon bone are very common, eſpecially among young horſes, owing to the blood-veſſels in them being larger in proportion to the abſorbents than in old horſes; and hence the depoſition of bony matter may, in certain caſes of injury, be greater than what the abſorbents are able to take up again. Theſe excreſcences are eaſily produced in young horſes, by any blow or other injury that is capable of producing conſiderable inflammation; as ſtriking part of the canon bone which is the uſual ſeat of ſplents in what is called the *ſpeedy cut*, or by producing unuſual preſſure on one ſide more than on the other. Although a ſplent may not be in the neighbourhood of any material tendon, it may ſtill produce lameneſs by the pain which it excites; but when it interferes with a tendon, or ſome important ligament, lameneſs muſt in general be the conſequence. 370 Splents.

When an excreſcence appears on any of the bones that enter into the formation of the hough, it is called a *bone-ſpavin*. It is moſt frequently found on the upper and inner part of the ſmall metacarpal bone, or on ſome of the wedge-like bones on the inſide of the hock. In the former ſituation it is often produced in conſequence of the outer heel having been raiſed by calkins; and in what are called cat, cow, or ſickle hammed horſes, it is often brought on by their natural deformity, though in theſe latter caſes the excreſcence is moſt commonly formed on the inſide of the hock. 371 Bone-ſpavin.

An excreſcence ſituated on the back part of the hock towards its point, is called a *curb*. This is ſometimes formed on the bone, but it is frequently only an unuſual hardneſs and ſwelling of ſome of the ligaments. 372 Curb.

When an exoſtoſis forms on the leſſer paſtern bone, producing a hard ſwelling round the coronet, it is called a *ring-bone*. A depoſition of bone over the lateral cartilages is ſometimes alſo called by the ſame name. 373 Ring-bone.

The treatment of all theſe excreſcences is much the ſame, and our object muſt be, either to excite the abſorbent veſſels to increaſed action, ſo as to remove the bony excreſcence, or to take this away by means of an operation. The former of theſe is not likely to be ſucceſsful, 374 Treatment.

Diseases. cessful, except in the early stage of the complaint, when the bony matter is not completely hardened. If the excrescence be discovered in time, blisters are to be applied over the part, and repeated frequently, and strong mercurial ointment, or an ointment composed of corrosive sublimate and blistering ointment, is to be applied over the part, and gentle friction should be frequently employed on those parts of the limb that are above and below the swelling. By these means the excrescences may sometimes be removed; but when they have become too hard, these stimulating applications will scarcely excite the absorbents to sufficient action. The only method to which we can then have recourse is an operation long ago practised by the old farriers, apparently with considerable success. The bony excrescence is laid bare, by making an incision through the integuments, and then the excrescence is cut off by means of a sharp chissel struck by a mallet. After this the skin is to be laid down over the part, and we are to endeavour to heal the wound as soon as possible, by sticking plaster and a proper bandage. Firing is much employed by the French for the removal of ring-bones and other excrescences. Mr Lawrence recommends that in firing a ring-bone, the instrument employed should be thinner than usual, and that the lines described should not be more than one-fourth of an inch distant from each other, being crossed obliquely like a chain.

375 Corns. Sometimes an inflammation takes place on the lower part of the hoof, between the sensible and horny soles, or between the outer crust and the binders, producing a slight effusion of blood, and leaving a considerable tenderness in the part. When the hoof is examined, after being perfectly cleaned, there is commonly seen a discoloured spot, sometimes red, but more usually blue, or blackish, like what is seen below one's nail, when the finger is jammed. The affection is commonly called by farriers a *corn*. (In Scotland, we believe it is called a *stone-cress*), though it is by no means similar to a corn in the human foot. Horny excrescences which might properly be called *corns*, are sometimes however produced on the horse's hoof; and of this nature, we suppose, were the *corns on the feet of Cæsar's horse*.

This complaint is always owing to an improper pressure on the horny sole, by which the sensible sole is squeezed between it and the coffin bone. Hence a quantity of blood is effused from the vessels of the sensible sole, which, if it remains for any length of time, produces an unusual tenderness in that part of the hoof. Corns are generally produced by shoes that are too hollow next the hoof, so as to allow a stone to get between the shoe and the sole, and thus press upon the latter; or it may be produced by the shoe being made too short or too narrow, and thus indenting itself upon the sole between the binders and the crust.

The best manner of treating a corn appears to be, to remove that part of the sole which is immediately below the seat of the affection with a drawing knife, taking care not to cut farther than the seat of the effused blood; then to insert a pledgit dipped in tincture of myrrh, into the opening. No pressure must be applied upon the part, and a piece of the shoe opposite the corn should be cut out, to prevent pressure from taking place. The horse must be allowed to stand quiet, on a level surface, and must not be worked till the horny part of the sole that has been cut away shall be renewed; Diseases. and even then it would be proper to turn him to grass for some time, without shoes, or with very small tips of iron at the toes.

4. Lameness may be produced by many injuries of the feet, brought on by hard work, bad shoeing, or other ill treatment. 376

When horses are ridden hard on pavement, or hard dry roads, especially if the frog has been pared down, or even the crust cut away too much in shoeing, the battering produced on the hoof frequently brings on an inflammation of the sensible part within. This may happen also to cart horses made to draw heavy loads, under similar circumstances.

When the horse's hoof is not very delicate or tender, 377 Grogginess. this battering sometimes only produces a stiffness, or swelling of the legs, and contraction of the sinews. This state is commonly called *grogginess*, or a horse that has his feet thus battered, is said to be *groggy*.

If inflammation is excited within the hoof, a most 378 Founder. painful species of lameness is produced commonly called *founder*, or the horse thus lamed is said to be *foundered*. The complaint is also called *foot-founder*, to distinguish it from a disease which we shall describe hereafter, and to which farriers sometimes give the name of *body-founder*. This inflammation may take place in any of the feet, or in all; but it is most commonly produced in the fore-feet: and as, from the pain which the horse experiences, he endeavours to throw as much as possible of his weight, upon his hind-feet, and appears unable to support himself on his fore-feet, he is said to be *down before*.

This complaint most commonly takes place in horses; but it may take place in cattle or sheep, brought on by hard driving, on hard stony roads, when sent to fairs, or markets. In these animals, however, the complaint seldom proceeds to such a height as in horses; and it is in them more easily relieved.

The symptoms of *founder* are thus described by Mr 379 Symptoms. Feron. "Foundered horses have a general stiffness of the fore-hand, attended with a considerable acute pain of the joints, ligaments, and muscles, connected with it. The pain which the animal suffers on moving the joints, obliges him to keep the flexor muscles in a constant relaxed state, which position ultimately produces an entire debility and stiffness of every joint which composes the fore extremity of the animal. If the horse has been neglected, or the disease so rapid in its progress that it cannot be removed, the symptoms will increase so rapidly, that in a very little time we may observe the cuticular veins become turgid and varicose, similar to the lymphatic enlargement in farcy. In this state, exercise considerably increases the pain and violence of the symptoms, the animal falls off his food, his health becomes very much impaired, and a general decay of the whole limbs, particularly observable in the extensor muscles of the fore-arm, soon renders the animal useless for activity *."

When the complaint affects the fore-feet, the horse throws his hind-feet as far forward as possible, which leads those who do not understand the nature of the complaint to suppose that the horse is affected with a weakness in his loins. When it is seated in the hind-feet the horse throws his body forwards, in order to re-

* Feron's Farriery, p. 120.

lieve

Diseases. lieve the hind-feet of their weight. In this case the horse is supposed to labour under an affection of the chest, which has been called *chest-founder*.

The complaint usually comes on very rapidly, and sometimes appears a few hours after hard riding, or after the application of other causes, that will immediately be mentioned.

It may be easily known that a horse is foundered, as he can scarcely walk on first coming out of the stable, and evidently labours under great pain. Like many other affections that produce lameness, the horse appears to be relieved by exercise, but this relief is only temporary; and exercise only tends to increase the disease.

Mr Feron says, that, on dissecting the feet of foundered horses, he has frequently found the membranes of the joints thicker than in their natural state, and sometimes a disposition to *anchylosis*, or stiff joint; which in some of the joints was evidently observed.

380 Causes. The *founder* is very commonly produced by battering the hoofs on hard ground. It may be brought on by any causes, that are capable of exciting inflammation in the internal sensible parts of the foot. It is frequently produced by washing the legs of a horse, while sweating; and according to Mr Feron this is so evident, that if we observe the horses belonging to public coaches, in whom this practice is very common, we shall see that sixteen out of twenty labour under the torture of this disease. Founder may also proceed from allowing the horse, while sweating and fatigued, to stand long in a cold, damp air.

381 Treatment. In the treatment of founder, the great object is to remove the inflammation, which is best done by bleeding in the veins of the foot, and the application of blisters about the joints. The shoe of the affected foot must be removed, and the toe of the crust may then be pared to the quick, in order to produce a discharge of blood from the vessels of the affected part. It will be proper to pare the whole of the crust as thin as possible, especially at the heels and quarters, in order to allow the frog to come in contact with the ground. Blisters are now to be applied round the fetlock, down to the foot. Mr Feron recommends immersing the feet in warm water 24 hours after blistering, keeping them there all day, and applying a large warm poultice of bran and water at night. Mr Blaine, on the other hand, advises the use of cold astringent lotions, as Goulard or sal ammoniac in vinegar. Sometimes the pain in the feet is so violent, that the horse can scarcely bear to support himself upon them, and indeed if he could remain quiet, it would be better to let him lie down. But if he proves restless, he may be partly supported by means of a sheet drawn round him, with its corners pulled up to the cieling of the stable by pulleys, so as to let the horse's feet just touch the ground.

The horse must be kept rather low, and if the inflammation is very great, or if there is any fever, it will be proper to administer cooling remedies, such as the drenches marked 22 and 25 in the receipts. The belly must be kept moderately open, and all exercise must be avoided.

Sometimes after the inflammation has subsided, the lameness still continues. This may be owing to the formation of horny matter between the sensible and horny sole. Mr Blaine recommends that this be removed by cutting away the horny sole; but we much doubt whether this operation would be attended with the desired effect. Diseases.

Founder, properly so called, can take place only in those animals that have horny hoofs; but a similar affection not unfrequently occurs in the feet of hounds, after a long and fatiguing chase. It consists in an inflamed state of the feet, produced by long running, especially over hard or stony ground. When the dogs come home their feet are hurt and swelled, inflamed, and sometimes cracked or chopt. The dog evidently feels considerable pain, and if he lies down for a little, he can scarcely be made to rise again. Dogs in this state are said to be stubbed in the feet, and are often so much lamed, that they cannot be taken out again for some days. 382 Stubbed feet in dogs.

When the inflammation is but slight, it requires but little attention, as the dog will himself allay the swelling and pain, by constant licking. When, however, the feet have been much bruised, the cracks pour out a bloody or purulent matter, and the case requires greater attention. The feet should first be bathed with warm water, and great care taken that no dirt or gravel be suffered to remain between the claws or in the cracks. After bathing, the feet may be rubbed with some digestive ointment, and a cold poultice composed of crumbs of bread well moistened with vinegar and water, should be tied round the affected foot.

The hoof of the horse frequently becomes lengthened, and contracted at the heels and quarters. This unnatural shape is commonly the effect of bad shoeing, by which the frog is deprived of the necessary pressure on the ground, and thus the heels are prevented from expanding, while the nails that are fixed in the quarters contribute to prevent expansion there, and thus the hoof is unnaturally lengthened at the toe. This contraction is considerably increased by the heat of ordinary stables; and by the evaporation that takes place from the hoof while the horse stands within doors, on account of the vacancy left below the frog, while the heels are elevated above the ground. Contraction of the hoof causes lameness, by producing an unnatural degree of pressure on the sensible parts within, especially on the sensible frog, which is not unfrequently inflamed in these cases. 383 Contracted feet.

The remedy for this defect is, to bring the frog gradually to press upon the ground, by lowering the heels; but as, in the very sensible state to which the feet are commonly brought by contraction, it might be dangerous to apply pressure to the frog at once, it is advisable to lower the heels gradually, in the manner directed in N° 146. If the frog is much diseased, as sometimes happens, a bar shoe should be employed, by which means slight pressure may be made by fixing an iron plate from the heels of the shoe towards the toe. The best means of producing pressure in these cases would probably be to employ Mr Coleman's artificial frog. The upper part of the hoof should be rasped thin, especially at the quarters, as these parts of the hoof will then be more easily expanded by the motion of the lateral cartilages. The lower part of the hoof should also be kept moist, especially the frog.

Mr Blaine remarks, that dark-chesnut horses are more subject to contracted feet than others, and he relates a case of a mare belonging to himself, who had all her feet contracted. These he endeavoured to expand by by means of jointed ſhoes, furniſhed with a ſliding bar, which was kept in its ſituation by means of pegs, ſo that in this way the heels of the ſhoe might be gradually widened, by moving the croſs bar farther on towards the toe. This method is very ingenious, but Mr Blaine acknowledges that it did not fully anſwer his purpoſe.

When the heels have been gradually lowered ſo far, that the frog can bear the proper preſſure, the horſe ſhould continue to wear a thin-heeled ſhoe; but if he is not required to be worked, it would be better to ſend him out to graſs without ſhoes, where the paſture is not too dry.

384 Running thruſh.

It often happens in caſes of contracted feet, and in ſome other caſes, when the frog does not receive the due degree of preſſure, that a running takes place from the cleft of the horny frog, occaſioned by a degree of inflammation which is followed by a ſecretion of purulent matter. This complaint is commonly called a running thruſh. While it extends no farther than the horny frog, it is ſeldom attended with any ſerious conſequences; but if it be neglected, the matter extends through the horny to the ſenſible frog and ſenſible ſole, and produces canker or quittor.

Some horſes have naturally a running from the cleft of the frog; and ſo long as this is ſlight, and the parts are kept clean, it is of little conſequence. We know there are ſome perſons who conceive a *ſlight running thruſh*, as rather beneficial to a horſe, and do not eſteem it as a mark of unſoundneſs; but we cannot agree with theſe gentlemen in either particular, as, though the complaint does not in itſelf abſolutely render a horſe lame, ſo long as his feet are properly attended to, it will, if neglected, degenerate into a foul ulcer, the matter of which may eaſily penetrate into the internal parts of the foot. A *running thruſh* is very commonly the conſequence of bad grooming, and ſuffering dirt and gravel to lodge in the clefts of the frog, and it is ſtill more frequently produced in the common method of ſhoeing, by cutting and paring away the frog.

In the treatment of a running thruſh, the principal objects are, to remove the cauſe that firſt produced it, and to ſtop the diſcharge of purulent matter. The latter is eaſily effected by applying to the part ſome ſtimulating liniment. Mr Blaine recommends for this purpoſe a compoſition of two ounces of tar, with ſix drachms of vitriolic acid, which is to be applied hot every day, by pouring it into the cleft of the frog from a ſpoon. The diſcharge, though eaſily ſtopped in this way, will ſoon return, unleſs the proper degree of preſſure be given to the frog; and this is to be brought about by proper attention to ſhoeing the horſe with thin-heeled ſhoes, taking care that the heels be lowered gradually, and ſlight artificial preſſure be made on the frog, till it is become ſufficiently healthy to bear the natural preſſure of the ground.

385 Canker.

When the matter of a running thruſh inſinuates itſelf upwards to the ſenſible parts of the foot, it forms what is called *canker*, in which there is a conſiderable inflammation, producing a luxuriant unhealthy fungus, ſpringing up from all the diſeaſed ſurface that is expoſed, and producing a great degree of tenderneſs, and what may be called a rottenneſs of the hoof. If this diſeaſe continues for any conſiderable time, it attacks the whole ſubſtance of the foot, extending to the tendons, ligaments, and bones, till at laſt the foot may abſolutely drop off with diſeaſe. Mr Coleman conſiders canker as generally the effect of too much moiſture applied to the foot or hoof.

To check the progreſs of a canker, the whole of the excreſcence that appears on the external part of the hoof, is to be cut away cloſe to the ſurface from which it ſprings, and ſuch parts of the horny ſole as appear to be detached from the ſenſible ſole, ſhould be removed, to prevent the matter from lodging in the internal parts. When the diſeaſed part is fairly expoſed to view, it is to be waſhed with a ſolution of ſome metallic cauſtic, ſuch as nitrate of mercury, N° 49 of the receipts, or a ſolution of lunar cauſtic, in the proportion of a drachm to two ounces of ſoft water. This is beſt applied by moiſtening a pledget of lint or tow, and confining this upon the cankered ſurface, by applying a regular preſſure by means of croſs bars of iron introduced beneath the ſhoe. A continuance of theſe applications, while the frog is gradually expoſed to preſſure, will in general ſoon ſtop the progreſs of the diſeaſe, and when this is removed, the horny parts of the hoof that had been cut away will be gradually removed; and by ſhoeing the horſe properly afterwards, the diſeaſe will be prevented from returning.

Cattle and ſheep are ſubject to a diſeaſe very ſimilar to canker in the horſe, producing a diſcharge of fetid matter from between the claws of the hoof, or ſometimes from only one claw.

This affection in cattle is commonly called *the fouls*, or the cattle are ſaid to be *foul in the foot*. Managers of cattle commonly divide this diſeaſe into two kinds, the ſoft, and the horny, which are ſaid to require different modes of treatment. In the *ſoft fouls*, a running of very offenſive matter takes place from the heels, or between the claws of the hoof; and the animal appears exceedingly lame. The treatment in this caſe conſiſts in cutting away all the ſoft and ſpongy parts, and then applying a cauſtic liquid, ſuch as will preſently be deſcribed, for the foot-rot in ſheep. The parts are then to be covered with a pledget ſpread with mild ointment, or, what is very common among farmers, a piece of fat bacon may be wrapt round the part, tied on the foot, and ſuffered to remain for two or three days. In the mean time the animal ſhould ſtand very clean, and be allowed to reſt as much as poſſible. 386 Fouls.

The *horny fouls* ſeem to be very analogous to corns in horſes. The animal is very lame, and, on examining the foot, the hoof feels very hot, and, when hard preſſed, the beaſt evidently feels much pain. There will commonly be found ſome part of the horn penetrating into the ſofter parts of the foot, either at the heel, or between the hoofs. In the treatment it is neceſſary to cut away theſe parts of the horn, as well as any part under which there appears much inflammation. For this purpoſe, it will probably be neceſſary to caſt the animal, but care ſhould be taken that he be thrown on a ſoft place. After the hoof has been pared away, a rag moiſtened with vinegar and water ſhould be tied on, and the animal muſt be ſent to graſs in a ſoft ſmooth paſture. If the inflammation and pain are very great, it may be neceſſary to bleed from the veins of the foot.

387 Foot-rot in ſheep.

In ſheep it is called the foot-root, and is generally produced by their being kept on a wet ſoil. It is remarkable that ſalt marſhes do not produce it. According to

Diseases.

to Mr Lawrence, frequent travelling to and from the fold, or by suckling ewes from the hot dung of a sheep-house, will occasion it. Some are of opinion, that it originates from the same cause which occasions chilblains in the human feet; and this opinion is maintained in the essay on the diseases of sheep, affixed to Mr Findlater's Survey of Peebles, where it is stated, that the remote cause of the disease is weakness, and the immediate cause cause cold and wet, as standing in cold weather upon wet pastures, with the feet constantly soaked in water. Dr Wilkinson of Enfield considers moisture as the predisposing cause, and has found the disease to be produced from the sheep continuing in long grass during a mild winter. The same cause generally, although perhaps gradually, operates upon the whole flock, and then it has been supposed that the disease is contagious. The late Lord Somerville had a piece of pasture which always produced the foot-rot on any sheep that were put into it; but the disease was entirely prevented or rooted out by a careful selection of the sheep in order, by paring the hoofs of those that began to be affected, and by the use of caustics not too corrosive. These appeared to be the most proper means of stopping the complaint, and the best caustic application is said to the nitrate of mercury. It is evident, that, during the application, the hoofs of the sheep should be kept as clean as possible. Whether its greater or less prevalence depends on the less or greater attention paid to the sheep, is not perhaps fully ascertained. It is, however, certain that the sheep of some districts are entirely free from it. We are informed, that in Tweeddale the complaint is scarcely known.

388 Pummiced feet.

There is a disease in the horse's foot, in which the coffin-bone is forced backwards, and made to press unnaturally upon the heels, by which its edges being subjected to unusual pressure, become partly absorbed. Hence this bone losing its support, becomes pressed in its concave part, where inflammation is produced, and bony matter is thrown out, rendering the lower part of the coffin-bone convex instead of concave, and the sole is rendered unusually thin. This disease is called *pummiced feet*, and may be brought on in three ways; from improper shoeing, from inflammation, as in case of founders, and from a natural defect in the foot itself. It is said to be very common in wet soils. It is very commonly produced by applying the shoe red-hot to the horse's foot. Its immediate cause appears to be an inflammation of the sensible laminæ, by which a quantity of coagulated lymph or of bony matter is thrown out, that forces back the coffin-bone in the manner above described. When the disease is completely formed, it does not appear capable of being radically cured, but only admits of palliation. Mr Blaine recommends, that the growth of the sole should be encouraged by every means, but the foot should not be kept improperly moist. The best means would be, the turning the horse out without shoes in a dry pasture. No part of the heels or sole should be removed in this case, as the parts are already too slight. A shoe should be formed, if possible, that presents a hollow surface to the foot, and a plain one to the ground. This may be done, by making it of rather an increased thickness, which will admit of its being hollowed within, and bevilled from the outer to the inner edge of the web.

389 Sandcracks.

Sometimes perpendicular fissures or cracks are seen in the hoof extending between the fibres in a parallel direction from above downwards. These are called sandcracks, and generally take place near the quarter, more frequently on the outer than the inner side, and oftener in the fore than the hind foot. These cracks sometimes come on suddenly, and then generally denote a contraction of the hoof. They are also said to have arisen from a wound in the vessel or part of the coronary ligament, bringing on a secretion of horny matter, which gets between the fibres of the hoof, and causes them to separate.

The means of preventing the crack from extending, are to thin the hoof where the crack has taken place as much as possible, and to make a transverse section a little way across at the upper part. If the crack should still continue to gape, it must be carefully covered, and the hoof bound round, so as to close it as much as may be, and the portion of the crust that rests on the shoe should be chambered away a little, by which means the divided parts will be more likely to come together.

390 False quarter.

When a wound has been inflicted on the coronet, the coronary ligament commonly becomes injured, and its vascular part does not secrete so much bony matter as usual. Hence there is a space left between the old horny matter of the hoof, and the new that is formed from other parts; and this produces what is commonly called a *false quarter*. A false quarter may also be produced, in consequence of a quittor extending upwards through the coronet. As the sensible laminæ within the hoof are liable to be pressed in this vacant space between the horny edges, thus causing violent pain, the false quarter is attended with a lameness of the worst kind; for as this interference of the lamina sometimes takes place suddenly, while the animal is in motion, the pain makes him shrink, and he not unfrequently comes down.

The only way of remedying this defect is, to excite such an action in the coronary ligament as may dispose it to throw out new horny matter, and thus fill up the vacant space. This is best effected by removing the surrounding horn, and applying blisters to the coronet, while the part of the hoof that is opposed to the shoe should be hollowed away as much as possible, to admit of the separated parts approaching each other.

391 Cutting.

When a horse in motion, especially in trotting, brings one foot so near another as to interfere, and thereby graze or wound one of the feet, he is said to cut. Sometimes the feet of a horse are in this way severely wounded, and temporary lameness is produced. In cutting, the horse may either wound the heels of the fore feet, with the toe, or side of the hind shoe, which is the most common case; or he may wound the fore part of the hind-foot, just above the hoof, by striking it against the heel of the fore shoe; or, lastly, he may bring two of the feet so closely together, as to wound the inner side of either.

Cutting may arise from a bad habit, or from a natural deformity of the feet, but it is very commonly the consequence of bad shoeing. When horses cut from turning out their toes, which is by much the most common cause, they are observed to have the inner quarter of the hoof lower than the outer, and the fetlock joints are thus nearer each other than those of horses which have their limbs straight. These facts led farriers to a conclusion, that if the inner quarters were raised to a level with the outer, and especially if made even

Diseases. even higher, the fetlock joints would be thrown further apart, so that the foot would pass the supporting leg without striking: Accordingly, it has been usual to make the inner quarter of the shoe higher than the outer, and this has been the common practice for a long time. Mr Morecroft, by making trial of a shoe, of a shape the reverse of what we have described, namely, having the outer quarter thick, and the inner thin, completely prevented cutting in the horse, on whom those shoes were tried, and the utility of the improvement has been confirmed by succeeding trials. According to Mr Blaine, the principle on which this is supposed to act is, that when a horse is at rest, he supports his weight equally on both feet; but, having his inner quarter much raised, in the common mode of attempting to remedy the defect of cutting, when one foot is elevated he must be supported obliquely on the other, and hence have a tendency to fall outwards; to prevent which he brings the moving foot nearer the supporting one, by which he strikes it. Considering it in this point of view, it is not difficult to account for our author's mode of reasoning on his method, which, by elevating the outer instead of the inner side of the supporting foot, must necessarily give it a disposition to lean inwards, and fall to the inside, which will throw the moving further from the supporting foot. But, ingenious as this mode of reasoning may be, it is to be feared, that by thus throwing an increase of weight on the inner side, we shall sometimes be in danger of producing evils, that will counterbalance the prevention of cutting*.

* *Blaine's Outlines*, vol. ii.

392 Lameness may be produced by any one of the causes that we have mentioned, but it may happen that a combination of two or more of these causes takes place at the same time in different parts of the same limb: thus the foot may be pricked with a nail, and a strain may take place, nearly at the same time, in the sinews of the leg, or the ligaments of the joints; for the pain excited by the nail first makes the horse trip or stumble, and then, his making a sudden exertion to save himself, or ease the pained foot, a strain of the ligaments or sinews frequently takes place. A similar complication is often produced in a horse that is affected with spavin, or other bony excrescences, as his exertion to save the limb that feels painful from the rubbing of the muscles or tendons against the spavin, may produce a severe strain in the muscles of the shoulder.

As the causes of lameness are so various, and the real seat of it frequently very obscure, a practitioner should be extremely cautious how he gives a decisive opinion with respect to either, before he has well examined the parts where lameness may take place, and enquired into every circumstance that may assist him in forming his opinion. For want of such precaution, and from a superficial examination of the part that is supposed to be the seat of the affection, egregious blunders and dangerous mistakes are not unfrequently committed, and applications have been made to parts that are really sound, when it is afterwards discovered, to the confusion of the practitioner, that the real cause of the lameness was in a different place. Nothing is more common than for ordinary farriers to apply their liniments and embrocations to the shoulder, when in fact the affection that causes the lameness is seated in the feet.

As, perhaps, in nine cases out of ten, the foot is the part that has received the injury, this should first be examined with the strictest attention, the hoof should be made perfectly clean, especially in its under surface, to see whether there be any crack or fissure, any discoloration, any particular heat, &c. The pastern and all round the coronet should be also carefully inspected; and, if nothing is found, the examination should be repeated next day, or even a third time. The foot is more particularly to be suspected of being the seat of the complaint, when the lameness makes its appearance soon after the horse has been shod, or has had his shoes fastened; as the foot may be lamed by a nail in shoeing, though the point of the nail has not penetrated to the quick. The nail may be so thick, or may pass so near the quick, as to press in a small part of the hoof upon the soft parts, thus producing exquisite pain, and perhaps inflammation. It is therefore proper always to remove the shoe from the foot of the affected limb, and if the cause of lameness is not very evident to wait a few days, to see whether the removal of the shoe has produced any alteration for the better.

No certain rule can be laid down for judging of the seat of lameness from the motion of the affected limb, though this is considered by some as one of the surest marks. The deranged motion in one part of the limb very commonly arises from sympathy with another part that is the real seat of the affection.

We have now, we believe, mentioned all the important cases of lameness, except the *string-halt*, or *click-spavin*. This is an affection of the hind quarters, producing a sudden jerking of the legs upwards, when the horse attempts to move. It appears to be a nervous affection, and seems to be somewhat analogous to the *chorea*, or *St Vitus's dance*, in children. We do not know that this affection has ever been cured, but it is said that it may be palliated by allowing the horse to run much at large, and letting him remain untied in a large stable. Mr Lawrence recommends that, after a hard day's work, both hind legs be immersed in a warm bath up to the hocks, and kept there as long as the water continues warm, when they are to be rubbed perfectly dry, and the same bath and rubbing repeated in the morning. He also advises anointing the back sinews, and about the hocks, with strong camphorated ointment. 393 String-halt.

We have occasionally, in this and the preceding chapters, spoken of abscesses and ulcers, and their treatment; and we can add little here on that subject, as it will be fully treated of in the article SURGERY; and the instructions to be there laid down will apply nearly as properly to the inferior animals as to man. We may just remark, that foul ulcers, and such as do not heal kindly, are perhaps more common in some of the inferior animals than in man; and hence they require in the former applications of a more stimulating nature, to excite a proper degree of healthy action in the ulcerated part. There are a few particular ulcers which call for consideration in this article, and we cannot, perhaps, treat of them in any part of the treatise more properly than under the morbid affections of motion. 394 Ulcers.

There sometimes takes place an inflammation, and consequent suppuration in the mucous capsules, at the articulation of the head with the first vertebra of the neck, near the insertion of the cervical ligament. This affection is commonly called the *poll-evil*. It is almost always 395 Poll-evil.

Diseases. always the consequence of an injury done to the back of the head, by a horse's hanging back in his collar, by striking his head against the rack or manger; and is very frequently produced by a blow given on the head by brutal coachmen or carters. An ulcer in this part is often very difficult to heal, and when it extends beyond the skin, the matter sometimes insinuates itself below the ligament of the neck, and on each side of it, and it not unfrequently produces a caries or rottenness of the vertebræ. The cure of the poll-evil is most easily effected when the inflammation is first discovered, before a suppuration takes place; as, when once matter is formed, it commonly produces sinuses in the loose cellular substance about that part of the head, and these are not easily healed. When, therefore, we have reason to suppose that inflammation has begun in the skin of this part of the neck, every means must be employed to prevent its progress towards suppuration. A blister should be immediately applied over the part, and when this has done its duty, a solution of sal ammoniac in vinegar, or vinegar and water, should be applied by means of a cloth kept constantly wet. If a suppuration appears inevitable, it must be encouraged by fomenting the part frequently with warm water, or by the repeated application of warm poultices; and when the swelling appears sufficiently ripe, it must be opened, which is best done by introducing a seton from the highest to the most depending part of the tumour, as directed in No. 173. The cord of the seton must be examined every day, wiped dry, and rubbed with a little digestive ointment, and the sore should be carefully excluded from the air.

If the suppuration has proceeded any length, before it is discovered, there will probably be a number of sinuses, or *pipes*, as they are called, with matter lodging in each. If it can be easily effected, it would be proper to lay these open, and make them communicate with each other, or, if their direction can be ascertained, a seton may be passed through each. When a proper opening has been made for the matter, and care taken that none of it lodges, the sore will soon heal, by the application of the proper stimulating ointments.

It is sometimes necessary to employ the knife in this case; but when this is done, the greatest care should be taken not to wound the ligament, or, as the farriers call it, the *fix-fax* of the neck. The best method of avoiding this is, to have the animal's head fastened very high to the rack, by which the ligament will be more slack, and the finger can be easily introduced below it, so as to be a guide to the knife.

396 Fistulous withers. We mentioned in No. 341. the chafing of the back with the saddle. There is another injury of a similar kind, that is often suffered by the withers, from the saddle being allowed to press on them too long. This pressure and rubbing sometimes produces an inflammatory swelling, which, if it be not soon discussed, goes on to suppuration, and produces a sore which farriers call *fistulous withers*, or a *fistula in the withers*. This is also a very troublesome ulcer, as the matter sometimes penetrates below the shoulder, and makes its way down the bones of the fore leg; or, by insinuating itself among the vertebræ of the back, renders them carious. The treatment in this case is much the same as in the last; the inflammation should be discussed as soon as possible, and if matter forms, it should be evacuated by means of setons. It is frequently required to pass a seton through the tumour on each side of the withers, in order to produce a proper inclination of the orifice, to carry off the matter. When sinuses form, they must be opened, as in the case of poll-evil.

397 Canker of the ear in dogs. There is sometimes a species of ill-disposed ulcers in the external part of the ears of dogs, very difficult to heal. It is generally called *canker*. These, when they heal, leave hardened edges, which frequently break out again in the course of a few months. The best application in this case is lunar caustic applied to the edges, to encourage them to slough off; but if this should not be found sufficient, the best remedy will be to sear off the diseased parts with a red-hot knife, or they may be cut off by a simple incision.

Chap. III. *Morbid Affections of Digestion.*

398 In order that the food may be well digested, when received into the stomach, it is necessary that it undergo the previous operation of chewing; unless it be of such a nature, as to be easily soluble in the gastric juice, without this previous preparation. The latter is the case only with dogs, whose food consisting almost entirely of animal matter, requires little or no chewing. But the food of horses, sheep, and cattle in general, requires to be well chewed, either when first swallowed, or in sheep and cattle by subsequent rumination.

399 Sore mouth. The mouth in these animals is sometimes so swelled, or otherwise affected with sores or cracks, that it is with difficulty the animals can chew their food. Sometimes there are bloody chinks or chops in the palate, occasioned by thistles or other prickly plants, which are mixed with the hay, or grow up among the grass. These should be washed on their first appearance with salt and vinegar, applied by means of a rag tied to a stick. If neglected, these chops frequently become inflamed and ulcerated. If pimples arise, they must be opened when they begin to suppurate, by means of a pointed cautery. There are sometimes found within-side the lip of cart horses and other ordinary cattle, soft tumours, or pustules with black heads, which are called *giggs*, *bladders*, or flips in the mouth. They do not always occasion much inconvenience, but sometimes they grow to a large size, so as to grow troublesome, and prevent chewing. When this is the case, they must be removed, either by fastening a thread about their roots, as directed in the treatment of warts, where they are of such a form as to admit of a ligature; or by the knife, applying afterwards the hot iron or cautery. In performing this operation, care must be taken to draw the tongue to one side, so that it may not be wounded. After removing these excrescences with the knife and cautery, the mouth may be washed with a solution of white vitriol or alum. Excrescences of a similar kind, called *barbs* or *paps*, sometimes grow below the tongue, and must be removed where practicable by means of ligature, as it is dangerous to employ the knife. When these excrescences are neglected, there sometimes arise in the mouth little ulcers with white specks, very similar to the aphthous crusts that form in the human mouth. It is recommended by some writers to use the cautery on these occasions; but probably a detergent lotion, such as we have just recommended, will answer the purpose of removing them.

The

Diseases. 400 Wounds in the mouth. The mouth or tongue of horses are sometimes wounded with the bit or curb. When this happens, a lotion made with alum dissolved in water, and sweetened with honey, may be employed; and the bit should not be used again till the mouth is healed.

401 Lampas. Many veterinary writers have described the disease in the horse's mouth called the *lampas*, which is stated to be an inflammation and swelling of the first bar of of the mouth in a young horse, so as to prevent his chewing. We believe that Lafosse and Dr Bracken were the first to deny the existence of such a complaint, which is now generally discredited among most of our modern writers. We have no doubt that such a swelling may take place; but it can scarcely be attended with the ill consequences commonly attributed to it, or require such vigorous treatment as is usually recommended.

402 Choaking. It may happen, that any of these animals shall have a difficulty of swallowing, from various causes; either from an unusual narrowness in the gullet, or from the morsel attempted to be swallowed being too large. The latter very frequently happens to cattle who are fed upon turnips or potatoes; and the choaking thus produced sometimes proves very dangerous, as, if the obstruction is not speedily removed, the animal will die for want of breath. The method commonly employed among country farmers for *unchoaking* cattle, as they term it, is to thrust down the throat a large stiff rope, ravelled at the end, and well greased. This often succeeds, but it is a clumsy method; and if the rope, by having been long used, or becoming dry, should lose its stiffness, it will be bent in endeavouring to force down the obstruction; or, if the ravelled end be not pretty large, or the obstructing morsel of an irregular shape, the rope may pass between the side of the gullet and the obstruction, without this being removed. Several intelligent farmers have therefore laid aside the use of the rope, and have contrived an instrument similar to the probang employed by surgeons. An instrument of this kind has been already mentioned, in the description of Mr Hunter's feeding byre in N° 236. An account of one that appears to us to be more useful and ingenious, has been communicated to us by the reverend Charles Findlater, minister of Newlands in Tweeddale. It is the contrivance of Mr Charles Alexander, a farmer in Mr Findlater's neighbourhood, and has long been employed by him for the purpose of relieving choaked cattle. The following is Mr Alexander's construction of his instrument, as politely described to us by Mr Findlater.

403 Mr Alexander's probang. Take three small canes, of the thickness of the little finger, or thereabouts, of the length of $5\frac{1}{2}$ feet, that they may reach down the throat, and into the stomach of the largest ox. These canes are to be bound together by strong smooth twine rolled tightly about them (the circles of the twine touching each other), from top to bottom. Bees wax is then to be rubbed along the twine, to fill up any inequalities, and the whole rod is to be well oiled before it is used. There is a round knob at each end, the larger $2\frac{1}{2}$ inches in diameter for larger cattle; the other less for lesser cattle. These knobs are formed of the twine rolled hard, and when formed may be strengthened in their position, by being sewed by means of a shoemaker's awl or *brog*, and a waxed bristled thread, such as they employ. The thread knobs are made tapering up the canes from their broad extremity; but it must be remarked that the surface of this extremity is not rounded like a clue, but hollowed into the form of a cup. The intention of this hollowed form is, to make certain of catching hold of the obstructing body; as, if the knob was round, it might pass by it. After the knobs are formed, they are covered with soft leather, which by its flexibility will adapt itself to the hollow end of the knob as soon as it reaches an obstacle. The knobs must be securely fixed to the canes, for if they fall off, they leave an indigestible substance in the stomach. Such is Mr Alexander's probang, the only improvements on which that we would advise are, to make the knobs of sponge, firmly fastened to the canes, by passing twine through holes bored in them, and adding at each end two or three bights of twine, for the purpose of catching hold of any obstacle, thus making the instrument almost exactly like a surgeon's probang. We think the sponge preferable to the twine, as it will not be so liable to injure the animal's throat by its hardness, will adapt itself more readily to the form of the obstacle, and may be more firmly fixed to the canes.

When cattle are put into a field of young clover, or rich grass, especially if they have previously been kept on poor or dry fodder, they are apt to eat voraciously of their new repast, and the young succulent food, when received into the stomach, soon ferments, and produces such a quantity of air, as to swell the stomach to a violent and dangerous degree. Cattle thus affected are said to be *over-fed*, *hove*, or *blown*; or the affection of the stomach thus produced, is called *over-feeding*, or sometimes *fog-sickness*. If not speedily relieved, the animal's stomach not unfrequently bursts, from the inability to evacuate the accumulated air; for there seems, in these cases, to be a constriction of the gullet, so that the air cannot escape upwards, while the number of stomachs, and the spasmodic contraction produced by the unusual distention, prevents its passage by the anus. 404 Over-feeding or fog-sickness.

The necessity of speedily relieving the animal, prompted the employment of what must at first have been considered as a very desperate remedy; namely, stabbing the animal. An opening is made with a sharp penknife into the paunch, in the thin part between the last rib and the huckle bone; and through this the air rapidly escapes. Sometimes the barrel of a quill is inserted into the wound, to prevent its closing before all the air that is produced during the fermentation of the food, has escaped.

Stabbing the animal, is a remedy that should not be had recourse to, but on the most urgent necessity; as the wound can seldom be made with such nicety as not to wound some important organ, especially some large blood-vessel. Indeed frequently the distension of the stomach, and consequently of the skin and muscles of the belly, is so great, that the moment the knife is introduced, a dreadful rent takes place, producing such a wound, as may be attended with fatal consequences.

Happily this operation is not often necessary, as it is found that the administration of some internal stimulating medicines will check the fermentation of the green fodder, and promote the absorption of the extricated air. Many farmers have for some time given tar with this intention, administering an egg shell full to each beast; of late, however, the use of ardent spirits has been introduced, and it is found that a pint or mutckin

of

Diseases. of whisky or gin, mixed with an equal quantity of water, is the most efficacious remedy. Laudanum has also been recommended, but probably it is not superior to common spirits (D).

It has been the practice with some farmers, to introduce on these occasions, the common rope employed in cases of choaking, into the stomach, and move it up and down, so as to produce a gradual evacuation of the air; but we should suppose that the evacuation produced in this way must be extremely slow.

405 Dr Monro's flexible tube.

Dr Monro senior, professor of anatomy in the university of Edinburgh, some years ago contrived an elastic tube, that might be introduced down the throat into the stomach of the animal, and thus speedily and effectually evacuate the air. A description of this instrument, and the manner of employing it, appeared in an Edinburgh newspaper, we believe, with the doctor's authority. It has since been published in a popular treatise on the diseases of black cattle, entitled "Rowlin's Complete Cow-Doctor," from which we have taken it.

The doctor begins by observing, that the swelling of the belly is owing to the distention of the stomachs by fixed air, disengaged from the succulent grass in consequence of fermentation, the discharge of which by the mouth seems to be prevented by a spasmodic contraction of the upper orifice of the stomach. He concludes that the cattle may with certainty be saved, if the air be drawn off in due time, without injuring the stomach and bowels; and he affirms that this may be done with great ease by passing a flexible tube down the gullet into the stomach.

The tube is to be composed of iron wire, as large as a common stocking wire, or about one sixteenth part of an inch diameter, twisted round a smooth iron rod, three eighths of an inch diameter, in order to give it a cylindrical form; and after taking it off the rod, it is to be covered with smooth leather.

To the end of the tube, which is intended to be passed into the stomach, a brass pipe, two inches long, of the same size as the tube, and pierced with a number of large holes, is to be firmly connected.

To prevent the tube from bending too much, within the mouth or gullet, in time of passing it down into the stomach, an iron wire, one eighth of an inch diameter, and of the same length as the tube, is put within it, which is to be withdrawn, when the tube has entered the stomach.

He has found that the space from the fore teeth of the under jaw, to the bottom of the first stomach of a large ox, measures about six feet, and he has passed such a tube, five feet and nine inches long into the gullet and stomach of a living ox. The tube ought therefore to be six feet long, that we may be sure of its answering in the largest oxen.

After the tube is passed into the stomach, it may be allowed to remain for any length of time; as when it is pressed to one side of the throat, it does not intercept the breathing of the animal. The greatest part of the elastic and condensed fixed air, will be readily discharged through the tube; and if it be thought necessary, the remainder of it, or the superfluous drink, may be sucked out, by a bellows fixed to the upper end of the tube, with a couple of valves, one at its muzzle, and the other at the side of it, so disposed as to allow the air to pass in the direction from the stomach upwards. Diseases.

By means of such a tube, the air is not only more certainly discharged than by stabbing the animal; but the dangers avoided which the stabbing occasions, not so much by the irritation which the wound creates, as that the air, and the other contents of the stomach, getting into the cavity of the belly, between the containing parts and the bowels, excite such a degree of inflammation as frequently proves fatal to the animal. This tube may be also useful for the purpose of introducing stimulant medicines into the stomach, when the contraction at the upper orifice would prevent their being given without some such contrivance.

An instrument of this kind is sold in London, at Macdougal's, N° 15, Great Wind-Mill Street. It should be made of various sizes, for sheep, as well as cattle. According to Mr Blaine, Mr Eages of Graffham farm, near Guildford, has simplified this mode of relief much, by the invention of an instrument, for which he was rewarded by the Society for the encouragement of Arts, with fifty guineas. This is simply a cane of considerable diameter, and six feet in length for oxen; to which is affixed a knob of wood, at the end to be introduced into the stomach. That for sheep is considerably smaller, and three feet long. This instrument, for its simplicity, is much to be preferred, as it is found to occasion the evacuation of the air as effectually as the other. In cases of emergency, and in a judicious hand, the flexible part of a common cart whip might answer the end.

Flatulence may be produced in horses, by eating greedily of rich food, to which they have been unaccustomed, or after having fasted long; especially if they drink much water immediately after. A horse in this state should not be taken out to work, as, from the distension of the stomach, there is danger of injuring the horses wind, or even in some cases of bursting the stomach. If the distension has not proceeded to a great length, and if the horse is not costive, gentle friction on the belly, and administering a ball made of some of the cordial seeds, will generally procure relief; but if the complaint proceeds to a great height, and there is griping pain, attended with costiveness, it becomes a case of flatulent colic; the descriptions and treatment of which will be considered in the next section.

When this flatulence comes to a great height, it forms the disease that is commonly called acute indigestion. It very commonly arises from the horse eating voraciously, after having been kept without food for many hours; especially if the food then given him be of a flatulent kind, such as grains or draff, young sweet grass, clover, or the like. The horse's stomach being naturally small, is easily distended by an unusual quantity of food, or by the air disengaged from such as easily runs into fermentation. Hence arise swelling and tightness of the stomach, and acute pain. The horse discontinues eating, 406 Acute indigestion.

(D) The use of spirits in these cases was, we believe, first introduced by Dr Whytt of Edinburgh, who was in the habit of administering a pint (mutchkin) of gin on these occasions.

Diseases. eating, holds out his head, and appears exceedingly destressed; he looks anxiously and mournfully at his side, stamps with his feet, and breaks out into cold sweats. If he is not soon relieved, the head becomes affected, and there appear evident marks of pressure on the brain. Symptoms very similar to those of staggers follow, and the horse commonly dies apoplectic, or the stomach bursts.

As this affection is so dangerous, immediate relief is necessary. Stimulant medicines, such as are called carminatives, as oil of anisefeeds, essence of peppermint, or oil of turpentine, should be immediately administered; and if there appears much determination of blood to the head, which may be known by a swelling and heaviness of the eyes, and the violent throbbing of the arteries of the temples, it will be necessary to draw blood pretty largely by opening one of these arteries. If the horse is bound in the belly, he must be raked, and have a strong purgative clyster with some aromatic substance in it, as anisefeeds, or carraway seeds.

407 Poison. All these animals may occasionally swallow poison, and the treatment in these cases must depend in a great measure on the nature of the poisonous substance, where this can be ascertained. It is seldom that a horse, cow, or sheep is poisoned; but in the dog, this may frequently happen, either from accidents, or design. Dogs often pick up *nux vomica*, (which is the poison mostly used by warreners,) and which usually causes convulsive fits, and soon kills. Apply immediately the following remedy. As much common salt as can be got down; hold the head upwards, and force open the mouth, and by fixing a stick across, prevent its shutting, whilst the throat is filled with salt; a sufficient quantity to purge and vomit will soon dissolve, and be swallowed; the stomach once cleared by a free passage obtained by stool, warm broth should frequently be given to prevent the faintness which might otherwise prove fatal. Two table spoonfuls of *castor oil*, added to the salt, would very much accelerate its action downwards.*

* *Daniel's Rural Sports.*

Arsenic is frequently given to dogs by design, or it may be picked up by them in places where it has been laid for rats. If the accident is discovered soon, the dog may sometimes be recovered by giving him a vomit of white vitriol, and drenching him well with sweet oil and milk; and when most of the poison appears to have been thrown up, the rest may probably be rendered harmless by repeated doses of liver of sulphur.

If a horse is poisoned, the danger is very great, as from his inability to vomit, the stomach cannot be cleared of the poison. But fortunately this accident scarcely ever happens; as arsenic, the most common poisonous substance, will produce little effect on the horse, unless given in a very large dose.

408 Worms. The stomach and bowels of all these animals may be infested by worms, but these are most common in the horse and dog.

The worms that most commonly infest the horse are what are commonly called the *bots*. They are not properly worms, but are the larvæ of several species of the *Oestrus* or *Gadfly* mentioned in N° 337.

409 Bots, Oe. equi. The horse is attacked by 2 or 3 species of *Oestrus*, but more especially by the *Oe. equi*, which deposites its eggs in such a manner as that they shall be received into the animal's stomach, where they form the bots.

The method pursued by the parent fly, in order to lay its eggs in the most favourable situation for being received into the stomach of the horse, is extremely curious. It is thus related by Mr Bracey Clark, who appears to have witnessed the process. Diseases.

"When the female has been impregnated, and the eggs are sufficiently matured, she seeks among the horses a subject for her purpose, and approaching it on the wing, she holds her body nearly upright in the air, and her tail, which is lengthened for the purpose, carried inwards and upwards. In this way she approaches the part where she designs to deposit the egg, and suspending herself for a few seconds before it, suddenly darts upon it, and leaves the egg adhering to the hair, by means of a glutinous liquor secreted with it. She then leaves the horse at a small distance, and prepares a second egg, and poising herself before the part, deposits it in the same way. The liquor dries, and the egg becomes firmly glued to the hair. This is repeated by various flies, till four or five hundred eggs are sometimes deposited on one horse. The skin of the horse is always thrown into a tremulous motion on the touch of this insect, arising from the very great irritability of the skin and muscles at that season of the year, occasioned by the continual teasing of the flies. The inside of the knee is the part on which these flies seem to prefer depositing their eggs, and next to this the side, and back part of the shoulder. It is curious that these parts are what are most exposed to be licked by the animal. In licking, the eggs adhere to the animal's tongue, and are carried into the stomach with the saliva.

"The bots attach themselves to every part of the horse's stomach, but are usually more numerous about its farther orifice, and are sometimes, though less frequently, found in the bowels. Their number varies considerably; sometimes there are not above half a dozen; at others they exceed 100. They most usually hang in clusters, fixed by the small end to the inner membrane of the stomach, to which they adhere by means of two small hooks.

"The body of the *larva* is composed of eleven segments, all of which, except the two last, are surrounded with a double row of horny bristles, directed towards the truncated end, and are of a reddish colour, except the points, which are black. These *larvæ* evidently receive their food at the small end by a longitudinal aperture which is situated between the two hooks or *tentacula*. The lips of this aperture appear somewhat hard, horny, and irregular.

"Their food is probably the chyle, which, being nearly pure aliment, may go wholly to the composition of their bodies without any excrementitious residue, though on dissection the intestine is found to contain a yellow or greenish matter, which is derived from the colour of their food, and shews that the chyle as they receive it is not perfectly pure.

"The slowness of their growth and the purity of their food must occasion, what they receive in a given time to be proportionally small; from which probably arises the extreme difficulty there is found in destroying them by any medicine or poison thrown into the stomach. After opium had been administered to a horse labouring under a case of locked jaw for a week, in doses of one ounce every day, on the death of the animal I have found the bots in the stomach perfectly alive. Tobacco has

Diseases.

has been employed in much larger quantities in the same complaint, and has been also longer continued, without destroying them. They are also but rarely affected by the drastic purgatives, which bring away in abundance the *Teniæ* and *Ascarides*."*

* *Linnæan Transf.* vol. iii. p. 298.

Mr Clark does not apprehend they are so very injurious to the horses as is generally conceived. When removed from the stomach a deep impression remains where they adhered, but whether they ever irritate it so as to bring on a fatal spasm of the stomach itself, or of the *pylorus*, or, by collecting round this passage, prevent the food from entering the intestine, has never been investigated with sufficient accuracy. The ignorant surprise of farriers on opening the stomach after death, and being presented with so singular an appearance as the bots, has without doubt very often occasioned the death to be attributed to these, though it is certain but few horses on our commons can escape them.

Instances have occurred of violent inflammation excited in the stomach by the bots. An example of this is related by Mr James Clark. He was once desired by a farrier in the neighbourhood who was indisposed, to visit a horse that had been a patient of his for some days, and report the situation he was in. When Mr Clark entered the stable, the servant was giving the horse a drink, which he was afterwards informed was composed of an infusion of lintseed, in which was dissolved one ounce of nitre, with honey to sweeten it; and in the last hornful was poured, from a small phial, about half an ounce, or more, of spirits of hartshorn. The horse seemed very uneasy after the drink, he was soon seized with a violent trembling and shaking, a profuse sweat broke out all over his body, and run down his sides, as if water had been poured on him; at the same time his legs and ears were quite cold; he lay down seemingly in great agony; he was soon after convulsed all over, and died in about half an hour from the time the drink was swallowed. Mr Clark obtained leave to take out his stomach where he was, on condition he should sew up the skin afterwards, in order to prevent any bad smell in the stable, till he could be carried off. On inspecting the stomach, the coats of it were found greatly inflamed, and a mortification had taken place on one side, where it appeared of a darker colour, and here there was a small hole, through which a lead probe passed into the cavity of the stomach from the outside; the coats of the stomach were considerably thickened, and of a darkish red colour resembling the liver; at the same time the stomach was considerably distended and full of food: on turning it inside out, an incredible number of *bots* were found sticking all round the sides and lower part of it, so that it appeared entirely covered with them, sticking as closely to one another as bees in a honeycomb; and so firmly were the heads of these vermin fixed in the coats of the stomach, that endeavouring to pull some of them off when alive, they broke in two, and their heads remained sticking in the coats of the stomach.

The great irritation produced by such a number of these worms sticking in the coats of the stomach had no doubt occasioned at first an inflammation there, and from its continuance this was tending to a mortification, before the drench was given, and would have occasioned the horse's death.†

† *Clark on Prevention.*

410 Oe. Hæmorrhoidalis.

Another species of *Oestrus*, viz. the *hæmorrhoidalis*, also produces eggs, which when received into the stomach of the horse become bots. This insect has been termed *hæmorrhoidalis* from the appearance of the bots when coming out of the anus of the horse, when they are very like the swelling produced by the piles or hæmorrhoids. It was supposed by Linnæus and some other naturalists, that this and the last species introduced their eggs into the bowels of the horse, by entering the *rectum*, *mire per anum intrans*; but this opinion is now fully refuted.

The part chosen by this insect for this purpose, is the lips of the horse, which is very distressing to the animal from the excessive titillation it occasions; for he immediately after rubs his mouth against the ground, his fore legs, or sometimes against a tree; or if two are standing together, they often rub themselves against each other. At the sight of this fly, the horse appears much agitated, and moves his head backwards and forwards in the air, to baulk its touch, and prevent its darting on the lips; but the fly, watching for a favourable opportunity, continues to repeat the operation from time to time; till at length finding this mode of defence insufficient, the enraged animal endeavours to avoid it, by galloping away to a distant part of the field. If it still continues to follow and tease him, his last resource is in the water, where the *Oestrus* is never observed to follow him.

The teasing of other flies will sometimes occasion a motion of the head similar to this; but it should not be mistaken for it, as it is never in any degree so violent, as during the attack of the *Oestrus*.

At other times the *Oestrus* gets between the fore legs of the horse while he is grazing, and thus makes its attack on the lower lip; the titillation occasions the horse to stamp violently with his fore feet against the ground, and often strike with his foot, as aiming a blow at the fly. They also sometimes hide themselves in the grass; and as the horse stoops to graze, they dart on the mouth, or lips, and are always observed to poise themselves a few seconds in the air, while the egg is preparing on the point of the *abdomen*.

When several of these flies are confined in a close place, they have a particularly strong fusty smell; and I have observed both sheep, and horses, when teased by them, to look into the grass, and smell to it very anxiously; and if they by these means discover the fly, they immediately turn aside, and hasten to a distant part of the field.

The eggs of this species appear of a darker colour than the former, and we are unacquainted with the circumstances attending their passage to the stomach.

The *larvæ* of the *Oestrus hæmorrhoidalis*, as well as the former species, appear to have been termed among the Romans, *cossus*, which seems to have been a general expression for any kind of soft imperfect animal, and to have been very analogous, and as extensively applied as the word *grub* is at present in the English language.*

* *Linn. Transf.* vol. iii. p. 310.

411 Symptoms of bots.

The presence of bots in the horse's stomach and bowels, is not always easily ascertained, as it is certain that great numbers have been found in the stomach after death, without appearing to have produced any unusual symptoms in the animal while alive. When, however, they have collected in any great numbers, or when the animal's stomach is peculiarly irritable, they are attended with the following symptoms. The horse has a disposition

Diseases. position to rub his tail frequently, without any apparent humour or eruption that should make it itchy; he eats heartily, and is yet always lean and out of condition. His coat is rough and staring, such as we have described it to be in what is called a *surfeit*. There is also a sickly paleness of the mouth and tongue, attended with an unwholesome cadaverous smell. The horse appears tucked up in his flanks, which often heave; he turns his head now and then, and strikes his belly with his hind feet. These latter symptoms indeed, as they only indicate griping pains, and often occur in ordinary colic, are not to be relied on, unless accompanied with the former. In cases of worms, it is said that the dung is yellowish, like melted sulphur, or is otherwise discoloured and very offensive. The surest mark, however, of the presence of bots is their being voided by the anus, where they are sometimes found sticking.

411 Treatment.

As the bots are extremely tenacious of life, it is very difficult to expel them, and where they do not occasion any considerable irritation or other bad symptoms, it will be better to let them alone till they come away spontaneously. But when it is judged necessary to attempt their expulsion, this may be done by administering the sal indus, as directed in N° 60 of the receipts, and after it a strong dose of calomel and aloes.

We have said the bots are not properly worms; but there are several species of worms that are very frequent in dogs, and are now and then found in the horse. These are the *lumbrici*, or *long round worms;* the *ascarides*, or *thread worms;* and the *tæniæ*, or *tape-worms.*

412 Lumbrici.

The long round worms are seldom met with in these animals; but when they occur in the horse, they produce much uneasiness, and sometimes occasion colic and inflammation of the bowels. It is very difficult to expel these worms, as the only remedies by which this could be properly attempted, such as powdered tin and strong purgatives, cannot with propriety be often given to a horse, as, from the structure of his stomach, the former might produce considerable injury, and the latter are extremely debilitating.

413 Ascarides.

Ascarides are now and then found in the great guts of the horse, and sometimes prove troublesome, but are seldom or never dangerous. They are best removed by clysters of lime-water, followed by purgative clysters.

414 Tape-worm.

The tape-worm is seldom found but in dogs, where they are sometimes the cause of fatal diseases, especially to puppies. The symptoms of worms in dogs are, an itchiness of the nose and at the anus, both of which they are perpetually rubbing against every thing; swelling and hardness of the belly, leanness, running at the eyes and nose, and frequent purging of a slimy or stringy matter. There is also a peculiar staring appearance of the hair, which points the wrong way.

Mr Blaine says that the bowels of dogs are so irritable, that they will seldom bear strong physic, and that he knows of nothing that will certainly destroy the worms in their intestines. He has tried with variable success, tin, quicksilver, pewter, calomel, and savine, with other substances, but none of them appeared sufficiently certain to demand his confidence. When the worms are early detected, he thinks that purging doses of the compound powder of scammony with calomel, prove the most efficacious means. Mr Daniel recommends aloes, hartshorn, the juice of wormwood, with some flower of brimstone, mixed together into a ball, about the size of a hazel nut, which is to be wrapped up in butter, and given three or four times a-week, letting the dog fast for a few hours each time, which, he says, will destroy the worms. He also says that they may be destroyed by giving the dog as much finely powdered white glass as will lie on a sixpence, for three successive mornings, mixed up with butter; and if the worms are not voided in that time, the dose of the glass is to be increased, and it is to be repeated for three other mornings, by which time it will scarcely fail of producing the desired effect.

415 Concretions in the stomach.

There is a sort of concretion often met with in the stomachs of cattle, and sometimes in that of horses, which is partly composed of a chalky substance, and partly, or sometimes almost entirely, of hair evidently arising from the animal's licking off their hair and swallowing it with their saliva. The mass thus received into the stomach, being wholly indigestible, collects there, and forms these globular concretions which sometimes grow to such a size as to prove fatal.

The growth of these concretions is thought to be encouraged by the long use of hard dry food, without the animal's being allowed to feed from time to time on fresh green herbage. It is even thought that the timely use of fresh grass may prove the means of dissolving these concretions. Van Swieten, in his commentaries on Boerhaave, when speaking of chalky matters found in the liver and other organs, remarks, that sometimes there are concretions of the like sort found in this organ, but of a more friable texture, and of a whiter appearance, like gypsum or plaster of Paris. Such incrustations were often observed by Glisson in the pori biliarii, and its larger branches dispersed through the livers of oxen that had been fed in stalls with hay and straw during the winter season and without exercise. But then these concretions are very friable, and they afterwards dissolve again, and pass out of the body when the cattle come to feed upon the fresh grass of the meadows; for in oxen that are slain in the spring or summer, they are very rarely to be found.

" In dissecting horses, (says Mr Clark) I have frequently met with chalky concretions in their livers and in the lungs, especially in those that have been fed long on dry food, and likewise round balls in their stomachs, sometimes of an oval shape. The latter seem for the most part to be composed of the dust they lick from their own bodies mixed with the hair. Whether the fresh grass dissolves them is not so certain; but that it causes these concretions to pass through the intestines, I have had a full demonstration. In May 1786, a horse that had been long fed on dry food was turned out to grass; in about eight or ten days afterwards, he was seized with violent griping pains, which lasted for about 24 hours, when he died. As the horse was very fat, the man who had the charge of him wanted to make something of his grease. In searching for it, he observed a large space of the intestines of a very black colour; and on feeling it, found something hard and weighty within them. He immediately cut it open with his knife, and took out a large oval hard ball, which measured four inches in length, and three inches and a half in breadth, and which I have now in my possession. That this concretion was originally formed in the stomach,

ſtomach, there can be no doubt, as they frequently upon diſſection have been found there, and nothing but its great bulk had hindered it from paſſing through the inteſtines." *

* Clark on Prevention, p. 60.

The beſt means of obviating theſe concretions, is to allow the animal to feed occaſionally on freſh green fodder; and, according to what has been ſaid, this may ſometimes remove them after they are formed.

416 Loſs of appetite.

Horſes and other domeſtic animals ſometimes labour under a loſs of appetite. Animals may eat leſs than uſual, or they may refuſe to eat at all, either from a want of that ſenſation in the ſtomach, which we call hunger, or from a diſlike that the animal takes at the food that is ſet before him. Want of appetite is a ſymptom of ſeveral diſeaſes, particularly of fevers and internal inflammations. When this happens, it would be abſurd to force food on the animal's ſtomach, as it could not be digeſted, and would only aggravate the violence of the diſeaſe.

Want of appetite very often attends very great fatigue. It is alſo very frequently the effect of an improper uſe of cordial and ſtrengthening medicines. It may however, be the effect of weakneſs of the ſtomach, not brought on by thoſe means. In ſuch a caſe, cordials and tonics are very proper, and their uſe ſhould be accompanied with gentle exerciſe.

This loſs of appetite in the horſe, is commonly called *chronic indigeſtion*, and is uſually accompanied with a roughneſs and ſtaring of the coat, the ſkin having the appearance which we have deſcribed in N° 328 under hide-bound.

An affection of a ſimilar kind takes place in cattle, in whom it is called *loſs of the cud*, from their not chewing the cud as uſual. It is known by the animal's mourning, having no inclination to eat, or dropping his food, without ſwallowing it. It frequently ariſes from the ſtomach being loaded with hard food that is difficult of digeſtion, ſuch as acorns, or coarſe dry ſtraw. It may alſo ariſe from a weakneſs of the ſtomach, which is not uncommon in hot weather, and may be brought on by confinement and want of freſh air. The treatment is much the ſame as in horſes.

417 Foul feeding.

Horſes are ſubject to an affection of the ſtomach, in which they ſometimes eat voraciouſly, or greedily ſwallow ſubſtances that are indigeſtible. Horſes labouring under this complaint are called *foul feeders*, as they eat clay, mortar, dirt, foul litter, or even the dung of other animals.

This is properly a ſymptom of indigeſtion, and ſeems to be owing to a peculiar acrimony of the gaſtric juice, and in moſt caſes there is evidently an acid upon the ſtomach. The beſt remedies are bitters, and other ſtrengthening medicines, combined with ſalt of tartar, or ſome other antacid. The receipts marked 61 and 62 are well adapted to theſe caſes. Theſe remedies ſhould be aſſiſted by pure air and regular exerciſe; and where coſtiveneſs is preſent, it ſhould be obviated by the uſe of warm laxatives. Care ſhould alſo be taken to keep the ſtable clean, and to have a quantity of clean ſtraw below the manger, that the horſe may not be tempted to eat other ſubſtances that are more injurious.

418 Surfeit in dogs.

A ſurfeit is ſometimes occaſioned by hounds eating putrid fleſh, or that of horſes that have died, or been killed when violently affected with the farcy. Ariſing from the former cauſe, the fatality which attended the hounds of Mr Finch in Kent, is a curious inſtance. In drawing the covers, the hounds met with the carcaſe of a diſeaſed bullock, with which they gorged themſelves; the contamination was immediate through the pack; they were generally ſeized with ſtaggering convulſive fits, operating to ſo violent a degree, that eight couple of hounds died in the field in leſs than two hours, and it was ſuppoſed the whole pack would have fallen victims, but for the timely application of oil and other medicines. Mr Daniel, from feeding with the fleſh of horſes ſent from a poſt ſtable, in which the farcy and the glanders had ſpread their ravages, had an opportunity of ſpeaking to the latter; the hounds broke out all over in blotches, diſcharging a watery humour, ſimilar to thoſe occaſioned by the farcy; they cauſed great ſtiffneſs, and were extremely painful. This inoculation took place, notwithſtanding moſt of the horſes were ſent alive to the kennel, and were properly ſlaughtored, and none of the fleſh was given raw to the hounds. Phyſic, and taking them frequently to the ſalt water, and well rubbing the ſores by hand with it, at length recovered them. For checking a common ſurfeit, ox gall and train-oil, equal quantities; the affected parts to be well rubbed, and ſome phyſic taken inwardly will quickly reſtore them *.

* Daniel's Rural Sports.

There are two diſeaſes that affect the bowels, which we cannot conſider more properly than at the end of this chapter. Theſe are *rupture* and *falling of the fundament*. Theſe may take place in any of the domeſtic animals, but they are more common in horſes, as they are moſt frequently the effect of great exertion. *Burſtenneſs* or *rupture*, commonly proceeds from ſtrains in labour, kicks on the belly, high and difficult leaps, eſpecially when heavy laden. It may be produced by the goring of oxen, by being ſtaked, and by various other accidents. Gibſon ſays that he has known it produced by too deep an inciſion being made in inſerting a rowel. 419 Rupture.

The bowel may be ruptured either at the navel, or through the rings at the back part of the belly into the ſcrotum or cod. The tumour, when not too large, will return on being preſſed, as if it were merely flatulent, and the rupture or chaſm may be felt. It is eaſy to conceive that ſuch a defect is incurable, excepting poſſibly in a very ſlight caſe, and a very young ſubject; the intention muſt be to palliate, to render the animal as uſeful as poſſible, and as comfortable to itſelf. In a recent caſe, bleed, and give emollient and oily clyſters, boiled barley, malt maſhes, nitrated water. Foment twice a day with camphorated ſpirits, and vinegar warm; and poultice with oatmeal, oil, and vinegar.

Falling of the fundament is ſometimes occaſioned by a long-continued looſeneſs, and is moſt likely to be produced in ſuch animals as are of a weak and delicate conſtitution, but it is frequently brought on by hard riding or hard driving. Mr Lawrence ſays, that he has frequently ſeen it in hard-driven pigs. According to Soleyſel, it is in horſes ſometimes the conſequence of docking. 420 Falling of the fundament.

When this complaint is firſt ſeen, it may in general be eaſily cured. The gut ſhould be returned as ſoon as poſſible, by puſhing it up with the ends of two or three fingers wrapt round with a piece of ſoft linen rag gently greaſed; but before returning the gut it ſhould be bathed with ſome aſtringent lotion, as a ſolution of

Diseases. of alum or white vitriol, or port wine and water; and a little of either of these should be frequently injected. If the gut should become inflamed, it must be anointed with some cooling liniment, such as receipt N° 28. Care must be taken to keep the animal's bowels open, by frequent bran mashes. If the complaint continues obstinate, nothing will effectually remove it, but cutting off a part of the protruded gut. This may be done with a common surgeon's knife, called a *scalpel*, but it is sometimes performed with a sharp red-hot cautery. The wound commonly soon heals, but the animal should not be worked for some time after; but should be allowed a long run at grass, or in a straw yard.

Chap. IV. *Morbid Affections of Absorption.*

421 The absorbent vessels of the human body have been described in the article Anatomy; and the structure of these vessels, in the animals now under our consideration, is sufficiently similar to render a particular description of them here unnecessary. The function of absorption, and the derangements produced in it by disease, will be explained under those medical articles that have for their object *physiology* and *pathology*. It will be sufficient for us, in this place, to remark, that many of the disorders of the animal frame, are greatly influenced by the state of the absorbent system; and that some complaints seem chiefly to depend on the loss of the proper balance between the function of absorption, and that of circulation. Sometimes the absorbent vessels are too active, while the circulating system is proportionally languid; at others the absorbent system is languid, while that of the circulation is either unusually active, or continues in its natural state. The former seems to be the cause of leanness, costiveness, and some other morbid affections; to the latter may be referred the several species of dropsy. We shall here only consider two of these affections, leanness, and swelled legs, as most of our readers will expect costiveness treated of as a morbid affection of *excretion*, and most of the species of dropsy must be considered as general affections of the system; and therefore to be explained in the next section.

422 Leanness. An unnatural degree of leaness may take place from many causes; as, 1st. From the want of a proper supply of food, whether from this being dispensed too sparingly in proportion to the labour of the animal, or from its not being sufficiently nourishing. Hence we see that such horses and dogs as are hard worked and ill fed, are extremely lean.

2d. In stallions leanness is often the effect of being suffered to cover too often, or too long at one season.

3d. It is a common attendant on several acute diseases, as fevers, some inflammations, especially dysentery, or what has been commonly called *molten grease*.

4th. Leanness is a common attendant on old age.

This symptom requires little attention, as it is seldom dangerous, except when it comes on very rapidly, and is attended with great weakness, and manifest signs of decay, in stallions that are too *hard worked*. It commonly soon disappears after the cause that produced it, or the complaint of which it is a symptom, is removed.

423 Swelled legs. A swelling of the legs is very common to horses that are suffered to stand long in the stable, without being worked, or in some other cases that will presently be mentioned. There is a swelling of the legs that is the consequence of hard work, strains, or other causes, that excite inflammation; but what we are now considering is a dropsical swelling, consisting in an accumulation of watery fluid below the skin, similar to the swelled legs of old people, and *chlorotic* girls. It may affect all the legs, but it is more commonly confined to the hinder extremities. The swelling generally takes place above the pastern and fetlocks; but if it continues long, it extends further up the legs, and the skin sometimes cracks, and there oozes out a watery fluid, or sometimes a purulent or greasy matter. In this last case it has degenerated into grease, which will be considered hereafter.

Swelled legs frequently take place in horses that are newly brought into the stable, or a straw yard; especially if they are not regularly worked, and their legs regularly rubbed down, at least twice a day. It is more certainly produced, if the horse should be suffered to stand long on hot litter. It is also not uncommonly the effect of wading through snow or cold water, especially when the legs are heated. It evidently depends on a decreased action of the absorbent vessels and veins of the legs.

It may in general be prevented by regular exercise, and frequent rubbing: but if it should occur in a horse that is too full of blood, it may be necessary to bleed and physic. If the swelling should continue obstinate, it will be proper to apply a blister to the part, or to rub the legs frequently with some stimulating liniment, and if the complaint is of long standing, it may be proper to insert a rowel in each leg; and the dispersion of the swelling may be assisted by rolling hay bands round the legs, by way of bandage. One of the most effectual means of preventing a return, will be firing, making perpendicular lines with the cautery from the fetlock to the coronet. Regular exercise and friction must be persisted in; and if the complaint is accompanied with general weakness of the system, a nourishing diet, and strengthening remedies must be added.

Chap. V. *Morbid Affections of Circulation.*

The pulse in the inferior animals has been very little attended to by veterinary practitioners; indeed the common farriers and cattle doctors scarcely know whether their patients have a pulse, or where it may be most readily felt. 424 Pulse in various animals.

The strength and frequency of the pulse in its natural state, differs very much in the several species of the domestic animals. It is in general stronger according to the size of the animal; but its frequency diminishes in the same proportion, it being quicker in the smaller than in the larger animals, even of the same species. We cannot undertake to state exactly the average frequency of the pulse, in the several animals, and the accounts given by different authors vary considerably. Mr Clark says that the pulse of a horse in health, and no way terrified or alarmed, is from 36 to 40 beats in a minute. According to Mr Blaine, it ranges from 45 to 55, being generally from 45 to 50 in large horses, and from 50 to 55 in smaller horses. Dr Hales found that the pulse of an ox in health, did not exceed 38 beats in a minute.

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Mr Blaine, in his first volume, states the medium pulse of a dog at 80 or 90; but in his second volume p. 149, he says, that a dog has usually from 90 to 100 or 110 contractions in a minute, so that we may probably take the average at from 90 to 100. Perhaps the pulse of a sheep is slower by about 10 beats than that of a dog.

425 Feeling the pulse.

The pulse in the inferior animals may be most conveniently felt in the temporal arteries, which as we have said in N° 164 are situated a little backwards above the outer angle of the eye. It may be felt also at the corner of the lower jaw, on each side of the fetlock joint, on the inside of the hock, and at the heart.

As much is to be learned from the pulse, respecting the nature of many diseases, and the degree of danger which they indicate; we earnestly recommend to our practical readers, that they take every opportunity of examining the pulse of these animals, when in a state of disease. We cannot here enter with propriety into an explanation of the morbid varieties of the pulse, as it would be only to repeat what is given in the pathological part of our work, to which we refer our veterinary readers; as the observations there delivered can be easily applied to the particular cases of horses, cattle, sheep, and dogs, by keeping in view the natural state of the pulse, in each species as above laid down.

426 There are two general states of the system, that may take place in all animals, and which are chiefly distinguished by the state of the circulation, as ascertained by the pulse. These are plethora, or fulness of habit; and debility, weakness, or inanition. The former is always attended with a fulness, and sometimes a hardness of the pulse; while in the latter, the pulse is weak and small, easily compressed or stopt by the finger, and is sometimes slower, but oftener much more frequent than natural.

427 Plethora.

When an animal has been kept for some time on a full nourishing diet, while he is at the same time confined within doors, and deprived of that regular exercise, which is necessary to carry off superfluities, he becomes fat, corpulent, and full of blood, or what we call *plethoric*. In this state the veins below the skin, from their being greatly distended with blood, are very prominent, excepting in those parts where they are bedded in fat; the pulse, is as we have said, full, and commonly strong, but in some cases it feels oppressed, as if the quantity of blood were too much for the cavity of the artery. The pulse in these cases is frequently slower than natural. The animal becomes dull and sluggish, averse to motion, and if he is obliged to exert himself, evidently does so with difficulty, pants, and labours, and becomes soon fatigued.

This plethoric state is extremely common in horses and dogs that are pampered with high living, and little or no work. A horse in this state, though he may look well, is far from being in good condition, and is by no means fit for active labour. In fact, if such a horse is put to hard work, before he is properly prepared for it, there is the greatest probability that he will be completely ruined. Instances occur every day of full fed idle horses knocking up, or even dying on the road, and a long list of violent diseases is the consequence of this plethoric state of body. It lays the foundation of broken wind, inflammation of the lungs, phrensy, and above all of staggers, or apoplexy. It is no uncommon thing to see a fat well-looking horse, fall down in convulsions, while drawing a heavy load, owing to the determination of blood to the head, from so great an exertion, while the vessels are too much distended. Most lap dogs and others who are parlour guests, commonly die of apoplexy. A lady of our acquaintance had a fine fat lapdog, who seldom quitted the cushion that formed his bed, beside his mistress's chair, where he was fed with the nicest bits from the dinner table. *Jack* had been unusually heavy for a day or two, and one morning was found lying dead on his cushion; *though* he had the night before eaten a *hearty supper*.

To prevent the ill consequences that must arise from this plethoric state, these animals should be regularly exercised, and not suffered to eat too much. Where the *plethora* has already taken place, and where no dangerous symptoms threaten the attack of some violent disorder, the best method of bringing the animal into good condition, is to lower his diet gradually, and as gradually increase his exercise or labour; but where the symptoms are such, as indicate approaching apoplexy, or some other dangerous disorders, it will be necessary immediately to bleed and purge, and to take care that the animal be not put to any violent exertion, till he be brought into good condition.

We must here remark, that frequent bleeding with a view to obviate *plethora*, is extremely improper, as it tends to produce the very state against which it is employed. Bleeding, therefore, ought not to be had recourse to, except in cases of imminent danger.

428 Hawkes, or hocks.

There is a complaint that sometimes appears among cattle, when they are suddenly put on high feeding, after having been long accustomed to a poor and sparing diet. It is called by the graziers, *Hawkes* or *Hocks*, and is probably of an inflammatory nature, but as it seems to depend entirely on a sudden distention of the blood vessels, and is speedily relieved by removing this distension, it may properly be considered in this place.

The complaint is said to begin with an uneasiness and swelling about the eyes, and about the glandular parts of the throat, which extends itself gradually over the whole body, to the legs and joints; and in cows to the barren and udder. The animal appears languid, dull, and heavy, and seems unwilling to stir from the place where he is; and when the disease has made some progress, he will not lie down till he is relieved. The legs become cold and numb, and as the swelling advances towards the hind parts, a copious secretion of saliva commonly takes place from the mouth, attended often with a swelling about the tongue. The disease is extremely rapid in its attack and progress, and if it be not speedily attended to, it will terminate in staggers, or some violent inflammatory disease.

The cure of this affection seems to depend entirely on bleeding, which should be performed as soon as possible, taking away a quart or two of blood at first, and repeating the operation some hours after, if the swelling is not diminished. It is recommended to rub the whole body well, both before and after bleeding, and if the mouth is much affected, it will be relieved by washing it frequently with salt and water. If there is any considerable heat, it may be proper to give a drench with nitre every four hours.

429 Inanition.

Inanition is a state of body directly the opposite of what we have described; and is produced by very different

Diseases. ferent causes; from starvation, hard work, loss of blood, or violent, or long continued diseases.

An animal in this state is lank and lean; its pulse is small and weak, his eyes hollow, his skin dry and hide-bound, his excrements small in quantity, hard, dry, and discoloured, his urine thick and turbid; he takes every opportunity of grazing by the road side, pulling at the hedges, or eating whatever comes in his way; he becomes mangy; and if this state of debility continues long, he falls into what is called an atrophy, which commonly proves fatal.

The above description is chiefly applicable to those animals, who either from accident or neglect, are half starved. The state of inanition produced from this cause, is frequently seen in horses belonging to the lower class; and it is no uncommon thing to see dogs that have been turned out of doors, perishing in the streets in this condition. Sheep are also often found in a state of inanition at the end of a hard winter, after having been left for months to shift for themselves among the snow.

On opening the bodies of such as have died of hunger, we find the stomach and bowels much contracted, and sometimes in the former there will be a small quantity of food, scarcely masticated and indigested: Sometimes both stomach and bowels contain balls of earth or other indigestible matters; the large intestines are exceedingly diminished in size, and commonly contain a quantity of dry, hardened excrement; the caul and other membranes that surround the intestines are much shrunk, and for the most part appear completely divested of fat; the heart and large blood-vessels are flabby, and filled with a thin watery blood.

Though inanition is most frequently the effect of starving, it not unfrequently follows great loss of blood, or profuse discharges from the bladder and intestines. It also not uncommonly attends an obstruction in the gullet, in which case the animal can take little or nothing by the mouth, and the nourishment which he can receive by clysters is little more than sufficient to support his existence.

Inanition from the last cause is the most hopeless; for when it arises from starving, loss of blood, or profuse discharges, the animal may, in most cases, be brought back to good condition, by nourishing diet and strengthening remedies, with proper attention to pure air, gentle exercise when he is able to bear it, and proper shelter from the inclemencies of the weather.

430 Wounds of arteries.

It is not uncommon, either from injudiciousness or want of skill in bleeding, or from accident, for an artery to be wounded. If the wound be large, or the artery of any considerable size, so much blood may be poured out as to destroy the animal in a short time; but, if the artery be wounded by a small puncture, such as may be made by the point of a lancet passing through a vein, blood is gradually effused, and insinuates itself in the cellular membrane below the skin. In this way a swelling is formed with an evident pulsation like the beat of an artery; and, as this enlarges, the skin becomes discoloured and distended, so as sometimes to burst and occasion death by a sudden loss of blood. The swelling produced by the blood effused from a wounded artery has been commonly called a *false aneurism*, to distinguish it from what we are immediately to mention.

The artery that is most liable to be wounded in bleeding is the external carotid, which runs below the jugular vein, or sometimes a little to one side of it. This accident, will, however, seldom happen, except when a ligature is used; but when this is employed, the jugular vein is pressed so closely on the artery, that the point of the fleam or lancet may easily penetrate through the vein into the artery. M. Huzard alleges, that in this way even the wind-pipe may be wounded, together with the artery, and that the animal may be choaked by the effusion of blood from the latter into the former.

When an accident of this kind has taken place, whether from bleeding, from wounds, or from the erosion of an artery by the acrid matter of a foul ulcer, it is necessary to take speedy means for preventing the ill consequences that may ensue; for, though the wounded artery be not very large, such an effusion of blood may take place from it, as may greatly weaken the animal, if it should not prove fatal. If the artery is very small, the bleeding is easily stopped, either by applying such a degree of pressure, as may be sufficient to obliterate the cavity of the wounded vessel, or, what is often more convenient, by completely dividing it; after which the divided ends will contract so much as to prevent the further effusion of blood. If the wounded artery be large, it can be secured with certainty only by means of ligature. For this purpose, pressure must be made on the artery, between the wounded part and the heart, while an incision is made through the skin and muscles down to the place where the artery has been wounded, so that this may easily be discovered. Then a pretty strong thread, doubled and waxed, is to be passed round the artery by means of a crooked needle, with a blunt point, and is then to be tied fast about an inch above the wounded part. A similar ligature is to be fixed upon the artery at about the same distance, on the other side of the orifice, and the artery is to be cut across between the two ligatures. Thus, the further effusion of blood is completely prevented, and the wound may be healed in the usual manner. The part that was supplied with blood by the wounded artery, will, if the vessel was pretty large, be colder and less sensible than usual, but it will in general be sufficiently supported by the small branches of other arteries that join with the wounded vessels beyond the ligatures; and these branches will gradually become so distended as to supply the place of the divided artery, and restore the part to its proper functions.

431 Aneurism.

It sometimes happens, that part of an artery becomes unusually dilated, forming what is called a *true aneurism*. This dilatation may take place in any of the arteries, but it is most common in the aorta or great artery within the body, and in the external carotid and popliteal arteries without. An aneurism of the external carotid is often seen in dogs, and sometimes in horses, especially such as are accustomed to draw heavy weights. An aneurism of an external artery is easily distinguished, by a considerable pulsation, which may be felt much more superficially than the ordinary beat of the artery, and is sometimes so remarkable, that it can be distinctly seen by the alternate heaving and sinking of the skin below which the swelling is situated. An aneurism of the aorta is not so easily distinguished in the inferior animals. The diagnostic marks by which it may be known

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known in the human body, will be given in the article SURGERY.

Those aneurisms are attended with considerable danger, and those of internal arteries commonly soon prove fatal. Aneurisms of external arteries are attended with a wasting of the bones over which they lie, owing to the increased absorption of bony matter produced by the pulsation of the dilated artery; and these swellings commonly burst in no long time, especially if the animal be exposed to any great labour or exertion.

The treatment of these aneurisms is exactly similar to that of a wounded artery described above. It consists in securing the dilated artery, either by pressure on the side of the aneurism next the heart, or by means of two ligatures, one on each side of the tumour.

432 Wounds of veins.

An effusion of blood into the cellular substance may take place from a vein, the orifice of which has not been properly closed after bleeding; or it may happen from the orifice in the vein not exactly corresponding to that in the skin, so that the skin gets over the orifice in the vein, and prevents the blood from flowing out. In this latter case there is said to be a *thrombus* of the vein.

When such an effusion of blood is observed, it is necessary to dilate the orifice in the skin, and to take away the clotted effused blood from below it. If the vein does not appear likely to bleed again, it will be unnecessary to pin it up; but if blood should still flow from it, it will be necessary to secure it by a pin. This, however, should not be suffered to remain too long, as it may produce inflammation and ulceration of the vein. Sometimes it is so long before the effusion of blood is observed, that the swelling is become considerable, and is attended with inflammation, or even suppuration. Where inflammation is present, but has not proceeded to suppuration, this latter may in general be prevented by keeping the part moist (after taking out the effused blood), with a solution of sugar of lead in vinegar and water. If matter is already formed, the swelling must be poulticed, or frequently fomented with warm liquors; and when the matter is let out, the sore must be treated as a common ulcer.

Sometimes the inside of a vein that has been opened in bleeding inflames, suppurates, and becomes a fistulous sore; and if this be neglected, the matter may extend to some important organ, as to the head, when the jugular vein has been opened, and produce death. When the vein is not very large, or the ulcerated part of it is inconsiderable, it may commonly be healed by means of the actual cautery, or firing, as described in N° 351; but if the wound is very large, or the ulceration very extensive, it may be proper to secure the vein by means of ligatures applied on each side of the ulcerated part.

433 Varix or blood-spavin.

When the enlargement of any part of a vein takes place, without the vein having been wounded, the swelling is called by medical writers *varix*, or the vein is said to be *varicose*. This swelling seldom takes place in any of the domestic animals except the horse, in whom sometimes the superficial vein that passes over the inside of the hock sometimes becomes varicose, and forms what farriers call a *blood-spavin*. The enlargement of this particular vein is always accompanied by *bog-spavin*, or an enlargement of the mucous capsules in the same part of the hock, and the former seems to be a consequence of the latter, being produced by the compression of the vein, by the swelling of the mucous capsule below it, whence an obstruction of the blood, and a consequent dilatation of the coats of the vein.

When the enlargement of the vein is not considerable, it requires no particular attention; but if it should increase so far as to be troublesome, methods must be taken for its removal. This may be effected, either by producing such a pressure on the vein as shall stop the circulation of the blood in it, or by tying up the vein with a ligature. In applying pressure, such a bandage should be adopted as may surround the whole hock, while the greatest pressure is made on the dilated vein. Mr Blaine recommends for this purpose a bandage including several of those elastic tubes, ladies glove braces or tops are made of, which would occasion permanent pressure, and yet permit motion. But, should it still be found to resist this, its removal must be attempted. For this purpose, an opening should be made above the enlargement, and then including the vein within a ligature, and an opening below likewise, including the vein also at that part; the enlarged part may then be punctured, to let out the distending blood, and the remainder suffered to slough away *.

* *Blaine's Outlines*, vol. ii.

CHAP. VI. *Morbid Affections of Respiration.*

In many complaints, especially fevers and inflammations of the internal organs, the breathing becomes hurried, and inspiration and expiration, but especially the former, are performed more quickly than in the healthy state of the body. This hurried respiration, in the inferior animals, is known by the rapid heaving of their flanks; and when it is attended with considerable heat and dryness of the skin, it denotes considerable danger. Any particular consideration of this symptom will, however, be more proper, when we come to treat of the particular cases in which it occurs. 434

The principal affections of breathing which we shall here notice, are those in which respiration is rendered difficult, without being attended with fever or inflammation. Horses are more liable than other domestic animals to difficulty of breathing, and one particular modification of it, *broken wind*, is peculiar to this animal.

There sometimes takes place within the nostrils a gathering of thick clotted matter, which, when it comes to any considerable height, very much obstructs respiration, and produces a snivelling noise when the air passes through the nostrils. This affection is called the *snores*, or *snivels*, and is almost peculiar to cattle. It is sometimes mistaken for a disorder of the throat, where it is imagined there is some obstruction; but when this rattling noise is found to attend the breathing of cattle, it may generally be discovered whether or not it be the disease in question, by a careful inspection of the nostrils. The swelling thus produced in the nostrils generally goes on to suppuration, and when it breaks the animal is relieved. The object of our treatment must therefore be to hasten the suppuration by the application of warm stimulating fomentations or liniments. A very common application in these cases is the oil of bays injected up into the nostrils; but perhaps the steam of warm water would answer every good purpose, and might be easily applied, by putting a warm bran mash into a canvas bag, and tying it to the animal's head; and this 435 Snores, or snivels.

may

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may be repeated till the imposthume breaks. The animal should in the mean time be kept in a well-sheltered house, and should be fed on nourishing diet.

436 Chronic cough.

Cough is almost a constant attendant on colds, consumptions, inflammation of the lungs, and other pulmonary complaints; and when it occurs as a symptom of these diseases, no particular attention is to be paid to it, as our principal object is the primary affection. It frequently happens, however, that after the inflammatory affection is removed, an obstinate cough remains; and if this is attended with no considerable difficulty of breathing, and if the horse eats well, and appears thriving, the cough alone requires our attention. This kind of chronic cough is generally more considerable in the mornings and evenings, and after eating, and is generally increased by any violent exertion.

Chronic coughs, though generally a consequence of previous inflammation, may arise from a peculiar irritable state of the top of the wind-pipe; and if this be the case, the use of some narcotic substance, as opium or hemlock, may be proper. A very obstinate cough is often the consequence of preceding inflammation, and is attended with a peculiar noise, as if the aperture through which the air came was diminished. This kind of noise is called *roaring*, and it is found on dissection that the wind-pipe is contracted by a quantity of coagulable lymph, that has been effused during the inflammation. Mr Blaine has seen a preparation where the diameter of the wind-pipe was reduced to one-third of its original dimensions, and it has often struck him as not improbable that the grasping the wind-pipe hard, as is sometimes done to try the wind, may bring on inflammation, and occasion this affection.

These chronic coughs, especially the *roarer*, scarcely admit of a complete cure; but they may in general be mitigated, by keeping the animal warm, and by avoiding violent exertion. The food should be such as is easy of digestion, and does not produce much distension of the stomach. Tar is much recommended in these cases, especially for the cough, or *hoose*, that sometimes occurs in cows. An ounce of tar, with the same quantity of vinegar of squills, and a little oil of aniseed is to be given every morning, in a quart or chopin of warm ale.

437 Broken wind.

One of the most common defects in a horse's breathing is that which is called *broken wind;* the nature of which complaint has been of late much elucidated by Mr Coleman. According to Mr Lawrence, broken wind is discovered by the quick and irregular heaving of the flanks, and a more than ordinary dilatation of the nostrils; sometimes also, by a consumptive appearance of the body. But the usual method of trying the soundness of a horse's wind, is to cough him; which is performed by pressing the upper part of the wind-pipe with the finger and thumb. The strong, clear, and full tone of the cough, prove his wind to be sound; if, on the contrary, the note be short, whistling, and husky, the horse is asthmatic and unsound. Horses labouring under the worst stage of this disease, are styled, in the language of the repository, *roarers*; from the noise they make in work, of very little of which they are capable. Broken-winded mares are generally barren, although we have heard of one which bred a whole team of horses after she became so. In confirmed broken wind there is sometimes observed a palpitation of the chest, with constant contraction and dilatation, and now and then a considerable cavity or depression may be perceived.

The older writers had many strange opinions with respect to the nature of this complaint. Gibson attributed it to an enlargement of the contents of the chest, and Dr Lower thought it proceeded from a rupture of the phrenic nerve. A friend of Bartlet supposed the disease to proceed from a morbid or obstructed state of the glands and membranes of the head and throat, the enlargement of which prevented a free passage to the wind. According to Mr Osmer certain glands, which are placed upon the air-pipe, at its entrance into the lungs, are become enlarged, and thereby the diameter of the tube is lessened; hence the received air cannot so readily make its escape, nor respiration be performed, with such facility as before; from which quantity of contained air the lobes of the lungs are always enlarged, as may be seen by examining the dead carcases of broken-winded horses.

It is now satisfactorily ascertained, that the immediate cause of broken-wind is a rupture of some of the air-cells of the lungs. The cause that most commonly produces such a rupture is over distension of the stomach, attended with hard and violent exertion. The horse being an animal that is always eating, will, when hungry, eat very voraciously, if he has an opportunity, and soon fills his stomach; and if, in this state, he is exercised violently, the circulation and respiration will be increased, but the lungs cannot expand sufficiently, because the diaphragm cannot descend from the pressure of the stomach. In this case, the circulation being hurried, the lungs do not undergo the necessary change, in consequence of their now being compressed. The animal then, endeavouring to take in more air, either actually occasions the cells to be ruptured, or something else to give way. If the cells are ruptured, the air escapes from them into the cellular membrane of the lungs, and there acts as foreign matter, or, at least, it cannot then produce the necessary change on the blood, when thus diffused; in consequence, difficulty of breathing arises from two causes: 1st, From the blood passing through the lungs before it has undergone its necessary alteration; and, 2dly, from the rupture of the air-vessels. The respiration is rendered slow, as is seen by the flanks being long in rising up, because there is no direct communication with the bronchia, as in the healthy state of the lungs; inspiration is, however, in a third of the time of expiration, which is seen by the sudden descent of the flank. The lungs, from containing more air, are specifically lighter than in the healthy state.

This local disease does not admit of a permanent cure, at least no medicine has yet had any such effect; but a temporary relief may be obtained, as we shall see hereafter. But we must not omit to mention here a most ridiculous practice which has sometimes been tried by common farriers, that of making an orifice above the rectum, and then introducing a machine similar to a musical instrument called a *flageolet*, with the idea of evacuating the superfluous air, or wind, which they suppose to have produced the disease.

Blistering the wind-pipe, rowelling the chest, and a small purgative of aloes and calomel now and then, have often produced a good effect.

A pound or two of shot has been strongly recommended to Mr Coleman, as a specific; but, upon trial, it has been

Diſeaſes. been found to have no obvious effect: it was thought that the ſhot would act by its ſpecific gravity inclining the ſtomach further back into the cavity of the abdomen.

The treatment muſt be nearly confined to diet and exerciſe; the animal ſhould have little hay, and water in particular muſt be adminiſtered with a very ſparing hand. Thoſe ſubſtances which afford moſt nouriſhment in the leaſt compaſs, as carrots, corn, ſplit beans, &c. ſhould be given; the horſe ſhould always be worked upon an empty ſtomach; and, upon the whole, his diet ſhould be ſmall in quantity, but nouriſhing. By obſerving this method, a broken-winded horſe may do a great deal of work, and be uſeful to the owner. *

* *Feron's Farriery.*

According to Mr Blaine, internal medicines have ſometimes been found uſeful in this complaint. Lime-water has been employed with advantage; and the uſe of tar is much recommended. Mr Blaine preſcribes a mixture compoſed of two gallons of lime-water, four pounds of tar, and an ounce of freſh bruiſed ſquills, or garlic, of which an Engliſh pint (or mutchkin) is to be adminiſtered every morning.

A complaint ſimilar to the foregoing often occurs in the horſe, and is called *thick wind.* It proceeds from a very different cauſe, being always the cauſe of previous

438 Thick wind. inflammation, during which coagulable lymph has been effuſed, as in the *roarer.* Thick wind may be diſtinguiſhed from broken-wind, by the inſpirations and expirations being equal in the former; while in the latter the reſpiration is not ſo frequent, and the principal difficulty conſiſts in expiration, which is of courſe performed in longer time than inſpiration.

Little can be done towards a cure of this complaint. We may prevent the diſeaſe by good management in the adminiſtration of the aliments, exerciſe, &c. Calomel has been employed to produce abſorption, but without any great effect; a rowel under the jaw, and frequent applications of bliſters on the windpipe, are the only methods capable of producing abſorption of the lymph. Half a drachm of the digitalis, or fox-glove, in powder, twice a day, makes an admirable remedy in this, and local diſeaſes of the lungs.

439 The breathing may be completely obſtructed, either by the want of a regular ſupply of freſh air, or by the animals being obliged to breathe ſuch kinds of air, as are unfit for reſpiration. The conſequence of this impeded breathing, is a ſuſpenſion of the vital powers, or, if the obſtruction continues long, death will ſometimes be produced. As ſuſpended animation is always attended with more or leſs of an apoplectic ſtate, we ſhall defer the conſideration of thoſe caſes till we come to treat of comatous diſeaſes.

Chap. VII. *Morbid Affections of Secretion and Excretion.*

440 The fluids that are ſecreted, or ſeparated from the general maſs of blood, by means of the organs called glands, are in ſome caſes ſecreted in an unuſual quantity, in others their ſecretion is leſſened, or their excretion or paſſage out of the body is obſtructed. Thus in colds of the head, as they are called, in glanders, and in ſome other affections, an unuſual running takes place from the noſe; in inflammation of the eyes the ſecretion of tears is generally increaſed, ſometimes diminiſhed, while it ſometimes happens that their paſſage from the lachrymal gland out of the eye is obſtructed. Diſeaſes. Again the ſecreted fluids may undergo various changes in their colour, fluidity, and compoſition. Thus the urine is ſometimes yellow, at others red, or blackiſh; it is ſometimes extremely watery, at others very thick and muddy, and in one particular diſeaſe, the *diabetes,* it ſeems to loſe altogether the properties of urine, and appears like a ſolution of ſugar, or honey.

In the preſent chapter, we ſhall conſider the morbid affections of the bile, and of the urine. We ſhall alſo make ſome obſervations on coſtiveneſs and purging.

The principal morbid affection of the biliary ſyſtem that takes place in the inferior animals, is the 441 Jaundice or yellows. obſtruction to the paſſage of the bile, from the liver into the bowels, producing the diſeaſe called *jaundice* in the human body, and commonly known to farriers and cattle-doctors, by the name of the *yellows.*

This diſeaſe ſeldom takes place in the horſe, for as it is almoſt always the conſequence of biliary concretions, or gall-ſtones formed within the gall bladder, and as this animal has no gall bladder, the diſeaſe in queſtion can ſeldom take place. It may however happen that an obſtruction may take place in the common duct or pipe, that conveys the bile from the liver, either from concretions formed in the duct, from a ſpaſmodic contraction of the duct, or from a ſchirrous or hardened ſtate of the liver. The diſeaſe is however ſufficiently common in cattle and ſheep; and a deſcription of the ſymptoms that mark the complaint in theſe animals will almoſt equally apply to the diſeaſe when it may take place in horſes. According to Mr Denny, young horſes are very ſubject to a variety of jaundice.

Its firſt viſible ſign is a yellowiſh tinge in the white part of the eyes, mouth, and tongue; the mucus and ſaliva, from the noſtrils and mouth, are of a greeniſh hue, bordering a little upon the yellow. The beaſt is dull, and heavy, loathing all kinds of food, eating no more than a bare ſufficiency for the ſupport of nature; the ſkin is dry and itchy, eſpecially behind the ſhoulders, where it can ſcarcely bear the touch. The beaſts have an utter averſion to exerciſe, or ſtirring from the place where they are, and if removed with the leaſt degree of precipitation, will break into a cold ſweat. Their urine is of a deeper yellow than uſual, which has ſometimes led to believe it was red water, or bloody urine. The dung undergoes a very conſiderable alteration in all ſtages of the diſeaſe, and its general colour is blueiſh or brown, and much reſembling burnt clay; but it varies in colour according to the ſubject, or different circumſtances and ſeaſons. If the diſeaſe continues long the beaſt gradually pines away, and at laſt dies of a decline.

It is ſaid that horſes have ſometimes died of jaundice, in two or three days; and in theſe violent caſes a black ſanious diſcharge has taken place from the mouth and noſtrils a little before death. This is called by farriers the black jaundice, and after death the liver is found totally decayed. Mr Lawrence ſays that he has repeatedly ſeen caſes of this kind. Gibſon ſpeaks of an inflammatory ſpecies of jaundice, attended with delirium and madneſs; but this was probably a violent inflammation of the liver.

We have ſaid that the immediate cauſe of this diſcaſe is an obſtruction of the gall pipe, commonly owing to

Diſeaſes. to the formation of gall-ſtones. The formation of theſe concretions is moſt likely to take place, when the animals are deprived of their regular exerciſe, and are at the ſame time allowed too full a diet, or are given food of an improper quality. It is ſaid to be very common in ſome of the cold provinces on the continent, where the cattle are ſtall fed during the winter; after which the moſt of them are attacked with it in the ſpring. It may ſometimes be brought on by hard labour and poor living; but then it probably depends on a diſeaſed ſtate of the liver.

In the treatment of jaundice, our chief reliance is to be placed on the uſe of purgative medicines; and of theſe rhubarb, calomel, and aloes, ſeem to be the moſt proper; and during their exhibition, gentle exerciſe ſhould be employed. Mr Denny ſays that much relief is often afforded in the jaundice of young horſes, by giving a ball compoſed of an ounce of aloes, half an ounce of Venetian ſoap, and a drachm of calomel; every ſecond or third night, and giving on the intervening mornings a ball of half an ounce of nitre, with the ſame quantity of powdered roſin, and of common ſoap. Maſhes and warm water are to be given plentifully, and the horſe muſt be kept warm by clothing, and fully exerciſed.

In cattle, a vomit of emetic tartar may be tried at the firſt appearance of the diſeaſe, as the effort of vomiting may aſſiſt in promoting the paſſage of the gall-ſtone. If, however, the diſeaſe ſhould ariſe in conſequence of previous inflammation of the liver, vomits will be of no uſe, and the beſt remedies will be mercurial purgatives with ſoap. The food ſhould conſiſt of ſucculent and watery ſubſtances, eſpecially of freſh graſs; as it is found that when cattle affected with this diſeaſe are ſent to paſture they commonly ſoon recover. Warm maſhes of bran or malt ſhould be given frequently, both to obviate coſtiveneſs, and as being good articles of diet. If the diſeaſe ſhould continue obſtinate, and the uſe of mercurial medicines ſhould be found neceſſary, the animal muſt be confined within doors, during night and bad weather; and a horſe ſhould during the exhibition of the medicines be covered with a ſingle cloth. It will be proper, whenever the weather and other circumſtances permit, to give the animal regular exerciſe in the open air; but if neceſſity obliges us to keep him within doors, the whole body, but eſpecially the belly, ſhould be well rubbed for a conſiderable time, twice or thrice a day. This friction will be proper, even though regular exerciſe can be taken in the open air.

442 Horſes, and ſometimes cattle, are ſubject to a profuſe diſcharge of urine; but as the complaint of which this is a principal ſymptom, ſeems not to be ſeated in the urinary organs, we ſhall not conſider it here, but ſhall treat of it among the general and more important diſeaſes.

443 Incontinence of urine. It often happens that there is an inability in theſe animals to retain their urine for any length of time; they are either obliged to void it very frequently, and in ſmall quantities, or, what is more frequent, it drops away imperceptibly and involuntarily, forming the complaint called *incontinence of urine*. This complaint differs from diabetes, or profuſe ſtaling, in the urine coming away by drops, or in very ſmall quantities at a time, whereas in diabetes it paſſes off in a full and copious ſtream. Diſeaſes.

Incontinence of urine is extremely common to dogs, and often ariſes in theſe animals from exceſſive venery, or from the violent efforts which they are ſometimes, by the brutality of byſtanders, obliged to make to ſeparate themſelves from the females. It is alſo not uncommonly owing to the preſence of a ſtone in the bladder. M. Barruel, profeſſor of the veterinary ſchool of Alfort, had a little Spaniſh bitch, not above five inches high, and about ſeven years old, who was troubled with an incontinence of urine, unaccompanied by any other ſymptom; ſhe was ſprightly and well, and was in good condition. Not knowing to what to attribute the complaint, M. Barruel tried a number of remedies, ſuch as warm bathing and clyſters of various kinds, but without effect; at laſt he killed the bitch, and found in her bladder a ſtone that weighed an ounce and 40 grains, a very conſiderable bulk, if we advert to the ſmall ſize of the animal.

This complaint is leſs common in the horſe, but it may ariſe in any of theſe animals from a paralytic affection of the ſphincter muſcle at the neck of the bladder; which is ſometimes the conſequence of the bladder's being unuſually diſtended with urine. When there is reaſon to ſuppoſe that it is owing to this cauſe, the beſt remedy is a bliſter applied above the pubis, or the frequent application of ſtimulating liniments to the ſame part.

A difficulty of making water, or even an entire ſuppreſſion of urine, is a very common diſeaſe among horſes, and frequently occurs in ſheep. The ſymptoms accompanying this affection, differ ſomewhat according to the cauſes which have produced it; we ſhall therefore conſider it under ſeveral heads. 1. One of the moſt common cauſes of a ſuppreſſion of urine, is ſuffering the animal to travel for a long time without ſtopping him to allow him to ſtale; a circumſtance which is often neglected by thoughtleſs people, while on a journey. 444 Suppreſſion of urine. 445 Cauſe from over diſtenſion of the bladder. From the urine being ſo long retained, the bladder becomes exceſſively diſtended; conſiderable irritation takes place, and when the diſtenſion has proceeded to a great height, the animal, though conſtantly ſtimulated to relieve nature, is not able to effect his purpoſe, owing to a paralytic affection that has taken place in the muſcular coat of the body of the bladder, attended probably with a ſpaſmodic contraction of the ſphincter. If the animal be not ſoon relieved, a conſiderable ſwelling appears above the pubis, accompanied with great uneaſineſs; the urine becomes abſorbed, and is carried through the circulation to various parts of the body, producing an itching of the ſkin, and generally, in no long time, apoplexy and death.

Sometimes, however, before any conſiderable abſorption can take place, the bladder either becomes inflamed, or burſts, and diſcharges its contents into the belly, producing there inflammation and mortification.

This complaint is, as we have ſaid, very common among ſheep, conſtituting an affection which in Scotland is called the *watery braxy*. It is ſaid that young and vigorous ſheep are moſt liable to it; and according to the writers of the ingenious appendix to Mr Findlater's ſurvey, the immediate cauſe of the diſeaſe, is feeding too freely on ſucculent diuretic food, and reſting too long 446 Watery braxy.

Diseases.

long in their laires in the morning. It has been frequently obferved, that this fpecies of braxy is moft apt to make its attacks upon Sundays, becaufe fhepherds generally fleep longer on Sunday mornings than other days of the week, and, of courfe, allow the fheep to remain too long in their laires. This difeafe may be prevented by avoiding too free a ufe of fucculent diuretic food, and by moving the animals from their laires early in the morning, making them walk about for fome time, in order to encourage them to pafs their urine and purl.

In attempting to effect a cure, it may be known whether the bladder is affected, by a great fulnefs in the lower part of the belly, immediately above the pubis. The feat of the diftemper being afcertained, a female filver catheter, or one of elaftic gum, ought inftantly to be paffed through the urethra into the bladder of females. This will draw off the urine, and give immediate relief. But this will be attended with greater difficulty in males; and if attempted, muft be done with a long and properly bent catheter or bougie. In either cafe, when this cannot be accomplifhed, a puncture may be made into the bladder with a trocar, directly above the pubis; taking care not to wound the inteftines. By either of thefe methods, the urine may be difcharged, and the animal relieved. In other refpects, with a view to allay or prevent inflammation, evacuations fhould be procured by clyfters and warm injections into the great gut.

447 From inflammation

2. In the cafe which we have been confidering, the urine, though fecreted as ufual, could not be difcharged; but a fuppreffion of urine fometimes takes place from the fecretion not going on as ufual, owing to fome affection of the kidneys, commonly an inflammation of thofe organs. We can fcarcely with propriety confider this cafe here, but fhall treat of it among the other inflammations in the fecond chapter of the next fection.

448 Stone.

3. Another caufe that may produce a fuppreffion of urine, or a difficulty in ftaling, is a ftone in the bladder, or gravelly concretions paffing from the kidneys through the ureters or urinary pipes. We have juft feen that a ftone is fometimes found in the bladder of dogs; but doubts have arifen, whether this could take place in the horfe. Examples of it are no doubt very rare, but we have fufficient proof that it may take place. Mr Clark of Edinburgh mentions that he has feveral ftones taken out of different horfes; and it is faid that Dr Mead had in his cabinet one that weighed 11 ounces. M. Huzard gives an account of a diffection that he made of a horfe that died of a fuppreffion of urine, in whom the following appearances were obferved. The bladder contained a confiderable quantity of red and bloody urine. Its internal membrane was thickened, efpecially at its lower part; and it was alfo inflamed and gangrenous in feveral points. The ureter contained at about its middle, a fragment of a ftone that entirely blocked up the paffage of the urine, and had no doubt been the caufe of this fuppreffion. The ftone was imbedded in a cavernous body like the kernel of a fruit. *Within the bladder there was alfo a ftone about the fize of a large pullet's egg, broken into two portions.*

If we confider that fymptoms of gravel are by no means uncommon in the horfe, that gravel is often found in his urine, and that calculous concretions have been frequently obferved in his kidneys, we fhall eafily fee that thefe cafes are not fo extraordinary as fome may imagine. There is no doubt, however, that cafes of a ftone in the bladder cannot fo frequently happen in quadrupeds, from their horizontal pofition, which prevents the ftone from paffing from the kidney into the bladder fo readily as in the human fubject. Hence the kidneys have often been found to contain ftones of a confiderable fize, without the horfe having been during life affected with fymptoms of calculus.

When concretions form in the kidneys, they generally produce a great degree of irritation, and confequent inflammation; but if a horfe is affected with a fuppreffion of urine, there is reafon to fuppofe that a ftone is lodged in the bladder. The certainty of this having taken place may be very readily afcertained, by introducing the hand within the rectum, as the ftone will, for the moft part, be felt below the finger.

It is not probable that internal remedies can have any effect in cafes of calculus in the horfe. In the beginning of the complaint, when the fymptoms are very flight, diuretic medicines may be tried, and will perhaps bring away the fmall fandy particles; but if a ftone of any confiderable fize be lodged in the kidneys, the cafe is incurable. If the ftone has got into the bladder, it may be extracted by making a cut into the bladder above the pubis, and taking out the ftone by means of forceps, fuch as are employed by furgeons in the operation for the ftone. In the mean time the animal may be relieved, by drawing off the urine from time to time by means of a catheter, which is eafily ufed in the mare, and by preventing coftivenefs. Too much labour or over exertion fhould alfo be avoided, and the animal fhould live chiefly on fucculent food.

449 Obftruction at the neck of the bladder.

4. A fuppreffion of urine may arife from an obftruction in or about the neck of the bladder. A curious cafe of this kind occurred to M. Huzard, and he has related the appearances on diffection, which were as follows.

There was at the bafe of the fpermatic arteries, on the right fide, a glandulous body about the bignefs of one's fift, through which oozed a lymphatic fluid, that was whitifh and thick, in fome places appearing like pus. The bladder was enormoufly diftended with urine, and extended into the belly beyond its ufual limits; it was inflamed and thickened; the urine was nearly in its natural ftate. The neck of the bladder was filled with varicofe excrefcences, that completely obftructed the paffage. Thefe excrefcences were red, and fo hard as to refift the knife; they contained each a fmall particle of hardened blood, in which two parts were diftinguifhable. The bottom of the bladder was very black, and its furface of a reddifh yellow; the whole of the urethra was red and inflamed.

450 Bloody urine, or red water.

It will be pretty evident, that, fhould a cafe like this occur, it is incurable. It fometimes happens that the urine appears unufually red, as if bloody. This affection may take place in any of thefe animals, and it is called *bloody urine*, *piffing of blood*, or *red water*. It is moft common among cattle. It may arife from falls or bruifes, from overftraining at hard work, as in horfes from a hard run heat in racing, or after any violent exertion, fuch as a defperate leap; or it may proceed from inflammation of the kidneys.

When it takes place in cattle, the animals are affected with an almoft inceffant defire to ftale; fometimes they

Diseases. they make but little water at once; sometimes the urine comes away in its usual quantity. In this latter case, if the urine be deeply tinged, it is considered as a very dangerous symptom, and when it happens, the beasts leave the herd, and appear to feel considerable pain; they hold up their tail, and sometimes hold their back higher than common. In fact, these symptoms, which do not seem well understood by the cattle doctors, indicate an inflammation of the kidneys.

When this disease is occasioned by strains, bruises, or any violent exertion, there is reason to fear that inflammation may take place. This must therefore be guarded against by bleeding, cooling drinks, and succulent food; by avoiding exercise and every thing that can heat or irritate. It is a common custom to give nitre and other saline substances in these cases; but when there is any inflammatory affection in the kidneys, these salts are improper, as they tend to increase the irritation of these organs. The best drinks in such cases will therefore be thin gruel, linseed-tea, or bran-water.

Cattle are said to be most subject to the red water in the spring, or summer, while at grass; and it is supposed to be produced sometimes by sudden changes of the weather, by want of water, or the use of such as is unwholesome. Young cattle are more subject to it than those of more advanced age; hence particular attention should be paid to these young animals; as when the affection has once taken place, it is considered as highly dangerous. These are the opinions of cattle doctors, and we suppose they refer chiefly to inflammation of the kidneys, of which bloody urine is, as we have said, a prevalent symptom. This formidable disease will be considered more at large hereafter.

It appears that when cattle are sent from Europe, to the West Indies, the bulls when first put on shore are extremely liable to this complaint, which often proves fatal. It is attributed to the eager desire which these animals, after having been so long confined to a dry diet on board, have for green succulent food, in which they will of course indulge to excess the first opportunity. The remedies found most effectual are bleeding, and the administering of nitre and purging salts; but it might probably be prevented by housing the cattle immediately after they are brought on shore, and accustoming them gradually to their change of diet.

451 Black water.

Sometimes the colour of the urine in sheep and cattle is nearly black, and they are then said to labour under the black water. This affection is not well understood, but it is probably a variety of the last. It is said to be produced by feeding on cold, wet land, and that simple removal of the cattle to a more favourable situation will often effect a cure. Mr Lawrence considers the black water as a symptom of incipient mortification of the kidneys, and commends bleeding, (unless in a cow), cordials and tonics, such as iron filings, with bark, opium, nitre, in strong beer, if the progress of mortification be apprehended. We may remark, that, if mortification of the kidneys has taken place, which may in general be known by the stinking smell of the urine; all these remedies could produce no effect; and it would be much better to kill the animal it once, than be at the expence of time, labour and medicines, in attempting to effect a hopeless cure.

452 Scouring or purging in horses.

A scouring or purging is a very common disease in all our domestic animals; and in some of them it is very dangerous, and very difficult to cure. The complaint is somewhat different in the several species, so as to require a particular description in each. Some horses are liable to be affected with a purging from the slightest causes, and on every exertion. These horses are called by grooms *washy horses*, and they are said to have narrower chests and lanker bellies than others; and it is to this unusual deformity that the purging is generally attributed. Some horses are said to labour under a nervous diarrhœa; those that are chiefly subject to it are young, and of a weak and irritable habit. The complaint generally appears on them only when at work; and when they are suffered to remain idle, their bowels are sufficiently healthy. Mr Lawrence had a favourite young horse that was subject to this nervous scouring, and on whom he tried a variety of medicines to no purpose, as it was found that nothing but idleness could arrest the complaint. To use Mr Lawrence's words, "the nag whilst at play, was always fat as bacon, and very firm in body; but a week's work reduced his flesh, and caused him to dung like a cow." Horses of this delicate constitution require great care and attention, or they will not be of much use to the owner. They should have strong nourishment, but it should be given in small quantities at a time. Mr Lawrence recommends good old beans mixed with their oats, lucerne, or strong upland hay, with rice mashes, carrots, and occasional runs of grass.

A purging may be brought on in horses by a sudden change of diet, as from hay to grass, or from grass to hay. Hence, in such horses as are liable to disorders of the bowels, these changes should always be made very gradually. It is very commonly the effect of exposure to cold while the body is heated, and is one of the least dangerous affections arising from that cause. A purging may also be owing to irritating substances, such as crude, unwholesome, or undigested food remaining in the bowels; and in these cases it is often attended with pain, from the formation of an acid in the bowels.

A purging in horses is seldom dangerous, except when it arises to a great height, or continues very long, so as to produce a great waste of flesh, or very considerable weakness.

In general it is sufficient, in order to carry off a purging in horses, to avoid the causes which have produced it, where these can be ascertained; to wash away irritating substances from the bowels, by giving plentifully of diluting liquors, such as water gruel and linseed tea, or gradually to change the diet, if the purging seems to have arisen from improper feeding. If, however, the disease should continue obstinate, or be attended with unpleasant symptoms, means must be taken for checking or removing it. Some caution is requisite as to the plan of treatment to be adopted; as, if the complaint be checked too suddenly, some other dangerous affection might be produced. Veterinary writers differ considerably with respect to the treatment of diarrhœa in horses; some recommending gentle laxatives, as rhubarb, which Mr Lawrence considers as the sheet anchor in these cases; while others as strenuously advise against the use of purgatives, and recommend opium and astringents. Probably in most cases there is little need of laxatives, and after plentiful diluting, one of the best remedies will be clysters of starch or water gruel, with a small quantity of laudanum. If there is acidity in the stomach

ſtomach and bowels, prepared chalk or lime water may be given with advantage; and if there is conſiderable weakneſs, the ſtrengthening aſtringent medicines may, in the latter ſtages, be uſed without heſitation. We agree with Mr Blaine, that theſe are leſs proper at the commencement of the diſeaſe.

453 In cattle.

In cattle this complaint is ſometimes very ſerious, and farmers not unfrequently loſe ſeveral of theſe animals by it in a ſeaſon. This has induced them to call it the *ſcouring rot*. When the purging has continued long, it produces in theſe animals a general weakneſs and loſs of fleſh. Their ſkin ſometimes hangs looſe about the body; in other caſes they appear hide-bound; the hair turns ſandy, or of a grayiſh colour; their eyes grow pale; the pulſe becomes weak and irregular; their excrements thin and ſlimy, and frequently change colour, eſpecially in the early ſtages of the diſeaſe; but when the complaint is pretty far advanced, the dung appears like half-chewed food; and in fact, in theſe caſes the food appears to paſs through the bowels without undergoing the digeſtive proceſs. It is ſaid that when the animals have been long affected with this ſcouring rot, they feel a great degree of diſtreſs and pain, when graſped on each ſide of the back-bone, juſt behind the ſhoulders; and this is conſidered as a ſure mark that the beaſt has become tainted or unſound, from the ſcouring rot.

This complaint in cattle may ariſe from moſt of the cauſes that have been ſtated to produce it in the horſe; but it is conſidered as being moſt commonly owing to their being overheated in driving, and to want of ſufficient nouriſhment, either with reſpect to quantity or quality. It may be produced in cows, by their being conſtantly and too frequently milked, while they are deprived of proper nouriſhment; and it is not uncommonly produced by lodging on wet ground in autumn, and feeding on a coarſe, unwholeſome fog.

In the treatment of this complaint in cattle, a number of ſtrange remedies have been employed, ſuch as hogs dung, turpentine and butter-milk; dock root boiled in ſalt and water, and nettle root boiled in forge water. Among the moſt ſenſible receipts that we have ſeen, is one in Rowlin's Cow-Doctor, compoſed of three ounces of bole armoniac, with two ounces of bay berries, and the ſame quantity of alum, of ſhavings of ivory, and powdered comfrey root, boiled in two quarts of ſkimmed milk, adding while boiling a handful of ſtarch. This is to be given for a doſe, for which, however, it is perhaps rather too ſtrong. Mr Lawrence recommends that, on the firſt appearance of the ſcouring, the cattle ſhould be taken to the home fold, and put on dry food, which will generally ſuperſede the neceſſity of medicine. The remedy which Mr Blaine ſeems chiefly to rely on, is a decoction of an ounce of ipecacuanha, a drachm and half of nux vomica, half an ounce of galls, two drachms of alum, and 20 grains of white vitriol, in a quart of water boiled to a pint. Perhaps this decoction is rather too complex, and ſome of its ingredients may be ſpared. The receipt, N° 30. is well ſuited to theſe caſes. It may be ſuppoſed that where the ſcouring has continued for any conſiderable time, the bowels are become extremely ſore and tender. In this caſe, mucilaginous or oily ſubſtances would be of advantage, and they ſhould be given frequently, both by the mouth and by way of clyſter. Mr Lawrence recommends a pound of freſh mutton ſuet boiled in 3 quarts of milk until the ſuet is diſſolved, to form a drink to be given warm. This, we doubt not, will anſwer extremely well. If the diſeaſe ſhould go to an alarming height, ſtarch clyſters with laudanum may be given as a laſt reſource. Mr Blaine remarks, that, in theſe caſes, he ſhould be diſpoſed to try animal food altogether; giving broth to drink, or the blood of other animals, with meat balls forced down the throat; as he thinks it not improbable that thus a change might be effected in the conſtitution, which might pave the way to a cure.

Dr Dickſon thinks that much advantage may be derived in theſe caſes, from a ſtrong decoction of hartſhorn ſhavings and caſſia, with powdered chalk, in the proportion of half a pound of chalk, four ounces of ſhavings, and an ounce of caſſia, to be boiled together in two quarts (chopins) of water to three pints, (mutchkins), adding the caſſia towards the cloſe of the boiling. A hornful of this mixture is to be given ſeveral times in the day, ſhaking it well every time.

Calves, when firſt weaned, are ſubject to a ſpecies of purging which ſometimes proves extremely obſtinate; and it is ſaid that the principal reaſon of the calf-feeders giving them chalk to lick, is to prevent this purging. It appears that this diſeaſe will take place in calves, when they are fed on the milk of ſome particular cows; and that when the milk is changed the complaint goes off. The purging may in general be checked by boiling ſtarch and bean flour in their milk; and if it ſtill continues obſtinate, a little ginger and laudanum may be added. 454 In calves.

This diſeaſe is extremely incident to young lambs, and it is called by the ſhepherds *pinning*, becauſe when the purging has continued for any time, there flows from the fundament a glutinous matter that faſtens or pins down the tail to the hips, and prevents any farther evacuation. When this is obſerved by the ſhepherds, they commonly ſeize the lamb, and after waſhing away the glutinous matter from the tail, ſo as to diſengage it from the hips, they rub the parts with fine earth, or other fine powdery matter, to prevent their ſticking in future. Something of this kind is very proper, but hogs lard, or any other greaſy ſubſtance, would anſwer the purpoſe much better. The diſeaſe is ſaid to be produced by wet and cold in ſpring, together with the ewes eating too greedily of ſoft moiſt graſs. It may be prevented or cured, by removing the flock to heathy or poorer paſtures, that abound with aſtringent or aromatic plants. 455 Pinning in lambs.

Mr Findlater remarks that among lambs fed with their dams, upon the rich improved paſture of Lothian parks, *pinning* never occurs; whence it is probable that it originates from milk concocted from poorer paſture, which gives more curd than cream to the milk, rendering the excrements of the lamb more viſcid. When the mothers have little milk, the lambs are very rarely *pinned*. *Pinning* is therefore conſidered as a favourable ſymptom of the lamb's being well nurſed. It is not conſidered as a diſeaſe in Tweeddale; though, if not redreſſed, it would be productive of diſeaſe. It is conſidered as an accident to be guarded againſt, and which, like other accidents to which ſheep are liable, requires the ſhepherd to be conſtantly walking through his flock. No Tweeddale farmer would, on this account, remove his ewes and lambs to poorer paſture, where the lambs

 lambs would be worſe nurſed; as he knows, that if the pinned lamb is timeouſly noticed, and relieved by pulling up the tail, all danger is removed.

456 In dogs.

Dogs are alſo very ſubject to this complaint, and it may be brought on in theſe animals by any of the cauſes which we have mentioned as producing it in the other ſpecies. In young dogs it is often the effect of worms, and in this caſe the ſtools are ſlimy, greeniſh, and ſometimes bloody. Common looſeneſs in dogs may be removed by much the ſame remedies as in other animals, as by ipecacuanha, opium, with ſtarch, or arrow root clyſters, and prepared chalk, if there is any acidity in the bowels; but where it proceeds from worms, it cannot be effectually removed till they are expelled.

Purging muſt be carefully diſtinguiſhed from dyſentery, or what is called bloody-flux in the human ſpecies, and *brake-ſhaw* in ſheep, as in this latter there are ſymptoms of inflammation, and commonly more or leſs of fever. The diſtinguiſhing marks of this diſeaſe will be conſidered hereafter, as we cannot properly treat of it in this place.

457 Coſtiveneſs.

Coſtiveneſs, or binding of the belly, occurs occaſionally in all theſe animals; but it chiefly calls for attention in the horſe, as in him it is more frequent and more dangerous. It ariſes for the moſt part from want of exerciſe, when the horſe is kept upon hard dry food, as oats or beans. It is a conſtant ſymptom of colic and of inflammation in the bowels, and the continuance of it always aggravates theſe complaints, and ſeldom fails to produce them where they were not before preſent.

It is beſt prevented by occaſional change of diet; by giving the horſe barley boiled, or green food now and then, where he cannot be frequently ſent to paſture; and every night or two allowing him a maſh of bran, or, if he is of a very coſtive habit, of malt. Regular exerciſe and good dreſſing, eſpecially friction on the belly ſome time after feeding, are alſo good preventives. If it ſhould ariſe to any conſiderable height, the bowels muſt be emptied by back-raking, and the adminiſtration of ſoftening, laxative clyſters, which may be repeated every three or four hours till the bowels become ſufficiently regular. Purges given by the mouth, though they may, after ſome hours, remove the coſtiveneſs, ſeldom fail to do more harm than good, eſpecially if the complaint has continued long; and there is conſiderable heat of the body, fulneſs of the pulſe, pain in the bowels, or great irritation. In theſe caſes, while the bowels are opened by clyſters, it may be proper to take away a little blood.

Suckling calves are ſometimes ſubject to coſtiveneſs. When this happens, the chalk ſhould be taken away, and half an ounce or an ounce of magneſia be given them in a pint of warm gruel; or if the coſtiveneſs continue, a little rhubarb may be added.

Chap. VIII. *Morbid Affections of Generation.*

458 It has been wiſely ordained by nature, that the inferior animals ſhall feel the paſſion of deſire only at certain ſeaſons; and theſe periods are generally ſo adapted, that delivery ſhall take place at ſuch a time of the year as will be beſt ſuited to the rearing and feeding of the young animal. It is probable that in a ſtate of nature theſe animals, whether male or female, do not experience inordinate deſire, except at the proper periods; and when domeſticated, the females are ſcarcely ever ſalacious, except at theſe times. The males of theſe animals, however, in the domeſtic ſtate, eſpecially dogs, are occaſionally ſubject to exceſſive luſt, and all of them, during the periods aſſigned by nature, become ſometimes very unruly, if not permitted to indulge their natural appetite. Should circumſtances render it neceſſary to prevent them from indulging this propenſity, they muſt be kept on a lower diet than uſual, or have ſuch food as contains leaſt nouriſhment in the ſame quantity; and muſt be made to uſe more exerciſe than common. They muſt alſo be kept extremely cool, and horſes ſhould at theſe times have leſs litter to ſleep on than uſual.

It is of conſiderable conſequence to thoſe who make breeding an object, that the animals who are to copulate ſhould not be indifferent to the act in which they are to engage. It ſometimes happens that either the male or the female betrays a coolneſs or indifference, which may defeat the object of the breeder. When it appears that a ſtallion or a bull regards the mare or cow preſented to him with tranquil air, or turns from her when he ought to do his duty, it is clear that ſomething is wrong, and that the iſſue of ſuch a forced connection would ſcarcely be worth the trouble of rearing. It is ſaid that Spaniſh ſtallions are more ſubject to this indifference than others. 459 Indifference.

If an indifference of this kind ſhould take place in an animal that is generally keen and vigorous, it would be wrong to employ any incitement to ſtimulate him to an action for which he has perhaps been unfitted by too much exertion of the ſame kind during the ſeaſon; but where the animal is naturally thus cool, and has otherwiſe the requiſite qualities of a good ſtallion or bull, it may not be amiſs to employ ſome ſtimulating means before leading him to the female. He ſhould be kept on a generous diet, and when particularly required, he may have a cordial ball given him, with a quart of good ale after it. This will generally anſwer the purpoſe, or, if it does not, the animal is unfit for his office, and ſhould be diſcarded. It is a common practice among ſome grooms to inſert a ſlice of ginger into the fundament of an indifferent horſe, and this is ſaid to have the effect of rouſing his latent powers.

Indifference for coition is more likely to take place in the females of theſe animals, and it is no uncommon thing for a mare or a cow to refuſe the male. In general this is owing to a poorneſs of diet; and theſe females ſhould, like the males, before being taken to be covered, be put on a generous diet with moderate exerciſe. Probably all ſtrong, ſtimulating remedies, ſuch as cantharides, which are ſometimes given, do more harm than good, as they may produce inflammation of ſome internal organ, without producing completely the deſired effect. The cordial ball and ſtrong ale are the moſt innocent remedies in theſe caſes, and where nature is tolerably ſufficient, they will be the moſt efficacious.

The parts of generation in theſe animals are ſubject to certain accidents or diſeaſes, and it is neceſſary that we ſhould notice the more common of theſe.

The horſe is ſubject to what is called a falling of the penis. This conſiſts in a relaxation, and total weakneſs of the parts deſtined to ſuſtain and ſupport it in its natu- 460 Falling of the penis.

ral

Diseases.

ral ſtate, and is in fact a kind of paralyſis of the erector and accelerator muſcles, or a total atony of the ſuſpenſory ligament.

It may be produced by various cauſes, as by too great exertion in labour; hence it is common to draught horſes that are hard worked. It may alſo depend on a violent ſpaſm of the muſcles of theſe parts, as this is always ſucceeded by a proportionate relaxation and atony. It is not unfrequently produced when a ſtallion is made to cover too many mares in one ſeaſon.

When the caſe is ſlight, after returning the penis within the ſheath, which ſhould always be done, a pail or two of cold water, or of ſalt and water, may be thrown over it ſeveral times in the day, and the muſcles may be anointed with ſome ſtimulating liniment. It has been adviſed to make ſuperficial punctures about the yard with a ſharp needle, and then to waſh it with diſtilled vinegar; but we do not know whether this plan has been attended with the deſired ſucceſs. If the complaint continues obſtinate, the penis muſt be bolſtered up, and a charge applied over the back part of the ſheath ſo as to leave ſufficient room for the horſe to make water. If the complaint is attended with a general weakneſs, tonics and cordial remedies muſt be applied.

461 Falling of the womb.

When a cow has been delivered with more than uſual difficulty, or has been very long in labour before procuring aſſiſtance, it not unfrequently happens that the womb is inverted, or, as it is commonly expreſſed, the calf-bed comes down. This accident is more likely to happen to ſome cows than to others, and is more eſpecially incident to thoſe of a weak habit of body, and ſuch as are unuſually wide between the thighs. In ſuch cows it would be proper to pay more than uſual attention about the time when labour is expected to take place, and the ſtall in which they are left ſhould be made very commodious, that they may frequently lie down, as the great weight of their burden will have moſt effect while they are ſtanding. When the calf-bed is come down, it ſhould be returned as ſoon as poſſible, by the operator clenching his fiſt after greaſing it and putting it to the middle part of the womb, which he is thus to puſh gently into its place, and when it is up, he muſt take care not to withdraw his hand too ſuddenly; but it would be better to keep it within the womb for a little, as it will ſtimulate the adjacent muſcles to preſerve the parts in the proper ſituation. After withdrawing the hand gently, the external parts ſhould be bathed with camphorated ſpirits, and the beaſt muſt be watched, to prevent the ſame accident from taking place again. It is the practice with ſome to lead the cow down a hill after returning the womb, as it is ſuppoſed that this is greatly advantageous to the parts recovering their proper poſition. If proper aſſiſtance cannot ſoon be procured, the inverted womb ſhould be laid on a clean ſoft linen ſheet, and carefully covered from the air, the irritation of which, might produce an inflammation. If the relaxation of the parts is ſo great that the womb ſtill comes down, recourſe muſt be had to a ſtay, to put behind, to prevent the womb from falling down; and ſome have recommended ſtitching it to the adjacent parts with a wax thread. Probably this operation would be attended with more danger than benefit.

462 Abortion.

Cows and mares ſometimes ſuffer abortion, or as it is called, ſlip their calf or foal, before the uſual time of labour. This accident may be brought on by violent exerciſe, eſpecially by leaping hedges and ditches; by ſudden frights, knocks, or bruiſes; and it is alſo ſaid that it may ariſe from bad ſmells, and ardent deſire in the mare or cow; but theſe latter cauſes are probably imaginary. It is adviſed by ſome to keep cows who have ſlipt their calves as free from having any communication with the reſt of the cattle as poſſible, under the idea that the accident may become infectious; and it is declared that experience has ſhown, that without great care and management it may go through the whole ſtock, and even return the next ſeaſon, if the ſame cattle are kept. We cannot vouch for the truth of theſe aſſertions, but if true, the circumſtance is very remarkable.

When a cow or mare has ſlipt her young, unleſs this accident has been occaſioned by great exertion, it is a proof that the animal is extremely weak, and ſhe muſt be put on a more nouriſhing diet, and have ſtrengthening remedies; but in general little is required after ſuch an accident, but reſt, and perhaps a warm bran maſh. This latter may be frequently given to mares or cows during pregnancy, as coſtiveneſs may be a great means of producing abortion.

SECT. II. OF COMPLICATED DISEASES.

Many of the diſeaſes, that have been treated of in the laſt ſection, are very important, and ſeveral of them highly dangerous; but thoſe which we are now to conſider, have a ſuperior claim to our attention, either from their fatality, the rapidity of their progreſs, or their intimate connection with ſome of the moſt important or deſtructive maladies that affect the human race. They will, therefore, require a ſomewhat fuller diſcuſſion than we have thought it neceſſary to give to the diſeaſes deſcribed in the laſt ſection. 463

We ſhall claſs them under the ſeveral heads of Fevers and Febrile Eruptions; Inflammations; Lethargic diſeaſes; Spasmodic diſeaſes; Dropsies; and Anomalous diſeaſes; which will form the titles of as many chapters, the laſt comprehending thoſe affections, of which the nature or cauſes have not been fully aſcertained, with thoſe that could not properly be reduced under any of the former heads.

For the general doctrine of fevers, inflammations, comata, ſpaſms, and dropſy, we muſt refer to the medical articles of this work.

Chap. I. *Of Fevers and Febrile Eruptions.*

All the domeſtic animals may be affected with primary fever; and this may be either of an inflammatory or putrid kind. 464 Inflammatory fever.

1. Inflammatory Fever. Synocha.

Inflammatory fever, is we believe, ſeldom ſeen as a primary or idiopathic complaint, except in the horſe; and to the conſideration of this fever, in that animal, we ſhall here confine ourſelves. The ſymptoms are thus deſcribed by Mr Blaine:

" It is not eaſy to ſay what is the firſt ſymptom of fever in the horſe; but from the effects that we ſee ariſe in ſome caſes, it may be preſumed that it is a cold fit. It is uſual however firſt to obſerve this complaint, by

Diseases. by the loss of appetite, and dull heavy appearance of the animal; the extremities are cold, and the trunk hot, or the body is cold, and ears are hot. If a horse is attacked with common fever, while he is at grass, he is found restless, roving about the field, with an unsteady staggering air, and his head held low; if in the stable, frequently shifting his position, and is evidently restless and uneasy. His pulse is generally full, frequent, and hard, the two latter states of it are almost always present, but the former may vary. If the mouth is examined, it will be found hot and dry, and frequently smells strong; the breath is particularly hot, and there is often an increased redness of the inner membrane of the nose, even though there should be no primary affection of the lungs. The eyes are dull, heavy, and sometimes inflamed, and the horse starts, and is at times drowsy, but has no regular sleep. In this fever the secretions are generally diminished, therefore the dung is hard, and in small quantities; the urine sparingly made, and high coloured, and the excretions from the skin equally confined, giving it a dry harsh feel. The respiration is quickened, which is shewn by the heaving at the flanks, and which must be distinguished from that difficulty accompanying inflammation of the lungs; in which case the air appears drawn through a part too small for it, as though we were to breathe through a quill; but in fever it is usually only simply accelerated.

"This forms the first stage of the complaint, and sometimes immediately succeeding to this, is an attack on some one particular organ, as the brain, lungs, bowels, or kidneys; in which case it ceases its primary affection, and becomes secondary and symptomatic; but when it remains purely of the febrile type, as the disease advances the symptoms become more irregular, seldom appearing the same in any two subjects, arising from particular states in the individual bodies, varieties in the treatment, or from some peculiarities in the disease itself. The pulse in this second stage continues hard, but loses some of its fulness, and increases in frequency; the skin becomes moister, the urine is secreted in rather larger quantities, and sometimes to these succeeds a purging; the watchfulness increases, and the horse is often observed in these cases to chew a lock of hay, and let it fall from his mouth again, as though insensible of its escape.

"This disease seldom remains very long in this state; but there either succeeds a gradual abatement in the hardness and frequency of the pulse, the countenance becomes more lively, the muscular weakness increases; but the irritability lessens; the animal appears more tranquil; the secretions gradually return to their natural state; the mouth becomes moist, and the heat regular and equable; and thus is formed a resolution of the fever. This kind of fever, I believe, seldom terminates in a crisis, nor often by sweating; perhaps, it may sometimes by purging.

"But when to the foregoing symptoms, instead of their latter appearances, there succeeds great restlessness, or sometimes constant drowsiness, the pulse becoming very quick, as from 70 to 80 pulsations in a minute, preserving some of its hardness, and accompanied with profuse staling, though at others the urine remains high coloured, and small in quantity, and the thirst unabated; when to these are added great prostration of strength, a fatal termination may be expected *."

* *Blaine's Outlines, vol. ii.*

We have said that simple fever is not common in sheep or cattle; but when it occurs in these animals, the symptoms differ little from those above described.

It must be remarked, that though the foregoing description will apply to most cases in horses, all the symptoms here laid down will not often be found in the same case; but they will vary according to the constitution of the animal and other circumstances. Sometimes the fever will have less of the inflammatory type, and will approach to what is called a low or nervous fever. Cases of low nervous fever are, however, very uncommon among horses. Mr Blaine says that he has met with no instance of this kind, but that he was assured by a Mr Bloxham, a veterinary practitioner of considerable observation, that he had met with a well-marked case of typhus fever. In cases that approach this low type, the heat of the body is more irregular than in the pure inflammatory fever, and the mouth often continues moist though drink be refused; and the secretions and excretions are usually not so much affected. Sometimes there takes place a discharge of glutinous matter from the nose, and the eyes are watery. The pulse in these cases usually ceases to be full after the first 24 or 36 hours; and though it still continues hard, it is more frequent than before, and becomes small and irregular as the disease advances. This low variety of fever is more dangerous than the true inflammatory fever, and requires more particular attention.

Inflammatory fever may be produced by any cause that violently agitates the body, and unusually accelerates the motion of the blood. It may be produced by excessive exertion and fatigue, or by an exposure to cold while the body is overheated. It is said to have been sometimes brought on by a sudden fright. A very common cause in hot climates, is long exposure to the direct rays of the sun. Pure inflammatory fever is certainly not contagious.

In the cure of inflammatory fever it is necessary to draw blood as soon as possible; and the quantity of blood taken away should be in proportion to the violence of the inflammatory symptoms. We are disposed, however, to think, that a less quantity than is usually recommended, perhaps not more than two quarts at once, will be sufficient, as the weakness that comes on in the latter stages of all fevers, will be greatly increased by too much loss of blood. The blood should be preserved in a proper vessel, as directed in N° 162. that it may be ascertained how far it will be proper to repeat the operation. When blood has been drawn, the horse should be back-raked, or a hand passed up the rectum, and the dung drawn carefully away; after which a clyster should be thrown up, such as N° 17. of the receipts. It should be blood-warm, and should be passed up carefully and gently. If there is much determination to the head, a blister may be applied to the neck, or a seton inserted as near the head as may be. Cooling medicines may be administered, such as the drenches, N° 22. and N° 26. All heating or cordial medicines, and stimulating food should, in the early stage of the fever, be carefully avoided. The diet should consist of light food that is easily digested, such as sweet hay, or, if that can be procured, lucerne or sainfoin; bran mashes, and, by way of drink, thin gruel.

The rational mode of treating fevers, lately introduced

Diseases.

ced into human medicine, will probably not soon be transferred to the stable. Grooms and farriers will not easily believe that it is necessary to keep a feverish horse cool, and allow him to breathe a free, pure air. The practice usually followed in these cases is to shut up the stable as closely as possible, and even to stop every cranny in the door and windows. This practice is not only sufficient to increase the disorder of the feverish horse, but even to excite fever in such horses as happen to be in the same stable. It is, besides, customary to cover up the horse with a load of body-clothes, in order that he may sweat off the fever; and probably these clothes are girded tight round his body by means of rollers.

Instead of this absurd method of treatment, a feverish horse should, if possible, be put into a stable where there is not more than one horse. As these animals naturally love society, it is better that he should not be quite solitary, otherwise he might be put in a stable by himself. The stable should be roomy and airy, and should be regularly cleaned. The horse may have a light cloth thrown over him, but this should not be fastened more than is sufficient to keep it from falling off his body.

When the inflammatory symptoms have subsided, and signs of debility begin to make their appearance, as they never fail to do in the course of a few days, a different plan of treatment will be required, as far as respects the administration of internal remedies. A horse labouring under fever must be carefully watched, in order to mark the time at which the inflammatory symptoms begin to give way to those of lowness and debility; and as the change is often very sudden, the horse should be visited at least twice a-day, or oftener if possible, as were the groom or other attendant to continue the debilitating treatment after the symptoms of debility come on, such a degree of weakness may be produced as will not easily be recovered. The change will be discovered chiefly by the alteration of the pulse, which, from being hard and full, becomes softer, and in general weaker. This is the time to exhibit strengthening medicines; but these at first should be of the gentler kind, such as Peruvian bark, or willow bark, which may be given at first in moderate doses; and if the debility continues, the dose must be increased, and the medicine administered more frequently. During the whole treatment, care must be taken that the horse be not suffered to remain costive, and his bowels may be kept moderately open, by giving him a warm mash every night. If the weakness becomes very great, and there appears much restlessness or heaviness, while the pulse continues low, it will be proper to administer some of the more powerful stimulant medicines, as camphor and opium, ammonia, or snake-root, as directed in the receipts N°. 35. and 38. As the horse becomes convalescent, the stronger tonics, as oak bark, with ginger, may be administered twice or thrice a-day; and as his appetite returns, he may be indulged with his usual food, with gentle exercise. It will be proper, however, to avoid any considerable exertion for a long time after the animal has become convalescent, as a considerable period must elapse before the body can recover its usual strength and vigour.

Inflammatory fever precedes or accompanies most violent inflammations, especially those of the brain and other viscera, and it generally ushers in several of the eruptive diseases. In some of these complaints the fever demands particular attention; but in most of them it is merely a secondary symptom, and yields to the general treatment of the disease.

2. Epidemic Putrid Fever. Typhus. *Murrain, Pest, Garble.* Epizooteé, Fr.

465 Putrid fever.

Putrid fever does not commonly attack horses, though it has occasionally raged epidemically among these animals. Lancisi, an Italian physician, has described an epidemic fever that raged among horses in Italy about the year 1712, and Mr Osmer mentions an epidemic of a similar kind, attended with critical abscesses. He calls it the distemper, and says that it had raged at different periods for more than 50 years.

466 Murrain.

The most serious epidemic fevers that have ever appeared among domestic animals, are those which, from their violence and fatality, have been called *murrains*, or *pests*, and which have raged occasionally from the earliest historical accounts.

Columella mentions a contagious disease, which he calls *cruditas*, that scarcely differs in its symptoms from the murrains that we are presently to describe. The following is his description. "Crebri ructus, ac ventris sonitus, fastidia cibi, nervorum intensio, hebitas oculi, propter quæ bos neque ruminat, neque lingua se deterget." He advises bleeding in the tail, and back-raking, and clysters; and if it appears that the disease is contagious, he recommends the infected cattle to be separated from the rest of the herd.

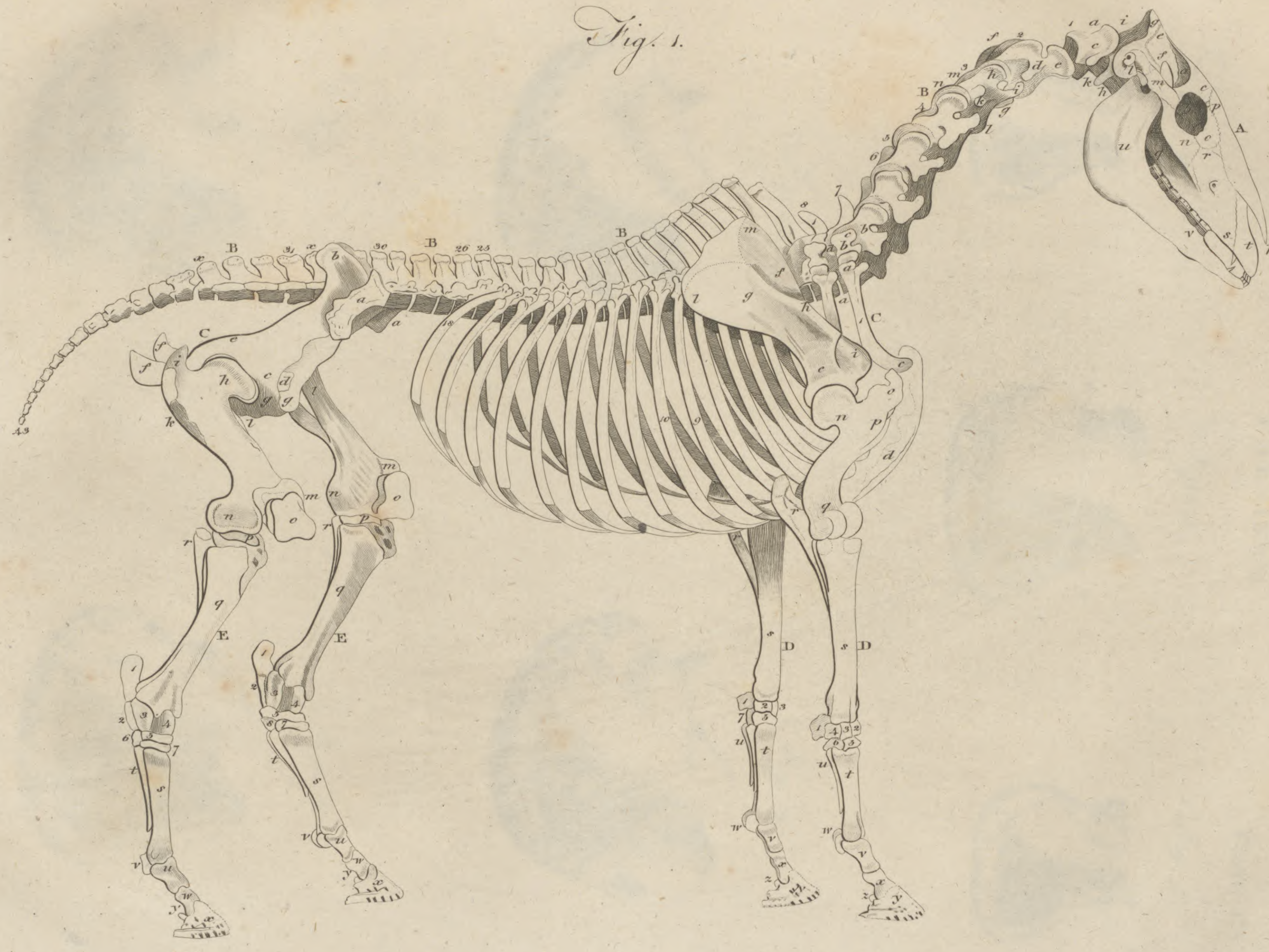
A similar disease is also described by Vegetius, who recommends a similar treatment, with the additional advice: "Mortua cadavera ultra fines villæ projicienda sunt, et altissimè obruenda sub terris;" To carry the carcases to a distance from the farm, and bury them deep in the earth.

Marius, a Burgundian ecclesiastic, who wrote in the 6th century, mentions a disease, which he considers as the smallpox, that destroyed great numbers of cattle. "Hoc anno (570) morbus validus, cum profluvio ventris et *variola*, Italiam, Galliamque valdè afflixit, et animalia bubula per loca superscripta maxima interierunt." *

The first accounts that we have of any disorder of this kind, since the beginning of the present century, are related by Ramazini and Lancisi, two physicians then living in Italy, where this disorder first broke out, in the year 1711, in the territories of the republic of Venice in the country round Padua; and was said to have been brought from Dalmatia, a province of Turkey, by some merchants importing living cattle, according to their annual custom, from that and the neighbouring parts. The disease soon spread itself through most parts of Italy beyond the river Po, and appeared two years after in the duchy of Ferrara, where it so ravaged the country, in the years 1713 and 1714, that Lannonius, a celebrated physician of that time, informs us, it was a prevalent opinion, that the whole species would quickly become extinct. From Italy it travelled through the Tyrolese into France. Shortly after Germany suffered, as well as the low countries; and from these parts it was supposed to have been transported into Great Britain and Ireland. But there is no

* *Muirhead's Travels in the Low Countries.*

Fig. 1.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 2.

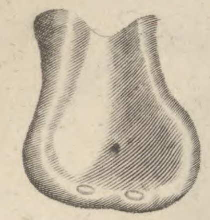


Fig. 4.

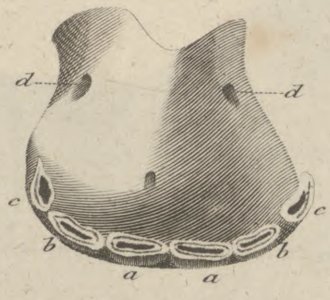


Fig. 3.

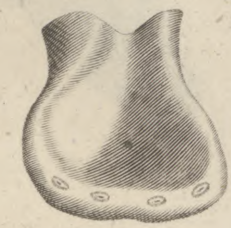


Fig. 5.

Fig. 6.

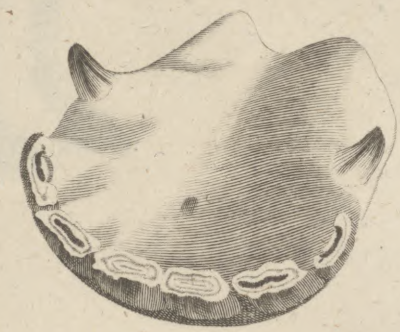


Fig. 7.

Fig. 8.

A. Bell Prin. Wal. Sculptor fecit.

Fig. 9.

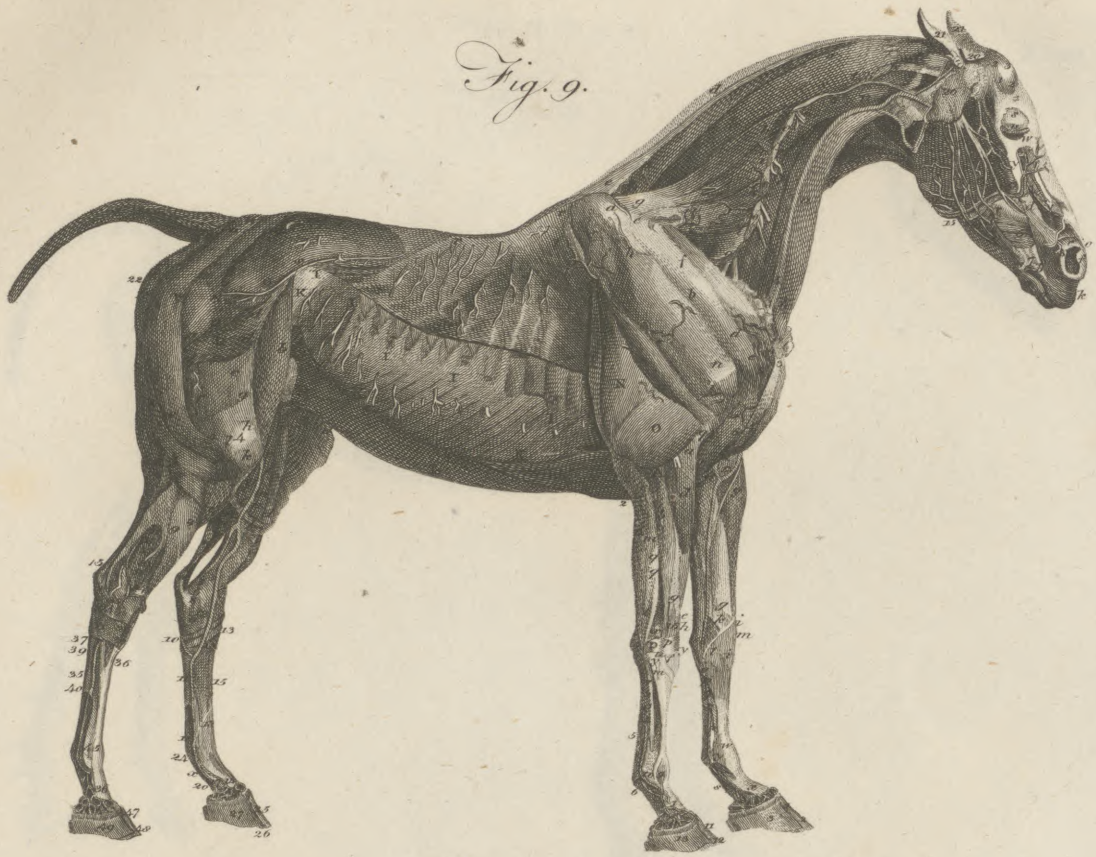
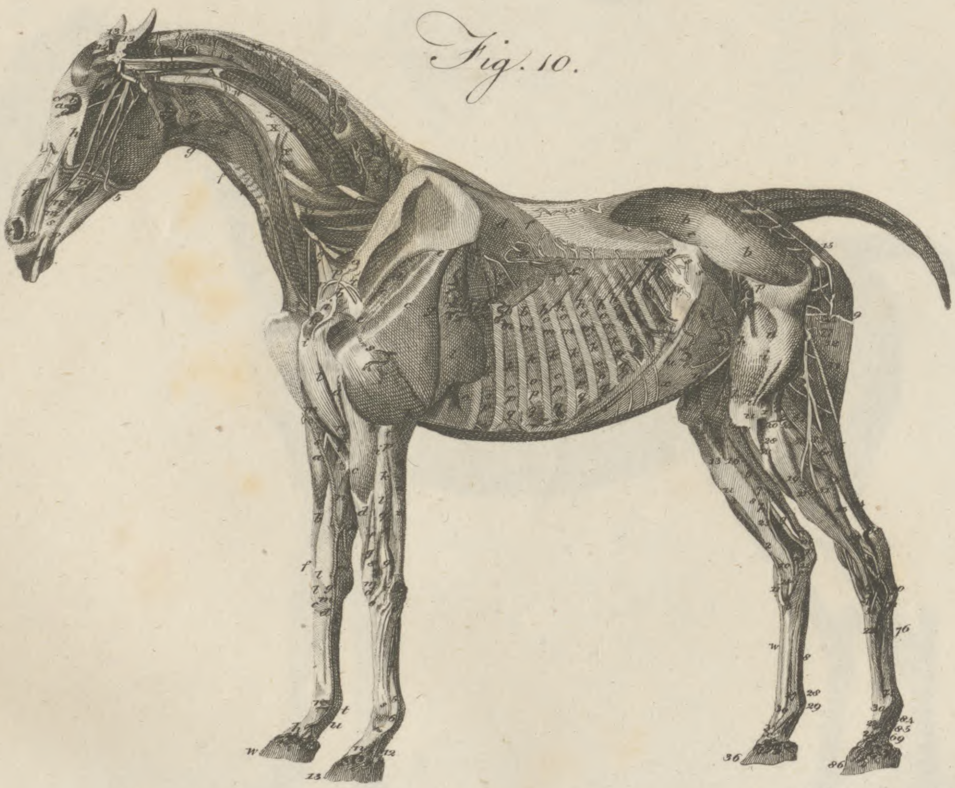


Fig. 10.



A. Bell Prin. Wal. Sculptor fecit.

Fig. 11.

Fig. 12.

A. Bell Prin. Wal. Sculptor fecit.

Fig. 13.

Fig. 14.

Fig. 15.

Fig. 16.

A. Bell Prin. W. Sculptor fecit.

Fig. 17.

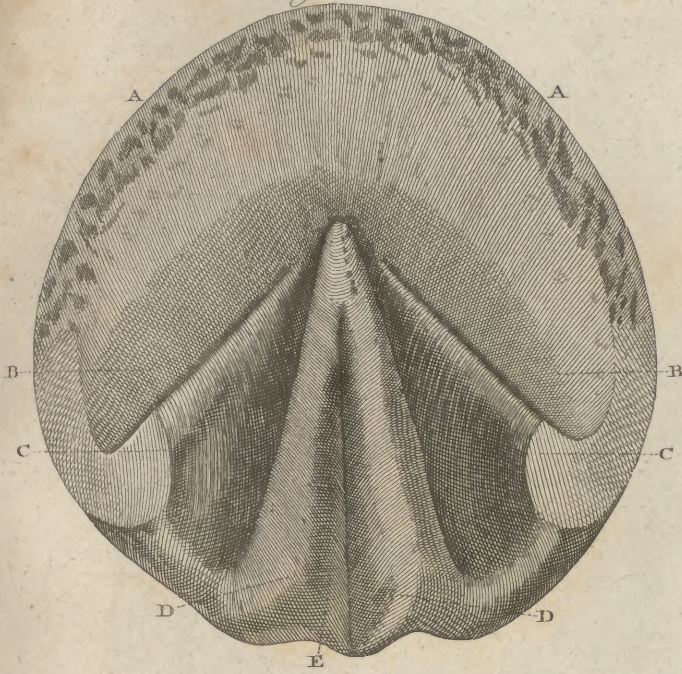


Fig. 18.

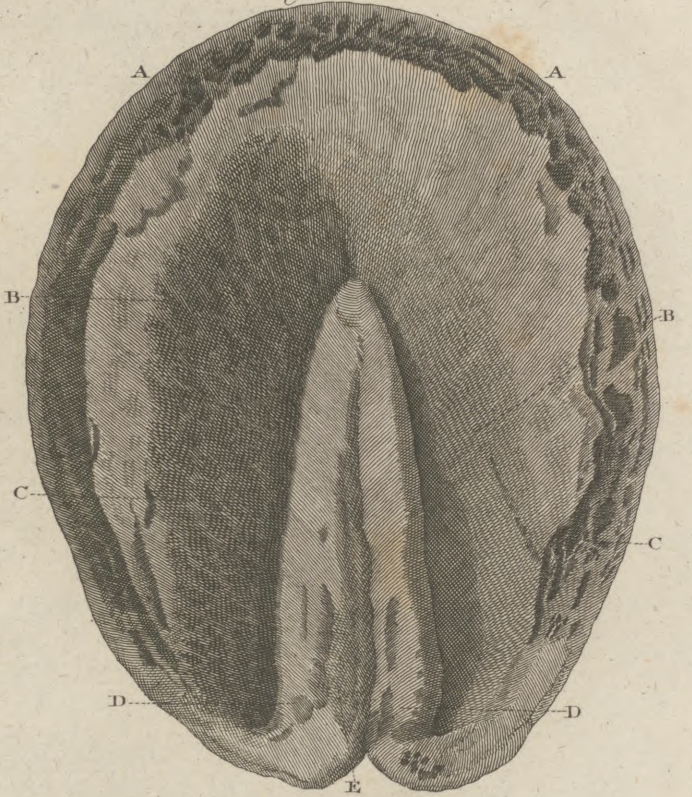


Fig. 19.

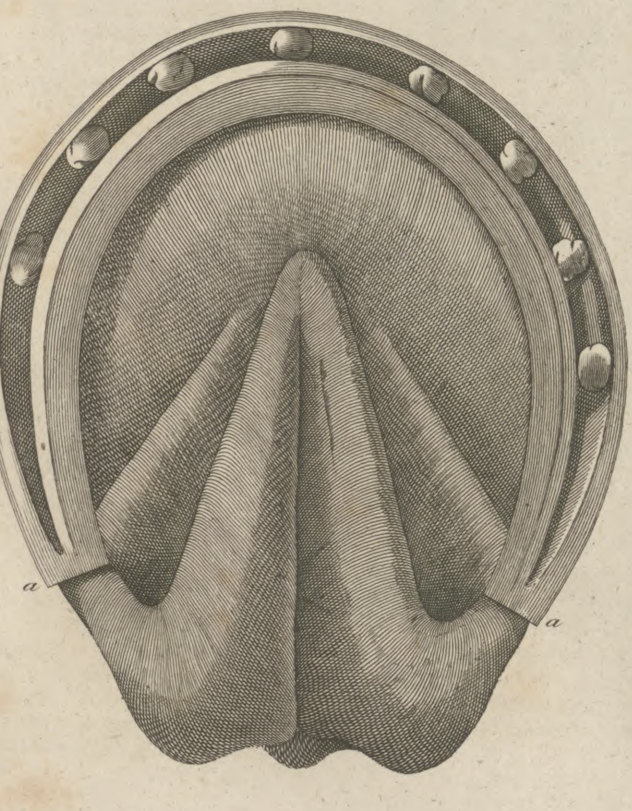


Fig. 20.

A. Bell Prin. Wal. Sculptor fecit.

Diseases. no record of a new infection in this country since the year 1714, till the middle of last century, when we probably received the infection from Holland, where this disorder then reigned, having received the infection from some of the neighbouring parts of Germany and Flanders.

467 Appearance of the murrain in Britain.

About the year 1744, it was reported to have been brought by some traders into Essex, who had purchased calves in Holland, or some other of the provinces of the low countries, which had the infection, and spread through several counties, till it became a matter of importance to the state; and on the 13th of February 1745 gave occasion to the passing of an act of parliament, commanding that every probable, or even possible, means should be employed, by officers appointed for that purpose, to prevent the farther spreading of it. Premiums were given to those who killed their cattle as soon as the infection made its appearance; and fines were imposed upon every one who acted in opposition to the established laws, respecting driving, exposing, or selling cattle, supposed or found to have caught the disorder. Every precaution, however, which could be suggested at that time, proved ineffectual; and fresh orders were issued by his majesty in council, which for some time were also found to produce very little effect. It became so alarming to the country, that many eminent medical characters in different parts of England, closely applied themselves to the study of remedies for this calamitous distemper. They differed in opinion, whether it was a disease of an infectious nature, or proceeded from a malignancy in the state of the atmosphere, or some peculiarity in the nature of their food. The contradictory opinions which prevailed among them, nearly prevented some of the ablest professional men from appearing in behalf of the public; especially Dr Barker, who wrote an ingenious pamphlet on the subject, and whose mode of treatment proved more successful than that of many others, whose pretensions were given to the public in a more confident manner, and more strenuously supported.

468 From the several histories that have been given of the disorder, it appears to have differed in its symptoms and effects, according to the countries in which it appeared; the various seasons in which it commenced its ravages, and some other circumstances not fully ascertained. There seems to have been no doubt that the disease was infectious, or at least that it was easily propagated among the species of animals which it attacked; but it does not appear to have been capable of spreading to other species; as men, horses, sheep, and dogs, that lived in the neighbourhood of the infected cattle, shewed no marks of having received the contagion.

In the historical sketch of the writers on veterinary medicine, we mentioned several works on the subject of the murrains that prevailed over Europe in the last century; and of these it will have appeared that the greater part were the production of foreigners. The most celebrated of these foreign publications were those of Sauvages, Goëlicke, and Camper. The work of the latter upon this subject is extremely valuable; and as it was written for the instruction of people in general, having been delivered in the form of lectures before a crowded audience, it is preferable to many others that have appeared on the subject. It is given in the third volume of Camper's works on natural history, physiology, and comparative anatomy, lately published at Paris. Camper delivered four lectures; in the first of which he explains to his hearers the structure and direction of the principal blood-vessels of the neck and extremities in cattle, and the natural position and appearance of the entrails of these animals. In the second he describes the natural structure of the four stomachs, the liver, and the spleen, and of the heart and lungs. In the third he explains the function of rumination, or chewing the cud, in all ruminating animals, but especially in cattle. In the fourth lecture he gives an account of the several writings that had appeared on the subject of *epizootic diseases*; among which he particularly recommends a German work by Dr Krunetz, that of Goëlicke, and those of our countrymen Brocklesby and Layard. In the same lecture he gives a very accurate detail of the symptoms of the disease as it appeared in the province of Groningen in the year 1768, with the appearances on dissection; his own opinion with respect to the nature of the malady, and an account of the most approved method of treating it. We regret that this work came into our hands too late for us to make any considerable use of it in this article.

The medical practitioners in England, to whom we are most indebted for an accurate account of the symptoms of this disorder, and a rational mode of treating it, are Dr Brocklesby and Dr Layard. As the account given by these gentlemen differs in several particulars, though there can be no doubt that both describe the appearances which fell under their own observations, we shall extract a few particulars from both their publications. The following is Dr Brocklesby's account of the disease.

469 Brocklesby's description of the murrain.

For ten days or a fortnight the cattle were troubled with a dry cough, which is indeed not an uncommon symptom among cattle, at that time of the year, and therefore Dr Brocklesby did not consider it belonging to the present disease; the hair was rougher on the skin than ordinary; their eyes looked heavy, and, when the principal disorder appeared, they refused fodder, but had an insatiable thirst for a time: The milch-cows decreased in their milk, which remained to a certain quantity, sometimes for two days, before it changed colour, but at length often dried up. Upon ceasing to chew the cud, a shivering seized them all over, and a high fever immediately came on; the milk, if any remained to that time, curdled over the fire, but did not in the first of the disorder. At first the belly was costive, but for the most part a looseness succeeded within forty-eight hours after the shivering fit. The stools were first green and watery, and of a stinking smell; their consistence, however, altered afterwards to a viscid, slimy matter, the purging accompanied till about the seventh day, and about that time the excrements became thicker, in such as recovered; and these soon chewed their cud again, and tasted of fodder, which they had before absolutely refused through the whole disease. All that had not the looseness before the third day died. The urine was very high coloured, and in smaller quantities. The degree of fever was observed very high; upon the third day the pulse beat near a hundred times in a minute, whereas the ingenious Dr Hales found a sound ox's artery not to exceed 38 pulses, in the same time. At different intervals,

Diseases.

vals, after the attack, they all laboured under a prodigious difficulty and panting for breath; some suffered these after the first day, others not before the third. But this disorder suffered remissions, and seemed to be augmented towards evening, and at night. Several beasts discharged, towards the fourth or fifth day, when ill, a very great quantity of a frothy liquor from the mouth and eyes; others ran actually purulent matter from the nostrils. As the disorder advanced, the eyes sunk more in their orbits, and some were observed to be quite blind. Towards the conclusion, the fore parts of the body, and particularly the glands about the head, were prodigiously swelled, and several beasts had a universal emphysema, or crackling of air beneath their skin; those that were not blooded, equally with such as were. Frequently one might observe pustules break out on the fifth or sixth days, all over the neck and fore parts. Some cattle were raging mad on the first day; such were necessarily killed: some dropped down suddenly; others died on the third, most on the sixth or seventh, very few alive to the fourteenth day; before death the horns and dugs grew remarkably cold.

470 Appearances on dissection.

The appearances in the dead bodies of eight different cows were as follow: The flesh was of a sound colour, and everywhere lined with fat, the cellular membrane between the skin and flesh was distended with air to above the thickness of three inches. The paunch was prodigiously distended with food, in all of them, but it contained not any thing preternatural; nor indeed in the *reticulum* or second stomach, were there any morbid appearances; but, upon incision of the *omasus*, or third stomach, in which the food is naturally without much juice, a most offensive stench rushed out, with a large quantity of thin greenish water.

The blood-vessels on the inner surface of the ventricle were very full. The abomasus and part of the intestines discovered the like morbid phenomena. The liver, spleen, and kidneys were as usual; but the gall-bladder seemed to be in the greater number fuller than ordinary; the consistence of some was thicker than the rest, and the gall tasted disagreeably sweetish. Dr Brocklesby did not observe any purulent matter investing the inner surface of the intestines, though other gentlemen discovered such, in some cattle, if hew as rightly informed; but there appeared in some a slimy mucus, all along the intestinal canal.

The lungs universally shewed the strongest signs of a preceding high inflammation; most of them were turgid with red blood, while the smallest vesicles of the bronchia, or air-vessels, were very much inflated. Some few arterious vessels were replete with a gelatinous, glairy mucus, and all the lungs appeared larger than they do in common. The whole inner surface of the trachea, or wind-pipe, was covered with a frothy mucus; but he never found any ulcers with purulent matter either at the root of the tongue, or in the lungs. Upon opening two or three heads, he found large quantities of extravasated serum; and the blood retained fluidity in the larger vessels long after death.

471 His mode of treatment.

The method of treating the 'cattle recommended by Dr Brocklesby is as follows: Before the cattle are seized, he advises two setons, or pegs, to be put deep into the dewlap, and into the under part of the neck; and immediately upon refusing fodder, the beasts should have three quarts of blood taken away; and after twelve hours, two quarts more; after the next twelve hours about three pints may be let out; and after the following twelve hours, diminish a pint of blood from the quantity taken away at the preceding blood-letting; lastly, about a single pint should be taken away in less than twelve hours after the former bleeding; so that when the beast has been blooded five times, in the manner here proposed, the worst symptoms will, it is hoped, abate; but if the difficulty and panting for breath continue very great, he sees no reason against repeating bleeding, or at least against taking away the fifth time, instead of a single pound, twice that quantity.

In the mean time the setons or pegs should be daily promoted to suppuration by moving the cord; and the cattle should have as much bran-water as they chuse to drink luke-warm. This should be made a little tart or sourish, either with common vinegar or spirit of vitriol; and immediately after the first bleeding they should have a drench composed of a drachm and a half of camphor, well rubbed with two ounces of honey, adding an ounce and a half of nitre, and about a quart of water-gruel.

It is extraordinary that this treatment, with a little variation in the internal medicine is recommended by Mr Feron as the result of his own experience, in what he calls the general inflammation of cattle. It is a curious coincidence; as we suppose that Mr Feron, from his not noticing Dr Brocklesby's pamphlet, has never seen it.

The doctor recommends keeping the cattle very warm, and guarding against the admission of any cool air, a practice in which he will scarcely be followed at the present day.

472 Layard's account of the murrain.

The symptoms of this distemper as described by Dr Layard are, on the first appearance of the infection, a decrease of appetite; a poking out of the neck, implying some difficulty in deglutition, a shaking of the head, as if the ears were tickled; a hanging down of the ears, and deafness; dimness of the eyes; and a moving to and fro in a constant uneasiness. All these signs, except the last, increase till the fourth day. Then a stupidity and unwillingness to move, great debility, total loss of appetite, a running at the eyes and the nose, sometimes sickness, and throwing up of bile, a husky cough, and shivering. The head, horns, and breath are very hot, while the body and limbs are cold. The fever, which was continued the three first days, now rises and increases towards evening; the pulse is all along quick, contracted, and irregular. A constant diarrhœa, or scouring of fœtid green fæces, a stinking breath, and nauseous steams from the skin, infect the air they are placed in. The blood is very florid, hot, and frothy. The urine, or stale, is highly coloured; the roofs of their mouths, and their barbs, are ulcerated. Tumours, or boils, are to be felt under the panniculus carnosus, or fleshy membrane of the skin; and eruptions appear all along their limbs, and about their dugs. If a new milch-cow be thus ill, her milk dries up gradually, her purging is more violent, and on the fourth day she is commonly dry. There is such acrimony or sharpness in their dung, that a visible irritation is to be observed during some time in ano. They groan much, are worse in the evening, and mostly lying down. These symptoms continue increasing till the seventh day from the invasion, on which generally, though

Diseases. though sometimes protracted till the ninth, the crisis or turn takes place.

If after the seventh day from the invasion (at which time a crisis may be expected), the eruptions, boils, or abscesses are decreased in bulk, or totally disappear, without having broken or discharged outwardly, or an aggravation of the symptoms already mentioned, with no intermission; it may be assuredly pronounced, that the beast will die.

As to the cure, immediately upon the first appearance of the distemper, the beast should be put into some place where it may be kept clean, warm, and as free as possible from infectious steams of other beasts in the same condition. The beast must be bled in proportion to its strength, washed with warm water and vinegar, to clear the hair from filth and insects, and rubbed every morning and evening, for a quarter of an hour, with a dry linen or woollen cloth, or straw, to promote perspiration. A rowel also is to be made in the dewlap, which is to be dressed twice every day, which rowel is also to be kept in a month at least after the recovery of the beast.

Should the beast be hot, hang down his head, breathe with difficulty after the bleeding, dung hard, and the skin feel tight and thick; then it will be very proper to give a gentle, cooling purge in this first stage. When the beast has voided the hardened dung, or if it should not have wanted purging, the following drench is to be given. Take of madder-root, three ounces; of turmeric and horse-raddish-root, each one ounce; of fenugreek-seeds, bruised, two ounces; of chamomile-flowers, dried leaves of feverfew, rue, and sage, of each one handful. Boil them half an hour in a gallon of small ale, well hopped, to three quarts; then strain the liquor, and give the beast three pints in the morning, and the remainder in the evening. No dry or solid fodder is to be offered till the beast chews the cud again. Between these drenches a quart or two of distilled vinegar-whey must be given frequently in the day, to dilute the hard fodder, and strengthen the coats of the stomach; and hay-water may be also given. Great care must be taken, twice or thrice a-day, to cleanse the mouth, barbs, and nostrils of the distempered cattle, with some absterging acidulated liquor. On the fourth day, if the beast be heavy, dull, shivering, no pimples or knots arise, and a purging be coming on, the following drench must be given at about eight in the evening, and repeated three or four nights, as occasion requires.

Take of Virginian snake-root, contrayerva root, chamomile-flowers powdered, of each half an ounce; Venice treacle, six drachms: Mix all these in three pints of vinegar-whey, and give the drench lukewarm. Let a person sit up all night with the beast, and give it frequently a quart of vinegar-whey. Venice treacle may also be serviceable; and if there be any signs of mortification from the dark and relaxed appearance of the mouth, the coldness of the skin, the black fetid dung, insensibility, &c. the Peruvian bark must be instantly given every four or six hours, as occasion may require, taking the usual medicines in the intervals. In the last stage, let the swellings that puff up the skin be opened and digested; and after the crisis takes place, if a scouring should ensue, it is not to be hastily stopped, though diligently watched and restrained, lest it weaken the beast too much; and to cleanse the stomach and bowels, let a purge of rhubarb, senna, &c. be given. Dr Layard advises to let the beast drink water-gruel lukewarm, and keep it on dry meat, though sparingly; and at night to give an ounce of electuary of diascordium, in a quart or three pints of small ale, warm. But if after the crisis the beast is costive, and the skin dry, harsh, and tight on the flesh; dunging may be procured by giving in the evening a mash of bran, with a handful of beans bruised, and an ounce of Epsom salt. He recommends, however, the greatest exactness in observing when the crisis is over; for the least laxative medicine, or opening food, at the height of the disease, and consequently in the former stages of expulsion and maturation, will certainly bring on a scouring, attended with fatal consequences, or at least very difficult to be removed. In winter time, the cattle, upon recovery, should not be turned out at once to the pasture-grounds, let these be ever so dry; but towards the middle of the day, in fair weather, turning them out two hours, and then bringing them in again, will gradually use them to the open air. In summer, morning and evening will be the most suitable times; for the heat of the sun, or cold, may bring on other disorders.

"A farmer, (says Dr Layard), lost ten head of cattle, and two more were dying, and seven others ill, when I took upon me the direction of the seven which were last fallen ill. By the preceding treatment five of these recovered. One cow, very near her time of calving, died; and the seventh was certainly lost for want of observing the due time of the crisis, and purging too soon."

Such are the accounts given by Brocklesby and Layard, of the symptoms and treatment of this destructive malady; and it will be seen that their accounts differ no more than what may be expected from two different persons describing a similar disease that occurred at two different periods; for the murrain described by Dr Brocklesby appeared in the years 1744 and 1745, while that of which Dr Layard has given an account occurred between 1750 and 1760.

The causes and nature of this disease have not been 473
exactly ascertained. Some have supposed it connected with a peculiar state of the atmosphere, and that it did not originate in contagion. Many considered the principal causes of the disease to be previous hard winters, obstructed perspiration, worms in the liver, and corrupted food.

Hard winters have been considered as a cause of this disease, because it was in 1710, after the hard winter in 1709 that the great mortality among the cattle was observed; and because the hard winter in 1740 was followed by the contagion in 1741, which spread over the most part of Europe. Not to mention many others, the murrain in 1768, followed immediately after a pretty hard winter in 1767. On the other hand Camper remarks, that the hard winter in 1727 was not followed by the contagion; from which it would appear that the epidemic does not necessarily depend on the severity or mildness of the preceding winter.

It was attributed by many to obstructed perspiration; and to prevent its attack, it was proposed to cover the cattle during the nights of autumn, and to make them sleep within doors during the spring nights. It

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It may, however, be obſerved, that if this reaſoning were true, the diſeaſe ought to have been leſs prevalent, or ought not to have appeared at all, in thoſe provinces where, for the ſake of ſaving the dung, they houſe the cattle at night, even in the ſummer, as well as in the ſpring and autumn. Beſides it appears that the contagion was not known at Bern, though the cattle in that diſtrict lay all night in the field whenever the weather would permit.

Camper juſtly ridicules the idea of the diſeaſe originating from worms in the blood, or in the liver.

"If (ſays Camper), you demand of me, to what I attribute the firſt origin of the diſtemper, I ſhall anſwer, as it were to be wiſhed that all naturaliſts would do in ſimilar caſes, that I do not know; that the ſubject is above my comprehenſion, and doubtleſs above that of every man *."

* *Oeuvres de Camper*, tom. iii. p. 120.

There ſeems no doubt, however, that the complaint was infectious, and that provided proper means were taken to prevent infection, the diſtemper would not ſpread. The means propoſed by Dr Layard and ſome other medical practitioners, to deſtroy the contagion, was to bury the carcaſes of the infected animals, and to ſlaughter all that appeared to have received the infection. Inoculation was propoſed by ſome, as a means of diminiſhing the ravages of the murrain; and is ſaid to have been practiſed in Denmark with conſiderable ſucceſs: but if this be true, it is probable that the epizootic diſeaſe that raged in Denmark was of a different nature from that which appeared in Britain, and on ſome parts of the continent; as inoculation ſeems to have been tried in theſe places without effect. What probably led to the propoſal of inoculation was, that the diſeaſe was conſidered by ſome as exactly ſimilar to the ſmallpox in the human body. This opinion was adopted by Dr Layard, and ſeems to have ariſen from the boils or ſuppurating tumours which appeared on the bodies of moſt of the affected cattle; but theſe tumours do not appear to be ſimilar to the eruption that takes place in ſmallpox, but rather reſemble the boils or buboes that take place in the plague and ſome other highly infectious fevers. On the whole, it ſeems to us pretty evident, that the diſeaſe is of the nature of putrid fever, and we have therefore ranked it under this head.

It appears from Camper's works, that inoculation was attended with ſo much ſucceſs in many caſes on the continent, that a great number of cattle was ſaved by it, who probably could not have been recovered from the natural diſeaſe. The advantages attending inoculation according to Camper are,

1ſt, That we can expoſe to the danger of contagion ſuch calves and heifers only as are of a moderate price.

2d, That the heifers paſs through the diſeaſe before they take the bull, and conſequently before they are pregnant. This is attended with more advantage than may appear at firſt ſight; for when the contagion attacks a whole herd, all at once, oxen, calves, heifers, and cows are ſeized without diſtinction. Such cows as are pregnant generally ſlip their calf, and even if they ſhould perfectly recover, their womb is ſo diſordered that it will never afterwards be capable of retaining the calf; beſides, that afterwards it is a long time before they come in heat, ſo that the proprietor is obliged to keep them for a whole year without deriving from them any benefit, except he fatten them for the butcher.

If the ſucceſs of inoculation, as well as the certainty of the cattle being incapable of a ſecond infection, were fully aſcertained, the plan of inoculation would be extremely proper. If theſe points were fully eſtabliſhed, would they not, however, militate conſiderably againſt the opinion that is entertained by the beſt writers on the ſubject, even by Camper himſelf, that this diſeaſe is an idiopathic putrid fever, and not an eruptive complaint like the ſmallpox?

474 Means of checking the contagion.

Conſidering the diſeaſe as one that is highly contagious, every method ſhould be taken to check the progreſs of the infection. For this purpoſe the houſes where the cattle are ſtabled, ſhould be kept perfectly clean, and well ventilated. It would alſo be proper to fumigate theſe places twice a-day with the vapours of ſome mineral acid, ſuch as the nitrous or muriatic acids, as has been recommended by Dr Johnſtone, Guyton Morveau, and Dr Carmichael Smith. This fumigation may be eaſily effected by placing pipkins of warm ſand in various parts of the cattle-houſes, and particularly at the doors, and placing on the ſand a cup containing common ſalt or pounded nitre, on which is to be poured a ſufficient quantity of ſulphuric acid or oil of vitriol, ſtirring the maſs now and then with a glaſs rod, to promote the eſcape of the acid vapours.

We ſhall conclude this ſubject with a ſeries of queries that were circulated among medical men on the continent by the Society of Medicine at Paris, for the purpoſe of gaining every neceſſary information reſpecting this alarming peſtilence, as they may tend to direct the inquiries of thoſe who ſhall in future have an opportunity of obſerving the diſtemper. 475

1. What is the ſituation of the country in which the epidemic appears, and what is the nature of the ſoil?

2. Of what quality are the waters which the cattle uſually drink, and of what dimenſions are the reſervoirs that contain them?

3. What is the quality of the paſturage, and what are the plants which moſt conſtantly grow in the paſtures?

4. Of what nature is the fodder and the grain that are given to the cattle within doors?

5. Have there been any abundant rains or inundations; has the water continued for a long time on the ground, and what are the effects it has produced on the fodder?

6. Or has there on the contrary been any great drought, and how long has it continued?

7. What has been the ſeaſon for getting in the hay, and for harveſt: and what effect does the ſeaſon ſeem to have had on the hay and other fodder?

8. What circumſtances ſeem to have rendered it neceſſary for the cattle to work?

9. Has the diſtemper been announced by any previous ſymptoms; and what were they?

10. Did the diſeaſe come on with ſhivering, with coldneſs of the horns and ears, and with the loſs of appetite?

11. Did the heat come on ſoon after the cold fit, or was it not preceded by a cold fit?

12. Do the animals continue lying, without being able to raiſe themſelves on their legs?

13. When

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13. When they are lying, is their head low, or how do they hold it?

14. Are their eyes red, watery, and hot?

15. Are their noſtrils dry, or does there ooze from them a mucous matter?

16. Is their tongue in the natural ſtate, or is it very red, or is it covered with a yellow or brown mucus; is it moiſt or dry, or are there on it any tubercles?

17. Is their throat inflamed, or are there on it any aphthous cruſts?

18. Is the animal fatigued with a cough, and is this cough very frequent?

19. Do the flanks heave or not?

20. Does the animal ſeem to feel any great pain when he is touched in the flanks, or the belly, on the ſpine, or on the rump?

21. Are there any puſtules or tumours on the ſurface of the body?

22. Is the hair ſmooth or ſtaring, or does it eaſily come off when the ſkin is curried, or even when the body is rubbed with a wiſp of ſtraw?

23. Does the animal ſeem much diſordered, or does he refuſe every ſort of drink?

24. Does he chew the cud?

25. Has he a frequent diſcharge of urine, and what is the colour and conſiſtence of it?

26. Has he a diſcharge by ſtool more frequently or leſs than uſual, and are the excrements natural, or very dry or very liquid; what is their colour and odour, and is their diſcharge preceded or accompanied with a frequent exploſion of wind?

27. Are there to be obſerved any little convulſions below the ſkin, eſpecially about the neck?

28. Is the belly in its natural ſtate, or is it ſwelled; is it ſoft, or hard and tenſe?

29. At what periods do theſe ſeveral circumſtances take place?

30. How does the diſtemper terminate; what are the ſymptoms that announce a healthy termination, and what are thoſe which precede death?

31. In what ſtate after death are found the ſtomachs, the bowels, the liver, the ſpleen, the lungs, the heart, and the brain?

32. What remedies have been adminiſtered to the diſeaſed beaſt?

33. What ſenſible effects have theſe remedies produced?

34. Laſtly, what regimen has been obſerved in the convaleſcent ſtate?

476 Eruptive diſeaſes.

The eruptive diſeaſes incident to domeſtic animals are but few, when compared with the *exanthemata* that take place in the human body. Many ſuch diſeaſes are, however, deſcribed by veterinary writers, eſpecially on the continent, where they ſeem to be much more prevalent than among us. In particular, it appears, that in the ſouthern parts of Europe the ſheep are frequently affected with an eruptive diſeaſe that nearly reſembles the ſmallpox; and, like this diſeaſe in the human ſubject, there are two varieties of this affection, a *diſtinct* and a *confluent*. A very particular account of this diſeaſe, as it occurred at Cauterets in the department of the Lower Pyrenees in France, was drawn up by M. Tenon, and communicated by him to the agricultural ſociety at Paris; and a tranſlation of it has been publiſhed in the Farmer's Magazine for May 1804, from which we have taken it.

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3. Sheep-pox. Claveau, Fr.

477 Sheep-pox.

This diſtemper, which at Cauterets is called the ſmallpox, is contagious; and indiſcriminately attacks wedders, ewes, lambs, and goats, more eſpecially when ſhut up during winter in confined cots, the animals are kept very hot. It is a very ſingular circumſtance, that this diſtemper ſhould only appear at Cauterets, after intervals of twelve, fifteen, or twenty years; while in Guienne, and the higher Languedoc, it rages every year. Beſides, that in the former mountainous tracts, the weather is colder than in the plains of the latter diſtricts, the ſheep of the Pyrenees are kept more apart from each other than in the low countries, and the different flocks are much leſs liable to meet together, or to paſs through the ſame roads, by which they are not nearly ſo much expoſed to the danger of infection.

When ſeized with this diſtemper, the ſheep become dull and weak, and they loathe their food; the head, eyes, ears, and gums, are ſwelled; and hard white tumours appear in the groins and under the joint of the ſhoulder. Three or four days after the appearance of theſe tumours, pimples break out in different parts of the body. At firſt, theſe are ſituated on the naked ſkin between the thighs, and on the places where the wool is ſhort and ſcanty; afterwards, they break out about the head, and ſucceſſively over the whole body, even on the eye-lids, ears, and throat. In this ſtage of the diſeaſe the animal ſwallows with pain, being obliged to hold back the head, and to ſtretch out the neck for the purpoſe, and it breathes with great difficulty. As the diſeaſe goes on, the pimples enlarge, and become inflamed, particularly at their baſes; they ſuppurate and burſt; the matter which runs out mixes with the wool, and mats along with it into hard lumps, but afterwards drys and falls to powder; the wool falls off in locks; and even the ſcarf ſkin peels off in large pieces, which are full of holes. When the diſtemper begins to abate, the ſheep rub themſelves on the poſts of the racks, or any other hard ſubſtance which comes in their way; and by this means the wool, along with the looſe ſkin and dried pus, are rubbed off. If proper precautions were not employed, this would infallibly ſpread the contagion by infecting any other ſheep that might be brought into the ſame cots: but, on purpoſe to deſtroy the infection, new cribs are either ſubſtituted for the old ones, which are pulled down and burnt, or elſe the infected cribs are waſhed with cream of lime, and the cots are thoroughly fumigated with burning juniper and other aromatic plants.

There are ſeveral varieties of this diſorder. In ſome of theſe the eruption of puſtules is by no means complete as above deſcribed; ſometimes the pimples grow black, and dry up without coming to ſuppuration; at other times the diſeaſe is of a complicated nature. But as the diſorder only appears at diſtant periods among the ſheep at Cauterets, we are not to expect very full information concerning its various degrees from the ſhepherds of that diſtrict; neither have they any decided experience of the effects of ſulphur, or ſetons, or of

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or of blisters, in the cure of this distemper. Blisters are said to have scarcely any effect upon the skins of sheep.

It is certain, that the flesh of such sheep, as have died of this disorder, is very unwholesome, has a very bad taste, and is even dangerous to eat; and they add, that when dogs happen to feed on it, they catch the disease, and spread it by infection. Three cats, by eating this food, had their heads affected with an eruption of pustules, by which they were first blinded, and afterwards lost their lives. Hence the necessity of the precaution which is taken at Cauterets to bury deeply the carcases of sheep which die of this disease.

I had an opportunity, says M. Tenon, at a butcher's in Paris, to examine some sheep which had died of this disorder. The skins were covered with suppurated pustules, which penetrated as far as the cellular membrane, and the fat in their neighbourhood was affected for a considerable distance all round, being browner and firmer than the ordinary fat; and this alteration penetrated even to the flesh.

The inhabitants of Cauterets affirm, that these pustules are found on the liver and other internal parts of the body.

M. Tenon made every possible inquiry to learn whether this disease was ever communicated from the sheep to mankind, but he could learn no instances of such infection: it is believed, however, in Languedoc, that it is communicated from sheep to rabbits. He could not learn whether the sheep were ever affected a second time with the same disorder; but we cannot expect information at Cauterets on this part of the subject, since the disease only appears there for a single season, after intervals of twelve, fifteen, or twenty years, while the sheep live but eight, or at most, ten years; so that any of them, which have once been diseased, cannot be alive when the next period of contagion comes round.

Whenever the disorder appears in the flock, the infected animals are separated from the rest, and shut up in warm cots, having plenty of wheat or barley straw given them for litter; they are fed with hay and aftermath which have been made on a dry field, with a little salt, and are allowed lukewarm water for drink.

In the flat country at Tarbes, which is ten leagues distant from Cauterets, and considerably warmer than in the Pyrenees, and where this distemper is much more frequent, a different method of treatment is followed. At the beginning of the disease blood is drawn by cutting the ear; the cots are fumigated for five or six successive days, by burning aromatic and strong smelling herbs, preferring the dried stems of garlic for this purpose; these are burnt on a large stone in the middle of the cot, while all the vent holes are carefully stopped, to prevent, as much as possible, the smoke from escaping. The shepherds of Tarbes have great confidence in the beneficial effects of fumigating with garlic steams, which occasions a great discharge from the nostrils, especially in such cases of the disease as are complicated with catarrhal disorders, and with the staggers or vertigo.

At Bellegarde, near Auch, they give to each beast a double handful of white mulberry leaves, which they alledge is a most effectual cure, and serves excellently for preventing the attacks of the disease.

When, at Cauterets, the disorder begins to abate, whatever be the season of the year, the animals are clipt, on purpose to assist the drying of the pustules, and to favour the growth of a new fleece. After this the sheep fatten very quickly; and it is worth while to remark, that the fleece which immediately succeeds this disease is finer and more silky than any former or future fleece on the same beasts.

Formerly this disease made great ravages among the sheep at Carcassone, till a method was fallen on to inoculate the disease. M. Tenon learned this fact in 1762 from Dr French, an Irish physician, who lived in Languedoc for several years; but it was not till 1763 that he received particular information on this curious subject from M. Berra, mayor of Carcassone, to whom he had written for information, and who procured him a memoir on the diseases of sheep in that part of the country. From this memoir the following account of inoculating the sheep-pox is extracted.

"The seigneur of Maux, in the diocese of Narbonne is the first, and almost the only person who has practised inoculating the small-pox on his flocks; and having been successful during ten years experience of the practice, his widow has ever since continued to follow his example.

"In the month of September, when the heat of summer is past, and before there is any danger of very cold weather; while the pastures are still in good order, and the lambs, which are now six or seven months old, are strong enough for withstanding the force of the disease, this season is chosen as the fittest for communicating the small-pox to the sheep. For this purpose the fresh skin of a sheep, either ewe, wedder, or lamb, which has died of the disease, or, instead of that, one taken from a sheep which has been killed while affected by it, is placed on the floor of the cot. Into this cot all the young sheep of the year are driven, and they voluntarily rub and roll themselves on the diseased skin. Very soon afterwards the symptoms of the disease begin to appear; they have a dull and heavy appearance, hold down their heads, are somewhat fevered, and loathe their food. On purpose to aid the eruption of the pustules, bread dipt in wine is given to the sheep; they are anxiously preserved from being exposed to great heat or great cold, and particularly from rain. By these precautions they speedily recover, and it very rarely happens that even one dies out of a flock of three hundred.

Although the disorder has often spread over the districts in the neighbourhood of the estate where this practice prevails, there has been no instance of a single sheep, after undergoing the above described operation, having been infected a second time. It ought to have been noticed, that the inoculated flock is carefully prevented from mixing with any other sheep, by keeping it in a separate cot, and on a particular pasture, the other shepherds being forbidden to use either for the flocks under their charge. By these precautions, the disease is prevented from spreading, and such proprietors as do not wish to have their sheep artificially infected, have themselves to blame if they do not avoid the place where the diseased sheep are kept. Since this practice has been followed, it has been observed that the disorder has not returned so frequently, but that it has not proved

Diseases. proved in the least degree destructive to the flocks which have not been inoculated.

M. Berra adds, that the lambs never lose their wool under the instance of the inoculated disorder, and that their fleeces are equally good in every respect with those of the uninfected, so that no difference can be perceived *.

This disease was once pretty common in Britain, but is now scarcely known among us. It is, however, justly apprehended, that importation of sheep from the continent may again introduce it; and Sir Joseph Banks has taken much pains to caution the public against the danger of such an introduction.

* Farm. Mag. vol. v. p. 175.

4. Cow-pox, or *Kine-pox*. Vaccina.

478 Cow-pox.

A greater blessing was never procured to mankind than what has been already derived, and will we trust, be ultimately derived, from the invaluable discovery of the inoculated cow-pox, in preventing the person who has received it from being afterwards liable to variolous contagion. For this blessing we are certainly indebted to the labours and experiments of Dr Edward Jenner. There is no doubt that the disease was known many years ago in some of our principal dairy districts; but Dr Jenner has all the merit of having extensively circulated the discovery, and of having first applied it to those valuable purposes to which an almost universal experience has shown it to be well adapted.

The symptoms and origin of this disease amongst cows, have been briefly described by Dr Jenner in his publications on the subject. The first of these appeared in 1798, while Dr Jenner was practising in Berkely in Gloucestershire, where he had an opportunity of frequently seeing the disease.

"In this dairy country, (says Dr Jenner) a great number of cows are kept, and the office of milking is performed indiscriminately by men and maid servants. One of the former having been appointed to apply dressings to the heels of a horse affected with the grease; and not paying due attention to cleanliness, incautiously bears his part in milking the cows with some particles of the infectious matter adhering to his fingers. When this is the case, it commonly happens that a disease is communicated to the cows, and from the cows to the dairy maids, which spreads through the farm, until most of the cattle and domestics feel its unpleasant consequences. This disease has obtained the name of the *cow-pox*. It appears on the nipples of the cows in the form of irregular pustules. At their first appearance they are commonly of a palish blue, or rather of a colour somewhat approaching to livid, and are surrounded by an erysipelatous inflammation. These pustules, unless a timely remedy be applied, frequently degenerate into phagedenic ulcers, which prove extremely troublesome. The animals become indisposed, and the secretion of milk is much lessened †".

† *Jenner's Enquiry*, p. 3.

There sometimes appears another kind of eruption on the udder of the cow, which on a superficial view may be mistaken for cow-pox. It consists of a number of white blisters on the nipples, and these blisters are filled with a whitish serous fluid. They are to be distinguished from the pustules that take place in the cow-pox, by their not having the blueish colour of the latter, and by their never eating into the fleshy parts, being confined to the skin, and ending in scabs. This eruption also appears to be infectious, but not nearly in so great a degree as the true cow-pox. Diseases.

Dr Jenner considers this spurious eruption as being chiefly produced by the transition which is made by the cow, in the spring, from a poor diet to one that is more nourishing, by which the udder at this season becomes more than usually vascular for the supply of milk. There is, however, another sort of inflammation and pustules, which appears to be not uncommon in all the dairy counties in the west of England. A cow intended to be exposed for sale, and having naturally a small udder, is for a day or two previously neither milked by the milker, nor is her calf suffered to have access to her; thus the milk is peternaturally accumulated, and the udder and nipple become greatly distended. The consequences frequently are inflammation and pustular eruption.

479 Originates in grease.

As the eruption of the cow-pox disappears in a few days, little more is required than to keep the teats clean, and handle them as carefully as possible during milking.

The fact of cow-pox originating from the matter of *grease*, or of the latter being capable of producing the former, was, we believe, first discovered by Dr Jenner; but the opinion was for some time considered as fallacious. Many unsuccessful attempts were made by Dr Woodville and by Mr Coleman to produce cow-pox by inoculating the udders of cows with matter from greasy heels. Some experiments made by Mr Simmons tended still further to disprove Dr Jenner's opinion. But about five years ago, Dr John Loy published a small pamphlet, in which he has related some experiments made by himself, with a view to determine this controverted point. He was led to make these experiments from some cases that fell under his observation, of a disease very similar to the cow-pox appearing on persons who must certainly have derived it from the matter of grease. Dr Loy's experiments fully confirmed the opinion of Dr Jenner, and proved that the matter of grease would, by inoculation, produce in the human body a disease exactly resembling cow-pox, and like it capable of protecting the inoculated person from an invasion of the small pox. Dr Loy also proved, that in some cases, the cow-pox might be produced in cows by the immediate application of the matter of grease, but that this experiment did not succeed unless the horse had also a general affection of the system. This led Dr Loy to suppose that there exist two species of grease, the one merely a local affection, the other a general affection of the system *.

* *Loy's account of Experiments on the Origin of Cow-pox.*

The reasons that induced Dr Jenner to suppose that cow-pox originates in grease are thus stated by himself, in his second publication on the subject of cow-pox.

First, He conceived grease to be the source of cow-pox, from observing that where the cow-pox had appeared among the dairies in Gloucestershire (unless it could be traced to the introduction of an infected cow or servant), it had been preceded at the farm by a horse labouring under grease, which horse had been attended by some of the milkers.

Secondly, From its being a popular opinion through that dairy country, and from its being insisted on by those who there attend sick cattle.

Thirdly, From the total absence of the disease in Scotland and Ireland (as the doctor was informed from the best authority) where the men servants are not employed in the dairies.

Fourthly,

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Fourthly, From having observed that morbid matter generated by the horse, frequently communicates in a casual way, a disease to the human subject so like the cow-pox, that in many cases it would be difficult to mark the distinction between the one and the other. The truth of this observation is well illustrated by the above experiments of Dr Loy.

Fifthly, From his being induced to believe from experiments, that some of those who had been thus infected by the horse, resisted the smallpox.

Sixthly, From the progress and general appearance of a pustule on the arm of a boy whom he inoculated with matter taken from the hand of a man that had been infected by a horse, and from the similarity to the cow-pox, of the general constitutional symptoms which followed. *

* *Jenner's further Observations*, p. 21.

480 Le Louvet.

5. Le Louvet.

Continental writers describe a variety of eruptions under the general name of *charbon*, or *carbuncle*, which affect various parts of the body, and have received different names according to the part which they attack. We shall here only notice one of these which raged epidemically about the middle of the last century in Switzerland, where it is called *le Louvet.*

It affected both cattle and horses, but seems to have been attended with different symptoms in each. According to M. Reynier, a physician at Lausanne, who published an account of the distemper, when an ox is seized with it, he suddenly loses his strength, trembles, seems desirous of lying constantly on the ground, whence he seldom moves except to refresh himself; he carries his head low, and his ears slouching; he is sad, and moans; his eyes red, his skin very hot and dry, and his breathing frequent and difficult. When the disease has made some progress, expiration is always followed with a considerable depression of the flanks; there is a frequent cough; the breath is very fetid; the heart and arteries beat violently; the tongue and palate are dry and become blackish; the animal loses his appetite and ceases to chew the cud; there is considerable thirst; the urine is scanty, reddish, and the excrement hard and blackish towards the beginning of the disease, and sometimes limpid and bloody. Cows lose their milk. On most of the animals inflammatory tumours are produced, which appear sometimes on the chest, sometimes on the vertebræ of the neck, and on the belly; at others on the udder, and the parts of generation. At other times they entirely cover the skin in pimples, like those of the mange or scab.

All these symptoms do not often appear on the same subject; but in proportion as more of them occur, the disease is the more fatal. In general, death takes place on the fourth day, when the symptoms are violent; if they pass the fourth day, and are not worse on the seventh, their recovery is pretty certain, though they are often not convalescent before the fifteenth day.

When the urine is turbid, and deposits a whitish sediment; when the excrements are more abundant than in the natural state, moist and not very offensive; when the skin is black and relaxed, the pimples filled with whitish matter, the thirst alleviated; when the appetite and rumination returns, and when the pustules begin to dry up, a perfect recovery may be expected: but on the contrary, when there is much swelling of the belly, when the animals moan much, when there appear great debility, tremblings, convulsions, retension of urine, diarrhœa or dysentery, a fatal termination may be looked for.

On opening the bodies of such animals as died of this disease, there appear on the skin numerous black tumours, full of a yellow serous fluid that effervesces with acids; the muscles are livid, soft and flaccid; the lungs wasted, full of tubercles and little ulcers, especially on those animals which died on the fourth day. The stomach and bowels are beset with red tumours, full of a tenacious clammy fluid.

M. Reynier considers the predisposing causes of this disease to be the bad quality of the water which the beasts drank, the corrupted state of their food, excessive fatigue, low and ill-aired stables, deficiency of herbage, and tempestuous weather. Like many other medical men of his time, he held the immediate cause of the disease to consist in an alkalescent state of the blood. The method of cure consisted in giving drenches of emollient decoctions, clysters of the same substances, with nitre and vinegar mixed with honey; and towards the latter stage of the disease, the Peruvian bark and camphor were administered. This was a very *innocent* and *gentle* treatment, and it is no wonder that so many of the cattle died.

6. Strangles.

481 Strangles.

The disease called *strangles* in horses, is considered by Mr Blaine as a specific fever, accompanied with a disposition to inflammation in the glands of the head and throat. It most commonly attacks horses betwixt four and six years of age, though it may occur at any period before six; but rarely appears after that age. Young horses are most subject to it when first brought to labour, and put on the nourishing diet of the stable, though Mr Lawrence has seen it in unbroken colts in the field. It seems that few horses escape having it once in their life.

It commences with a considerable degree of fever; the breath is hot, the eyes are heavy and languid, the horse thrusts out his nose, has a hoarse cough, and labours under some difficulty in swallowing. There soon appears a swelling between the jaws, or on the inside of the lower jaw, which usually extends to the parotid glands. These swellings, if left to themselves, go on to suppuration; and about the fifth or sixth day they break and discharge a considerable quantity of matter; but sometimes the heat, hardness, and swelling of the glands continue for a long time. These symptoms are usually attended with a running at the nose, which is considered as a favourable sign.

This complaint is seldom dangerous, though now and then there is some risk of suffocation, and sometimes it degenerates into glanders. Of this Mr Lawrence has seen several instances. It appears to be contagious, and may be propagated by inoculation, which has induced us to consider it among the febrile eruptions.

The writers on farriery have strangely differed with respect to the nature of this affection. The elder Lafosse considered it as analogous to the smallpox. Bracken as a species of *cynanche*, or *quinsey*, and it certainly nearly resembles the *cynanche parotidea*, or *mumps*. Others have supposed it to be like the chicken-pox, or measles.

It is not agreed on whether it is better to check the inflammation

inflammation of the glands, or to encourage their ſuppuration. Mr Blaine recommends the former plan, which is beſt effected by bleeding, purging, and the uſe of diuretics; while a ſolution of ſugar of lead is applied to the ſwelling externally; but if the ſwellings continue hard and hot, it will be proper to encourage ſuppuration by the frequent application of warm poultices. If there is much ſoreneſs and ſwelling of the throat, a large bliſter ſhould be applied to it. If there is much fever, nitre or emetic tartar may be added to the horſe's water; for it would be wrong to give him medicine in the form of a ball or drench. He may have frequent warm maſhes; and to encourage the running at the noſe, there ſhould be hung to it a bag containing a warm maſh, which ſhould be frequently renewed. The horſe's head ſhould be kept warm, and currents of cold air ſhould be avoided. When the tumours break, the diſcharge ſhould be aſſiſted by enlarging the opening and applying warm poultices, and the ulcers may be dreſſed with the common digeſtive ointment. If the diſcharge proceeds by the mouth, the parts ſhould be frequently waſhed with vinegar and water ſweetened with honey.

5. Grease. Eaux aux Jambes, Fr. *Greaſy heels.*

482 Greaſe.

In the fourth chapter of the laſt ſection, N° 423. we made a few obſervations on ſwelling of the legs, and we remarked that this complaint often terminated in greaſe.

Greaſe is a complaint that is extremely common among horſes, to whom it is peculiar, not being known to affect any other ſpecies of animals, or at leaſt there is no other animal in whom that peculiar ſecretion which conſtitutes the matter of greaſe in horſes is found to take place. There appears to be two varieties of greaſe, the one a mere local affection, the other a more general affection of the ſyſtem attended with fever.

The complaint firſt appears by a ſlight ſwelling about the coronet and paſtern, ſometimes accompanied with pain or itching, ſo that the horſe rubs his feet againſt each other, or ſtamps and ſhifts himſelf from ſide to ſide. On feeling the ſwelled part, it is commonly found much hotter than uſual, and is evidently red and inflamed. Very ſoon there may be perceived an oozing through the ſkin, of a yellowiſh fluid that is very offenſive, and of an unctuous greaſy feel. This ſwelling gradually extends up the cannon towards the knee, and when the horſe is taken out to work, he appears ſtiff and lame till he becomes heated; and when he returns from work, the leg appears hot and inflamed. The ſwelling and oozing of fetid greaſy fluid gradually increaſe till cracks begin to make their appearance in the ſkin about the heels, the hairs about theſe parts fall off, and the ſkin below appears puffy, of a whitiſh or livid colour; and on it are generally ſeen little bladders, from which a matter of the ſame kind as what we have deſcribed oozes out. Theſe veſicles ſoon become ulcers, and the matter they contain aſſumes the appearance of pus, which irritates and inflames the neighbouring parts, fretting and excoriating the ſkin. Generally a number of red granulations or excreſcences appear within the ulcers, and from their form are commonly called *grapes*; and if the complaint continues long, the hoof becomes fungous, or there is a luxuriant growth of ſoft ſpongy horn. If the complaint be neglected, the ulceration of the part increaſes, and extends even to the bones, which become ſoft, ſpongy, and at laſt carious.

In what is called the confirmed ſtate of greaſe, the affected parts are exquiſitely ſenſible, and they bleed on the ſlighteſt touch, and there are commonly produced a number of horny excreſcences about the fetlock. The hair ſtands erect, and the horſe becomes lean, weak, and exceſſively irritable.

Such are the general appearances and progreſs of greaſe; but there are often ſome little varieties in both. Sometimes the cracks appear very early in the diſeaſe, and ſometimes there is conſiderable fever; but whether this precedes the appearance of the veſicles, or is occaſioned only by the pain and irritation that accompany the complaint, we are uncertain. It ſhould ſeem, from the obſervations of Dr Loy and others, that a fever, ſuch as accompanies eruptive diſeaſes, frequently attends greaſe; and in this caſe, as we have ſaid, it is to be conſidered as a general affection. It is deſcribed as ſuch by Huzard, and other continental writers; and they even ſpeak of the appearances that have been found on diſſection of horſes that have died when affected with this complaint, of the repercuſſion of the eruption from cold, &c. On the other hand, there is no doubt that fever may be excited by the irritation of the parts, eſpecially if the horſe is obliged to work. It may take place in any of the legs, but is more common in the hind legs.

Such horſes as have round fleſhy legs, ſuch as have white hair upon their legs, and in general, ſuch horſes as are weak and phlegmatic, are more ſubject than others to greaſe.

It may be brought on by various cauſes. It is very commonly produced by allowing horſes to ſtand long idle in the ſtable. In this way the circulation, which is naturally more languid in the legs, eſpecially in the hinder legs, than in other parts of the body, becomes ſo languid in the heels, that the veins cannot readily propel forward their contents, and conſequently an accumulation takes place in the minute capillary branches; whence ſwelling and inflammation. This accumulation is aſſiſted by the perpendicular ſituation of the legs, by which a column of blood, that for want of the action of the muſcles is moved with difficulty, continually preſſes on the lower parts. Hence we find, that when horſes are not allowed to ſtretch themſelves at their eaſe, they are extremely ſubject to ſwelled legs and greaſe. The languid circulation is ſtill greater in horſes that are naturally of a weak conſtitution, or who have been debilitated by diſeaſe. So great is the effect of diminiſhed exerciſe in producing ſwelled legs and greaſe, that ſome horſes are always affected with this complaint when brought into the ſtable, and can be preſerved from it, only by being regularly turned out into the field after work. It is very commonly obſerved, that when horſes firſt come up from paſture, or from a ſtraw yard, they are all more or leſs affected with ſwelled legs; and if theſe are not diligently attended to, they ſoon have greaſy heels. It is certain that horſes in their natural ſtate, or while kept conſtantly at paſture, are never affected with greaſe.

Sudden changes from heat to cold, or *vice verſa*, frequently produce this complaint; but, according to Mr Feron, it is more commonly produced by ſudden changes

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changes from cold to heat. "If (says he) a colt is taken from grass, and immediately kept in a warm stable, after having been used to the severity of the atmosphere, he then gets the disorder. When old horses are troubled with the grease, we shall find that their feet have been exposed first to cold, and afterwards to heat, as when they have been in cold water or snow for a long time, and on coming into the stable have a large bed of straw, or perhaps hot dung, to stand upon. This sudden transition from cold to heat, produces a weakness in the legs, particularly in the skin; when inflammation and cracks, similar to chilblains in the human subject, take place, and are called the grease in horses."

Nothing contributes more to the production of grease than negligence, with respect to keeping the legs clean, and rubbing them often. It is a disputed point, whether the hair that grows about the fetlock is prejudicial or not to horses that are subject to grease. It is contended by Mr Richard Lawrence, that grease is a very common consequence of removing the hair; and considering that the hair is a good preservative against sudden transitions from heat to cold, we are disposed to think its removal improper, where the heels are not already ulcerated. On the other hand, Mr Blaine remarks, that whenever accidental wet occurs, this hair must retain a large quantity of it, and hence be long in drying, occasioning a copious evaporation, and thus producing much cold, and that the hair renders it difficult to keep the legs so clean, as they might be preserved without it. Even supposing these arguments to be just, they only show the necessity of greater care and attention in rubbing the heels dry and keeping the hair free from dirt.

Grease may also be produced by too much hard work, after which the legs swell, and if the swelling be neglected the heels may become greasy. This, however, is probably not a very common cause.

Grease is said to be most common in spring and autumn, when horses are moulting or casting their coats.

On the whole, it appears that this complaint may take place in two different states of the body; a state of general weakness, the effect of constitution or disease; and a state of plethora, attended with a proportional languid circulation in the vessels of the legs or feet.

In the treatment of grease, we must consider whether it be merely a local affection, or be connected with some general morbid affection of the body; and we must also attend to the state of the affection, as the nature of the local applications will depend much on the progress that the disease has made.

In the early stage of the complaint, when the inflammation is slight, and the skin is not yet broken, if it has been owing to want of exercise and plethora, it may be proper to draw blood from the veins of the thighs, and a diuretic ball, such as N° 12. or 13. should be given, and repeated every two or three days. The hair must be cut close, and the heels well washed with warm soap and water, after which they must be gently rubbed till they are perfectly dry, and bathed with some stimulating liniment. This plan, with gentle exercise and a cooling diet, especially bran mashes, with an ounce of nitre in each, every night, will probably prevent the complaint from going any farther. If the inflammation be very considerable, and the horse is plethoric, he must be bled pretty largely from the jugular vein, and have a mild purge. Cloths, dipped in vinegar and water, or in a solution of sugar of lead, should be applied to the heels after washing, and kept constantly moist with the same liquor. More than walking exercise here will be improper; but if it is dry weather, a run for a few hours a-day in a field will greatly contribute to removing the swelling. Mr Feron, who is a great advocate for warm fomentations in inflammatory affections of the feet and legs, recommends the legs to be kept the whole day in warm water; and when they are taken from the bath, to be well wrapt up in a warm poultice of bran and water. If by these means the inflammation subsides, the legs may be washed with a solution of alum.

If cracks appear, great attention must be paid to keep them clean from dirt, and they should be frequently washed with a solution of blue vitriol. If grapes appear, they may be touched with blue vitriol, or burnt alum; or if they become large, they must be cut away with a sharp knife, and afterwards seared with a hot iron. If the ulcers are foul, one of the best applications will be a solution of verdigrise, or the ointment commonly called *Egyptiacum*, of which verdigrise forms one of the principal ingredients.

The strictest attention to diet, regimen, and cleanliness, must be observed during the whole treatment, and gentle exercise must be persisted in. The best diet on these occasions will be cut grass, lucerne, fresh clover, carrots, or good sweet hay, and an occasional feed of corn. The horse should not be tied up in the stall, but should stand loose while he is in the stable, and should be allowed no litter, except at night. The stable should be kept perfectly clean and well aired, and not too warm.

Sometimes, even though the complaint should not at first have originated in debility, there will, if the disease is of long standing, be produced a considerable degree of weakness. In these cases the cure will be greatly assisted by giving strengthening remedies, such as bark, horse-chesnut bark, &c. And as in this weak state of the body the discharge from the ulcerated surface is commonly thin and ichorous, the sore must be dressed with stimulating ointment; and if there appears a tendency to mortification, as sometimes happens, a powder of equal parts of Peruvian bark and opium should be sprinkled on the sores, before applying the plaster. If the discharge is very offensive, a fermenting poultice, such as N° 64. may be applied over the dressings.

It will readily appear, that the best means of preventing grease, will be to give the horse regular exercise, to dress him well, and especially to keep his legs dry and clean, and to avoid the extremes of heat and cold.

Grease might perhaps have been considered under the head of specific inflammation; but as it is sometimes attended with a general affection of the body, and is ultimately connected with one of the most interesting eruptive diseases, we thought it best to treat of it in this place.

CHAP.

Chap. II. *Of Inflammatory Diſeaſes.*

1. Inflammation of the Brain. Phrenitis. *Mad Staggers, Phrenzy, Megrim,* or *Sough.* Mal de feu ou d'Eſpagne, Fr.

483 Inflammation of the brain.

This is one of the moſt ſerious and fatal inflammations which affect the animal ſyſtem. It attacks occaſionally all the domeſtic animals, but horſes and cattle are the moſt ſubject to it. In the former it is generally called the *mad ſtaggers,* to diſtinguiſh it from apoplexy, or ſleepy ſtaggers; when it occurs in cattle, it uſually takes one of the other names which we have given as ſynonyms.

Inflammation of the brain is ſometimes preceded by giddineſs and partial blindneſs; the animal holds his head low, or reſts it againſt the manger; he appears dull, heavy, and ſleepy; gradually, however, theſe ſymptoms go off, and are ſucceeded by others of a very different nature. His eyes appear red, fiery, and ſparkling; he now holds his head higher, and appears for ſome time to look conſtantly at any object before him; ſoon he becomes very reſtleſs, till by degrees he is quite unmanageable. He ſometimes lies down, and tumbles about, and then remains quiet for a while; but he ſoon gets up again, and is as ungovernable as before, rendering it dangerous for any perſon to approach him. The pulſe in this diſeaſe is full and hard, and there is conſiderable throbbing of the temporal arteries. The pulſe is not always the ſame in every caſe, being in general leſs frequent than in health, but ſometimes more ſo. There is always a conſiderable degree of fever, and the head ſeems peculiarly affected. The ſecretions and excretions are generally diminiſhed, but it is ſaid that they are ſometimes increaſed.

Such are the ſymptoms as they generally appear in the horſe; thoſe which take place in cattle, as they are deſcribed in the beſt books on the ſubject of cattle medicine, differ in a few particulars.

The animal is deſcribed as looking frightfully, being unuſually watchful, ſtarting often, groaning vehemently, as if affected with ſudden and violent pain; his reſpiration ſlow, but he ſometimes makes very long inſpirations, and appears for a time as if his breathing was entirely ſuſpended. Suddenly the beaſt will riſe, turn about, and inſtantly lie down again, ſhowing marks of great reſtleſſneſs and delirium. When the frenzy is high, the eyes look red and furious; at other times they border on languor and ſtupefaction; but the beaſt always appears to labour under conſiderable fear, and dreads the approach of every thing; he is often quite ungovernable, and ſcarcely ever inclines to reſt, except in the latter ſtage of the diſeaſe, when, if it has been neglected, or has not yielded to the uſual remedies, a lethargy takes place, and the animal ſinks. Sometimes the urine is hot and high-coloured; but it is ſaid that before a fit of phrenzy takes place, the urine is often of a pale colour, and thinner than natural.

When the ſymptoms of fury or irritation ſuddenly ceaſe, and a lethargy takes place, while the pulſe becomes feeble, and the ſtrength diminiſhes, the caſe is pretty certainly hopeleſs; but if the fever, redneſs, and fluſhing of the eyes gradually ſubſide, without the pulſe ſinking, or great debility coming on, the beaſt may generally be pronounced recovering.

On opening the head of ſuch animals as have died of this complaint, very evident marks of inflammation appear about the membranes of the brain, and very frequently in the ſubſtance of the brain itſelf. All the veſſels are turgid with blood; and on cutting into the brain, innumerable little red points are to be ſeen, which do not appear in the natural ſtate. Very commonly an effuſion of blood, or of purulent matter, is found to have taken place into the cavities of the brain, or in ſome part near its ſurface.

The cauſes of inflammation of the brain are generally the ſame that produce inflammatory fever, applied in a greater degree; as great heat, exceſſive exerciſe, a ſudden change from a poor to a rich diet.

The cure of this complaint requires the moſt prompt and deciſive meaſures. Blood muſt be taken in large quantities from the jugular vein or temporal artery. Not leſs than three quarts ſhould be taken from an ordinary horſe, ox, or cow; and if the animal is very large, four may be taken; and the bleeding muſt be repeated a few hours after, if the ſymptoms do not abate. When the beaſt is very furious, it is often dangerous to bleed in a very deliberate way; but as his recovery will almoſt certainly depend on a ſufficient loſs of blood in the early part of the diſeaſe, it will not be amiſs to bleed him in the manner deſcribed by Mr Blaine, as having been practiſed by an eminent veterinary ſurgeon, who being called to a horſe affected with ſtaggers, and in ſuch a ſtate of delirium that none of the ordinary precautions for ſecuring him could be adopted, plunged a lancet into each jugular, and permitted the animal to bleed till he fainted, by which means, though the diſeaſe was far advanced, he ſaved the horſe. After bleeding, a ſtimulant bliſter ſhould be applied to the top of the head, and the ſides of the neck ſhould be well rubbed with a mixture of powdered cantharides and oil of turpentine, and other means uſed to promote external inflammation, for the purpoſe of determining the blood from the head. Mr Coleman is ſaid to recommend in theſe caſes the pouring of boiling water on the paſterns, by which means bliſtering will ſpeedily be produced in thoſe parts. In deſperate caſes the determination of blood to the head may be moſt effectually ſtopped, by tying a ligature about one of the external carotid arteries; but in doing this great care muſt be taken not to include within the ligature the nerves that run near the artery, as theſe nerves are the principal branches that ſupply the ſtomach; and if they be included in the ligature, the functions of that organ will be in a great meaſure deſtroyed. In addition to theſe means coſtiveneſs muſt be carefully guarded againſt. After back-raking, a ſtimulating purging clyſter ſhould be injected as ſoon as poſſible, and if an interval of quiet will permit, a purging ball, ſuch as N° 15. may be given by the mouth. If the above means are adopted in proper time, the animal will generally be ſaved; but if ſome days have elapſed before vigorous ſteps are taken, there can be little hope of a cure.

Mr Downing, in his work on cattle-doctoring, mentioned in N° 87, adviſes a method of treating inflammation of the brain in cattle, that is extremely contradictory and inconſiſtent. He at firſt very properly adviſes bleeding; but he directs this to be followed by giving diapente, a very powerful cordial medicine, the adminiſtration of which completely counteracts the effects of the bleeding. *Dr* Downing deſcribes a fever of the brain

brain as distinct from inflammation; and he then treats of a sleepy fever. These are evidently symptomatic affections, and should have been given as such, as well as giddiness, or swimming in the head, which is described by *Dr* Downing " as a distemper belonging to the cavities of the eyes and optic nerves. It gives a wavering motion to the body. For if the optic nerve, or its expansion on the bottom of the eye called *retina*, be agitated by any preternatural heat or other emotion, objects will change their situation; therefore, this disease is a fever affecting the cavities of the eyes, or the optic nerves."

2. INFLAMMATION of the EYE. Ophthalmia Membranarum. *Moon-blindness.*

484 Inflammation of the eye.

Though in the human subject there are several species of ophthalmia, in the horse there is but one, which is in a great measure synonymous to what has been called *ophthalmia membranarum* by medical writers. This disease in the horse is of considerable importance, as it is not merely a local disease, but appears to be connected with some constitutional affection. Before we describe the symptoms and treatment of this complaint, it will be proper to remark, that in the eye of the horse there is a firm cartilaginous substance, situated at the inner corner of the eye, the greater part of which is hidden by the eyelids, but a small portion projects beyond them, and may be distinguished by its black colour. This is commonly called the *haw*, and by anatomists the *membrana nictitans*, and is supposed to be a production of the retractor muscle. Our reason for mentioning this part will appear immediately.

Inflammation of the eye sometimes makes its appearance very suddenly; at others it is gradual in its attack. In general, one of the earliest symptoms of it is a swelling of the eyelids, especially of the upper, which is with difficulty held open; the eyes water considerably, and drops of tears may be seen at the extremity of the lachrymal duct, which do not appear in the healthy state of the eye. The external transparent parts of the eye become discoloured and obscured, appearing of a blackish glassy hue; sometimes of a dull white, at others brown or bluish. Red vessels may be seen running over the white of the eye, especially at the corners, and sometimes reaching to the centre of the eye. The cornea is said to be most obscured on its upper part; but this is probably owing to the situation of the person who looks at the eye, who being below it, sees directly through the lower part of the cornea, and but obliquely through the upper. When the eyes are in this state, the horse is very impatient of light, and holds his head down to guard against it. The eyelids and ball of the eye are evidently much hotter than usual, and sometimes there may be seen through the cornea, a small quantity of thickish matter like *pus*, in the lower part of the anterior chamber of the eye. The cartilaginous membrane or *haw* is now much more visible, and projects forward considerably outward from the corner of the eye.

It not unfrequently happens, when the disease has not proceeded farther than we have described, that it gradually, sometimes pretty suddenly, disappears, and is seen again in the course of a few weeks, although sometimes it comes back in the course of a few days. The disappearance of inflammation in the eye of the horse is sometimes so sudden, that the eye, which one day is considerably inflamed, will appear the next perfectly clear and healthy. Sometimes it seems to appear and disappear periodically; and it has been supposed by ignorant people, that in these periods it follows the changes of the moon, whence it has received the name of *lunatic blindness*. If the disease does not thus disappear, or if it appears again, and reaches the height before described, the inflammation goes on, and the cornea becomes more obscure; or, what very frequently happens, the cornea recovers its transparency, and the crystalline humour becomes opaque, forming the disease already spoken of in N° 325.

In the horse, one eye frequently only is affected, whereas in man, both eyes are generally inflamed at the same time. This disease more frequently occurs in young horses of five or six years old, than in those of a more advanced period. It is said that horses are never affected with inflammation of the eyes till they are broken, or taken up from the pasture where they have remained from their birth.

A plethoric state of the body seems very much to predispose to inflammation of the eye, and this seems to account for its occurring so frequently in horses of five or six years old, as at that age they generally cease to grow, and are, of course, more disposed than at other times to fulness of blood. Sudden changes of temperature form a very common exciting cause of this disease, and the heat and foul air of a close stable frequently produce it. Such horses as are kept in dark stables are also more subject to it, from the effect of sudden exposure to broad day-light. Want of exercise, or extremes of idleness and hard work, may also assist in producing it. Mr Coleman considers this disease in the horse as an inflammation of a specific nature, very different from any that occurs in other animals. The principal reasons for supposing that the constitution is affected are, that a horse affected with an inflammation of the eye either does not perspire, or sweats profusely, indicating a slow fever. If the animal is bled or purged, the eye speedily becomes clear; and if the same causes are applied, the same eye, or more commonly the other, becomes inflamed, and sometimes the disease appears alternately in each eye.

Provided the proper means be taken in the early stage of the disease, the inflammation is commonly soon removed; but when the crystalline humour becomes opaque, no means hitherto employed have, as we shall presently see, produced any benefit.

In the treatment of this affection, it must be remembered, that the constitution is deranged, and that our remedies must therefore not be confined to local applications to the eye. General blood-letting will almost always be required; but, unless the horse is very fat or plethoric, this need not be repeated. It will be proper also to apply a blister or two to the head, as near the eye as possible, and the veins at the corners of the eye should be opened, to draw blood from that part. The horse must be put on lower diet, and should use only very moderate exercise; the stable should be kept well aired and cool; and if the horse's eyes are very sensible, and the stable happen to have windows, these should be darkened. It will generally be advisable to give a purgative medicine; and the horse may drink frequently of some cooling liquor, especially of water, with nitre dissolved in it. Rowels have been sometimes recommended; and it is said that considerable benefit has

Diseases. has followed the insertion of setons as near the eye as possible. They have sometimes been passed through the white of the eye, just below the transparent cornea; but to this we should object, as being liable to produce specks that may extend to the cornea. As there is generally considerable dryness of the skin in this complaint, it may be useful in some cases to administer a gentle sudorific, such as a solution of two drachms of emetic tartar, or N° 22. of the receipts may be given.

With respect to the applications to the eye itself, those which appear the most likely to be of advantage, are stimulating substances, such as tincture of opium, solution of blue vitriol, red precipitate in the form of a soft ointment, such as N° 40. Sometimes, however, these stimulating applications do harm; and it is found that a weak solution of sugar of lead, or acetate of zinc, as prescribed in N° 31. are most useful. We must here take notice of an absurd practice that is in use among common farriers, of cutting away the *haw*, which they consider as a very principal part of the complaint. There is no doubt, however, that relief may have been procured by this operation, as it will generally be attended with a pretty copious effusion of blood, that will relieve the distended vessels; but as this effusion can be more easily produced by scarifying the red vessels of the white of the eye; and, by opening the angular veins, there is no occasion to take away a part, which is certainly of considerable use to the animal.

Sheep are sometimes affected with inflammation of the eye; but in them, as in most other animals, it is merely a local disease, and is generally relieved by topical bleeding. In the corrected agricultural report of Perth, it is stated, that the common practice in that district for relieving inflammation in the eyes of sheep is, to open the veins in the corner of the eye, and hold down the animal's head, so as to allow the blood to get within the eye. There is no doubt that this bleeding does good; and the introduction of the blood within the eye may, we believe, also be of service; not, however, in the way supposed by the reporter, but because it acts as a gentle stimulus.

We have already, in N° 324. made some observations on cataract, and noticed the inefficacy of all the usual methods of treatment. It may not be improper here to add the result of Mr Coleman's experimental attempts to relieve this complaint, as stated by Mr Feron.

"The professor has begun with bleeding from the jugular or angular veins, and, at the same time, employing purgatives frequently repeated, as well as diuretics administered one after another. After which he has tried all the medicines of Messrs Phipps and Wathen, but without any degree of permanent success. The local and surgical treatment has been as follows, viz.

"1st, He has ordered scarifications, and to pass a seton through the membrana conjunctiva; but without effect.

"2dly, We have removed some of the larger vessels going to the cornea, and divided them with the actual cautery, but with no success.

"3dly, We have applied leeches to the conjunctiva, but without effect.

"Lastly, We have taken up both carotid arteries, which was of no avail, from the anastomoses, which the vertebral arteries form with them.

"Therefore, the treatment is confined entirely to bleeding, purging, and diuretics; fomentations of warm water, in order to diminish the irritation from the tears that run over the cheeks; and plenty of moderate and continual exercise, so as to increase the perspiration."

3. Catarrh. Catarrhus. *Mor Foundering*, or Common Cold.

485 Catarrh, or cold.

Catarrh has been placed by Dr Cullen among the *profluvia*, or fluxes attended with fever; we have ventured, with some modern authors, to rank it as an inflammation, because the increased secretion of mucus, which might entitle it to be called a *profluvium*, though sometimes pretty considerable, is not a constant, or often a very remarkable symptom of the disease; and in all cases appears to be the effect of an inflammatory state of the pituitary membrane. There are generally reckoned two species of catarrh, simple cold, and epidemic catarrh, or *influenza*. Though in the latter of these the catarrh is probably only symptomatic, we shall, in compliance with the usual custom, consider it immediately after common catarrh.

This disease attacks all the domestic animals; but horses and dogs are most liable to it, and in them the symptoms are most severe. It usually commences by a general dulness and heaviness, a dryness and increased redness of the inside of the nostrils, from which there soon proceeds an unusual secretion of mucus; a dryness of the eyes, or sometimes an increased effusion of tears. In a short time there is generally added some degree of cough and difficulty of breathing; and sometimes there is with these symptoms a considerable degree of heat and dryness of the skin; increased thirst, and not unfrequently a loss of appetite. At first the cough is dry, and sometimes continues so; but more frequently, when the complaint has remained for some time, a frothy whitish mucus is coughed up. The pulse is not always much affected in this disease; but in general it is fuller and harder than natural. The first symptom of the disease is not unfrequently a chilliness and trembling.

The principal causes of catarrh in domestic animals, as well as in man, are sudden changes of temperature, especially cold applied when the body is in a state of perspiration, or entering a warm apartment after having been long exposed to a cold air. Drinking cold water, when sweating, is also a common cause; and these causes are the more likely to produce their effect when the animal is in a plethoric state.

If neglected, catarrh may go on to inflammation of the lungs; in the horse it may produce thick wind, or even broken wind; in cattle it may end in chronic cough; and in sheep it may lay the foundation of consumption or pulmonic rot. It is also not unfrequently followed by the complaint called *glanders*, which we are presently to describe. An improper mode of treatment, especially giving cordials and other hot medicines, will hasten on these terminations of the disease. If attended to in time, and if the proper mode of treatment be adopted, the symptoms are, in general, soon removed.

If the complaint is slight, and there is little fever, it will often be sufficient to take the animal within doors into a warm stable, give him a warm mash, and put a cloth over him, when he will perspire through the night, Diseases. night, and be nearly well next morning. This plan will also answer, if it be adopted immediately, on perceiving the chilliness or shivering. If, however, considerable fever has taken place, and the animal's pulse is hard, it will be proper to draw blood, according to the urgency of the symptoms, before giving any internal remedy, or using warm clothing. After bleeding, a drench, composed of warm ale, with a drachm or two of salt of hartshorn, or half an ounce of spirit of hartshorn sweetened with molasses, will prove an excellent remedy; after taking which, the animal should be well rubbed down, and clothed as before. If the animal is costive, back-raking, followed by clysters, will be advisable; and throughout the treatment costiveness must be avoided. If there is considerable fever, the drench, N° 22. or 26. where costiveness is to be obviated, should be given every six hours. Some practitioners advise balls in these cases, as in most others; but as there is often some swelling of the throat, and always considerable irritation about the *fauces*, it is better to give the remedies in the form of drenches. The cough seldom needs particular attention during the inflammatory state of the disease, as it will generally go off when the inflammation is removed; if it should continue obstinate, it becomes a chronic cough, and must be treated as directed under N° 436.

4. *Influenza, or Epidemic Catarrh.*

486 Influenza. The epidemic catarrh also affects all these animals, and has sometimes been known to attack a whole yard of oxen, horses, and cows, in one night. It differs from common catarrh in the degree of fever, which, in this complaint, is always very considerable, and is one of the first symptoms. There is a smart shivering, followed by considerable heat and dryness of the skin, and the fever is commonly attended with great heaviness and pain of the head, and affection of the eyes. In this complaint there is also a great degree of weakness, which comes on pretty early in the disease, and this weakness not unfrequently brings on a fatal termination of the disease. Sometimes there is a considerable discharge from the nostrils; at others this discharge is either trifling, or the nostrils are dry, in which cases the fever is most considerable.

The epidemic catarrh appears to depend on some peculiar state of the atmosphere; but there is no doubt that it is capable of being propagated by contagion. It is more prevalent in the spring, especially when this has been preceded by a mild winter. It is said, that when cattle are at these times exposed to currents of air from the north-east, they are most likely to be affected with it.

In the commencement of this disease, it will be proper to house the animals; but too much warmth must be avoided, as it would tend to increase the weakness that forms a principal part of the disease. It may sometimes be necessary, when the fever runs very high, to draw blood once; and, at any rate, it will be proper to apply a blister to the head, or on each side the neck. Though warmth must be avoided, great care should be taken not to expose the animals to a draught of air. Warm mashes may be given as in common catarrh, but when the fever has subsided, cordials and strengthening remedies will be required; and if the appetite is tolerably good, the diet may be more nourishing than usual. The animals should on no account be hard worked, but be allowed to rest from the time the disease is first noticed, except taking gentle exercise when their strength will admit of it. Diseases.

What is commonly called the distemper in dogs is now pretty generally considered as a sort of epidemic or contagious catarrh. We shall therefore treat of it in this place.

5. *Of the* Distemper *in Dogs.*

No disorder is more general among dogs, than that which is generally known by the name of the *distemper*; and none is so destructive. It is asserted that, except the plague, no disease is so fatal to the animal which it attacks. 487 Distemper in dogs.

It appears that this disorder has not been known in Britain, till within the last 50 years, but, during that time, it is astonishing what numbers of dogs have fallen victims to it. For these last fifteen or twenty years, however, the distemper has been less frequent, and has assumed a milder form.

The symptoms of the distemper are not alike in every case. The following are, according to Mr Blaine, its usual appearances. It generally begins with a dry husky cough, attended with dulness and want of appetite, a running from the eyes and nose, and loss of flesh. As the disease advances, the dog appears much emaciated, and grows excessively weak, particularly in the loins and hind legs. Convulsive twitchings of different parts, especially of the head, come on, attended with dimness of sight; and, as the disease proceeds, and puts on a more virulent form, these twitchings degenerate into strong convulsive fits, which continue for a long time, and repeatedly return. In these fits, the dog foams at the mouth, runs round, and appears to be in great pain, and to have a constant desire to dung. This is sometimes attended with obstinate costiveness, at others with violent purging. The stomach is extremely irritable; every thing that the animal takes being immediately thrown up. When the disease has reached this state, the animal seldom recovers, and is usually carried off in one of the convulsive fits.

In every part of this disease there prevails a want of energy, and a particular paralytic affection of the nerves. This latter symptom, in some instances, remains long after the disease has been otherwise removed; but, in general, the strength returns almost immediately on the removal of the other symptoms.

The distemper in its worst form is often mistaken for canine madness; but they may in general be distinguished, by attending to the following points.

1st, The distemper seldom occurs except in puppies, its most common period being from six to twelve months. Madness may occur at any age, but seldom attacks puppies.

2d, In the distemper dogs drink freely; in madness, though they often attempt to drink, it does not appear that they are capable of swallowing the water.

3d, In the distemper the animal does not attempt to bite; but, in madness, the propensity to biting seems to be incessant.

4th, In madness there appears to be a loss of reason at all times, though, as is said, they are so sensible, as to know their master; but, in the distemper, though there is sometimes a loss of reason, it lasts no longer

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longer than during the continuance of the convulsive fits.

If, therefore, a young dog will drink, as soon as the effect of the convulsion is removed, but more particularly when his weakness is excessive, and strongly apparent in the intervals between the fits, it may be pretty safely concluded, that he is affected with the distemper, and not with madness. These circumstances, says Mr Blaine, should be carefully remarked, as they are unerring, and may save many a valuable animal from destruction, and many a timid mind from the most dreadful apprehensions.

The cause of the distemper is difficult to explain; nor do the most careful dissections, in every stage of the complaint, ascertain more than that there is a general inflammation of the mucous membrane; but whether the true seat of the disease is confined to that membrane, and all the other symptoms are the consequences of it, or are real affections of other parts, is an undecided point, although, it is certain that its first appearance is by an inflammation of the pituitary membrane, and which is one of most lasting, as well as constant symptoms. That this inflammation is given from the membrane of the nose, to the upper part of the gullet and wind-pipe, is evident by the swelling of the glands of the throat, the tenderness and dry cough; and that this inflammation extends from thence to the same membrane of the stomach and intestines, is equally so, producing vomiting, costiveness, or purging. It has generally, as we have said, been considered as a species of *catarrh*; but it has been suggested to us, by an ingenious friend, that, from several symptoms, as well as from its attacking dogs only once in their lives, it is more analogous to *pertussis*, or chincough, in the human subject.

With respect to the cure of the distemper, Mr Blaine's directions and remedies appear to have been tolerably successful. With the nature of his remedy we are unacquainted, but believe it to be a preparation of mercury. This medicine has been made known by extensively advertising it, and although certificates of its utility are numerous, they make no part of the advertisement, but are to be seen at Mr Boosey's, in Old Bond Street, London, the wholesale agent; the form is a powder. Explicit instructions accompany it; and the price, considered with its asserted efficacy, bears no proportion, as no sportsman would think five times the sum too much for the preservation of a valuable animal. Although so efficacious, it is nevertheless innocent enough for a child to take; nor must those who are advocates for strong remedies imagine, that, because the effects of this shake not the whole constitution, that the disease will not be eradicated by it. When the disorder is strong, after it is given, there is for the most part a gradual decrease of the symptoms, and nothing but a small moisture at the nose remains, which speedily disappears the next day. If the attack is slight, no more is seen of it, and the animal is at once well.

From the varieties in the size, and consequent strength of dogs, a difference in the quantity of the medicine is necessary; the packets are therefore marked 1, 2, and 3. For a mastiff, pointer, setter, or dog of a large size, No. 1. should be procured. Hounds, spaniels, and those of a middling size, require No. 2.; and all the lesser dogs, No. 3.

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It has been already observed, that, in the severity of the disorder, there is frequently so great an irritability of the stomach, that every thing taken into it is instantly thrown up; in such cases, the powder should be carefully mixed with a small piece of butter, at the same time adding to it thirty, forty, or fifty drops of laudanum, according to the age, size, and strength of the dog; who is to be watched, whether the medicine is retained, and kept as still as possible; but should it be thrown up, notwithstanding this addition, in two hours after the same quantity of laudanum should be given without the powder, in a little broth or milk, and half an hour afterwards the powder mixed into a paste with treacle, honey, or flour, and thus the vomiting will be prevented. Should there be at the same time obstinate costiveness, it is probable that sickness may be the consequence of it, and must be removed before it will cease; twenty grains of jalap, or, in preference, fifteen grains of calomel, with four or five drops of laudanum, may be given in a small ball; or two table-spoonfuls of castor oil may, if more convenient, be used. Should these not stay on the stomach, a clyster with milk, salt, and oil, seldom fails to remove the costiveness, after which the powder should be given, if there has been great sickness, with the laudanum; if not, without it.

When, likewise, extensive purging accompanies the complaint, the laudanum should not be omitted; as by running off rapidly by stool, the effect of the medicine is equally lost, as if it were vomited up. In such case it will be proper to give before the powder thirty or forty drops of laudanum, with two ounces of olive oil. We should always attempt to remove the sickness and purging, or costiveness, before administering the powder, as the effect of this will be then more certain. In the milder form of the disease, however, nothing is requisite but to give the powder in such a way, as that the dog may take the whole of it; for which purpose the powder should be well mixed with a small quantity of any thing that the dog will eat, or, if he is averse to eating, it should be made up into a small ball with honey, treacle, or butter, and forced down his throat. It must not be mixed with any liquid, as it is so heavy that it would fall to the bottom, and thus will probably be lost. Care should be taken to give the medicine on an empty stomach, as the effect will otherwise be lessened or destroyed; and the dog should be carefully watched to see if the medicine be thrown up, as, if this is the case, or if there is reason to suppose that the whole dose is not given, a second should be administered. Mr Blaine concludes with observing, that the symptoms remove without any particular appearance; yet so quickly, as that there is seldom any remains of the disease two hours after the medicines have been administered.

Mr Daniel has witnessed the extraordinary effects in the distemper, from Dr James's powder, given in the following manner. When the symptoms of the distemper are apparent, a third part of one of the parcels inclosed in the half-crown packets is to be given, mixed with a little butter, and the dog is to have plenty of warm broth, or milk and water, and, if possible, he is to be near a fire, or at least kept very warm. Two hours afterwards another third part is to be administered; and, should neither of these operate by vomiting or purging,

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at the end of four hours, give the remaining third. Should the two first portions have the effect, the remaining third should not be given until four or six hours (according to the evacuations) after the expiration of the four hours; in the interim the dog is to be encouraged to lap, and if he refuses, be forced to take plentifully of warm broth, or milk and water. Very seldom, even when the case is inveterate, but the evacuations are brought on by the taking of one packet, generally by the second dose; but should it so happen that there is no such proof of the powder's effect, the second parcel should be divided into similar proportions, and applied in the same manner, until the stomach is emptied. Warmth and warm liquids will quickly perfect the recovery. As soon as the dog's appetite returns, let him be fed (at first rather sparingly) with animal food *.

* *Daniel's Rural Sports.* vol. i.

Dr Darwin advises, that the dog be permitted to go about freely in the open air, and have constant access to fresh water. The use of being as much as may be in the air is evident, because all the air which we breathe passes twice over the putrid sloughs of the mortified parts of the membrane which lines the nostrils, and the maxillary and frontal cavities; that is, both during inspiration and expiration, and must therefore be loaded with contagious particles. Fresh new milk and fresh broth should be given them very frequently, and they should be suffered to go amongst the grass, which they sometimes eat for the purpose of an emetic, and, if possible, should have access to a running stream of water, as the contagious mucus of the nostrils, both of these animals and horses, generally drops into the water when they attempt to drink. Bits of raw flesh, if the dog will eat them, are preferred to cooked meat; and from five to ten drops of opium may be given with advantage, when symptoms of debility are evident, according to the size of the dog, every six hours. If sloughs can be seen in the nostrils, they should be moistened twice a day, with a solution of sugar of lead, or of alum, by means of a sponge fixed on a bit of whalebone, or by a syringe. The lotion may be made by dissolving half an ounce of sugar of lead in a pint of water *.

* *Darwin's Zoonomia*, v. ii. 4to.

438 Rheumatism.

6. Rheumatism.

There seems no doubt that horses, and perhaps cattle, are affected with rheumatism, but it is sometimes difficult to ascertain the presence of the complaint, or to distinguish it from other causes that produce lameness. It may take place in any of the limbs, but it is more frequently observed to affect the hip-joint and the adjacent membranes; and when seated here, it is called the *sciatica*, and sometimes the *hip-gout*. It will require considerable judgment to distinguish this complaint; but it may generally be known by attentively examining the limb in which the lameness is seated, from the hip down to the foot, and by attending to the causes that seem likely to have produced the lameness. In rheumatism the skin will be found dry, and the affected part swelled, and the lameness attendant on it will be more readily removed by exercise than that which has its cause seated in the foot, or which arises from bony excrescences. Rheumatism in the horse, as in the human subject, may be either acute or chronic, and the latter is the most obstinate.

Rheumatism, like catarrh, is produced by sudden changes of temperature, and by exposure to a cold moist atmosphere. It is no otherwise dangerous than as it renders the animal lame.

The cure of rheumatism differs according to its state. In the acute one bleeding may be proper; after which a warm mash, with two drachms of emetic tartar dissolved in the water, should be given, and the horse treated as directed under catarrh. If a sweat is produced, and kept up for some hours, the complaint will probably disappear, and its return may be prevented by frequent friction of the affected part, regular exercise, a nourishing diet, and attention to avoid changes of temperature. In the chronic rheumatism, bleeding will be improper; and the most likely means of relief will be, to rub the affected parts several times a day with some stimulating liniment, or, if convenient, to use the warm bath for a considerable time together, or to foment the affected limb for an hour or two every night, after which the limb must be rubbed perfectly dry. Pretty constant exercise will also contribute greatly to the cure, and costiveness must be avoided. A blister applied over the affected part will sometimes do good. According to Mr Lawrence, the only cure to be depended on is a month's run of salt marshes in the spring, and being continued abroad in some shady place till autumn, afterwards mercurial physic, and the best stable care.

7. Inflammation of the Lungs. Pleuritis. Peripneumonia. *Pleurisy. Peripneumony. Rising of the Lights. Rot.*

489 Inflammation of the lungs.

The lungs are frequently inflamed in the domestic animals; and, as in man, the inflammation may be seated either in the membrane covering the lungs and lining the chest, or the *pleura*, or in the substance of the lungs, constituting the two varieties, *pleurisy* and *peripneumony*. The disease has been called by common farriers, *rising of the lights*, from an idea that the lungs protruded against the throat, and caused that difficulty of breathing which is one of the principal symptoms of this complaint. The other vulgar appellation of *rot* seems to owe its origin to the appearance which the lungs sometimes present on dissection, being found in a state of mortification, and partial decomposition, as if they were rotten. It is of little consequence to distinguish the two varieties of the disease, as the treatment is the same in both.

According to Mr Feron, the symptoms of inflammation of the lungs in the horse are invariably as follow. The respiration is quick, the breath hot, the extremities cold, the tongue dry and hot, the flanks heaving, the patient never lying down, which forms a very characteristic symptom; and sometimes he hangs down his head. If nothing has been done, it is hardly possible to save his life, after three days have elapsed; and, after death, the right side of the heart is found to have been inflamed, and, on some occasions, so much distended with blood as actually to burst, and the lungs are found to resemble putrid liver, the cells filled with blood, from the great distension of the pulmonary arteries, and perhaps sometimes effusions take place; the pulse is oppressed, from the great distension occasioned by the blood in the right side of the heart, while the left side of that organ is weak, from want of sufficient blood.

To Mr Feron's account it may be added, that the pulse, Diseases. pulse, at the commencement of the disease, is generally more full, harder, and more frequent than natural; but, as soon as the disease reaches the stage at which it is usually first observed, the pulse has become small and oppressed, and but little increased in frequency; the veins of the neck are swelled and prominent, and the eyes are generally red and starting. There is sometimes cough, at others none; but the difficulty of breathing is always great, and the horse stands extended, panting for breath, with heaving flanks and open nostrils, till, no longer able to support himself, he drops down and dies. This fatal termination sometimes takes place in a very short period; in 48, 36, or even 24 hours.

The only disease with which this can easily be confounded, is colic; and the discriminating marks will be mentioned when we treat of this disease. At present it will be sufficient to remark, that when a horse appears dull, holds his head very low, breathes with difficulty, especially during inspiration, stands constantly, has a quick heaving of the flanks, a fullness of the eyes, and redness of the inside of the nostrils, and when the pulse is small and oppressed, he may almost certainly be declared affected with inflammation of the lungs.

It may not be improper to give a brief explanation of the symptoms which we have enumerated; and they are chiefly to be explained from the difficulty with which the blood passes through the lungs, on account of the unusual accumulation in the pulmonary vessels. Hence the difficulty of breathing, and the aversion that the horse expresses to lie down; for it is evident, that he will breathe more easily in a standing posture than if he were lying; because, as was remarked in the table of the extremities of the muscles, some of these act on the chest when the fore legs are fixed, and thus assist in carrying forward the ribs, and thus increasing the cavity of the chest. The impeded passage of the blood through the lungs also explains why the pulse is weak and oppressed; and hence, when this obstruction is relieved by lessening the quantity of blood, the pulse never fails to become stronger and fuller.

The causes of inflammation of the lungs are doubtless sudden changes of temperature, especially when the animal is plethoric; it is probable that the most common cause is a sudden change from heat to cold and moisture. It is at present, however, more fashionable to consider the reverse of this as the general cause of pulmonary complaints; and we understand that Mr Coleman goes so far as to say, that horses are never attacked with inflammation of the lungs from exposure to simple cold, for, that the turning of horses to grass without preparation, though it may render them emaciated, seldom produces the complaint in question. Mr Feron also, who may be considered as a pupil of the veterinary college, is of opinion, that inflammation of the internal viscera proceeds from a sudden transition from a cold to a hot temperature, but seldom or never from a hot to a cold one. We are aware that these gentlemen have borrowed their theory from Dr Beddoes, and it is of little consequence to our present purpose, whether it be correct or not.

The judgment to be formed with respect to the termination of this disease, which is always highly dangerous, will depend on the urgency of the symptoms, and on the changes that take place after the exhibition of the usual remedies. If the pulse becomes fuller and stronger after bleeding; if the breathing becomes less difficult; if the parts where blisters have been laid inflame soon, and the blisters rise well; and, in particular, if the horse lies down, and seems less distressed, we may hope that the danger is lessened; and if these favourable signs continue for 24 hours, we may consider a cure as pretty certain: but, if the pulse still continues small and oppressed, more especially, if it becomes quick and irregular; if the difficulty of breathing continues or increases; if there is a rattling in the throat, with partial cold sweats and extreme dejection; a fatal termination must be looked for, which will speedily take place, if the breath becomes cold or fetid. It is considered as a very unfavourable symptom when the horse appears insensible to external stimuli; as when blisters do not rise well, nor rowels easily suppurate.

In the cure of inflammation of the lungs, every thing will depend on the speedy adoption of the most vigorous measures, and the first and principal remedy is bleeding. This should be performed as soon as possible, and to a greater extent than in most inflammatory diseases. It will scarcely be proper to take less than five or perhaps six quarts at first, and the bleeding must be repeated, though less copiously, some hours after, if a considerable remission of the symptoms does not take place. It must not be expected that the pulse will rise much after a second or third bleeding; but, if it is not considerably weakened, and if the oppressed feel of it is removed, we may be sure that the bleeding has not been carried too far. Another principal means of checking the internal inflammation is, to excite an inflammation externally near the seat of the complaint, by every means in our power. A large blister should be applied on each side of the chest, and to the inside of the fore legs; a rowel should be inserted below the chest, and if the symptoms are very urgent, another near the belly. Mr Coleman recommends inflating the cellular membrane below the skin with air, so as to bring on an inflammation between the skin and muscles; and if this does not succeed, he advises that some stimulating fluid, such as oil of turpentine, be injected. We should suppose this carrying inflammation rather too near the lungs; but from some trials that Mr Coleman has made, and some others of Mr Feron, this method seems to have been attended with considerable advantage. In addition to these means, the fore legs should be well rubbed two or three times a day with oil of turpentine, or the liniment in No. 42. of the receipts. These are the external means that are chiefly to be relied on; and if these be followed up speedily, and with proper attention, there will seldom be any occasion for internal remedies. If these be given, they must be such as are calculated to cool the body, and check inflammation, such as the drenches No. 22. and 26. especially the latter, as it is necessary to keep the bowels open. Perhaps foxglove might here be given with advantage, as directed under that article, at 290. Mr Feron recommends diuretics, and a ball composed of *an ounce and half* of emetic tartar, a drachm of opium, and 15 or 20 grains of calomel. We do not know whether this is the practice of the veterinary college, but it appears to us to be inconsistent with the bleeding and other evacuants which are generally found most successful. As costiveness would tend to increase the inflammatory symptoms, back-raking and the occasional use of mild clysters, Diseases. clysters, will be requisite. In general, warm water, or this with a little Glauber salt dissolved in it, will be sufficient, as all heating purgatives would do harm. The horse should be kept rather warm, should be clothed, and should drink frequently of warm gruel. Food will not be requisite, and, if set before him, he would probably not touch it. Exercise of every kind must be avoided, at least so long as the inflammatory symptoms continue.

The most favourable termination of this complaint is by resolution, when the inflammatory symptoms go off without producing suppuration or ulceration of the lungs; but sometimes this state is unavoidable, an ulcer is produced, and, if the matter is not thrown off, it may either produce suffocation, or bring on hectic fever and consumption. When it is found that a cough remains after the inflammation has subsided, and a quantity of mucus is thrown off, the evacuation of this should be promoted by gentle expectorants, and the horse must still be kept warm. Though the matter may be completely expectorated, there will generally remain a difficulty of breathing, or thick wind, when inflammation of the lungs terminates by suppuration. Sometimes there is left an anasarcous or dropsical state of the lungs, and in these cases it is said that blue vitriol and turpentine, to the amount of two drachms of each, mixed into a ball, with a proper quantity of linseed powder, and given every morning, have been beneficial. It may also be proper to apply a blister over the wind-pipe.

Inflammation of the lungs in cattle differs little in symptoms, and nothing in the treatment, from that which we have been describing in the horse.

490 Pulmonic rot in sheep. The lungs of sheep are very frequently affected with inflammation, which forms one of the diseases that has been confounded under the name of *rot*. It most frequently attacks young sheep, especially those of the more delicate breeds; and it is most prevalent in damp pastures, and during unfavourable seasons. The symptoms of this disease in sheep have not been well described, but they probably differ from those in horses and cattle, only in degree. It does not appear to be so speedily fatal, although the animals seldom or never recover from it. Towards the latter stage of the disease there is considerable weakness; and at this time there appears below the jaw an œdematous swelling, containing a quantity of fluid, which is easily evacuated by piercing the tumour. This tumour is called the *pock* in Scotland. On opening the bodies of sheep that have died of this species of rot, the lungs are found full of knots or tubercles, similar to those which appear in human subjects that have died of pulmonary consumption, and sometimes the lungs appear mortified or rotten. The liver, however, in these cases is found, which distinguishes this variety from the other diseases called *rot*.

We do not know that this disease admits of a cure in sheep, though it might probably be prevented by housing them, or affording them shelter, at those seasons when it is most likely to occur.

491 Pleurisy in dogs. Inflammation of the lungs occurs sometimes in dogs, but it does not seem to be very frequent in these animals. It requires pretty much the same treatment as in the horse, except that here emetic tartar may be given in such a quantity as to excite considerable sickness, without vomiting. This would be improper in the horse, as it would be difficult to regulate the dose of the medicine, so as not to produce such an irritation of the stomach as might considerably increase the animal's distress, and augment the difficulty of breathing.

8. Inflammation of the Liver. Hepatitis.

We have no doubt that inflammation of the liver takes place occasionally in most of our domestic animals; and it is probably a more frequent disease than is generally supposed. Both species of it, viz. the acute and chronic, may appear in these animals, and it will appear presently, that the latter is a very common disease among sheep. Though dissection has clearly shewn, that the liver in cows, horses, and sheep, has been affected with inflammation during the life of the animal, yet any account of the symptoms of this disease that is given us by the veterinary writers, is so obscure, that we cannot pretend to give any thing like a perspicuous history. 492 Inflammation of the liver.

According to Mr Blaine, this disease, considered as a distinct affection, is seldom met with in the horse, though, when great abdominal inflammation exists, the liver often partakes of the general disease. In the description of the symptoms, this author states that it is usually accompanied with costiveness, for the gland ceases to secrete the bile from its being in an inflamed state; and that bile which was secreted, is not poured into the intestines, but becomes deposited in the skin, producing jaundice, which is known by the yellowness of the eyes and the tongue. The pulse is generally full, hard, and frequent, but the pain not very intense. It would be difficult to detect it, unless by the symptoms of fever, accompanied with yellowness of the mouth and eyes. There would *possibly* be pain in the shoulder as in the human, in which case the horse might on trial be found lame.

It is easy to see, that this description is a fanciful picture of the disease, drawn from the analogy that the author supposes to exist between inflammation of the liver in man and the same disease in horses; and it is probably not to be depended upon.

The writers on cattle medicine describe the symptoms of the disease in cattle to be a difficulty of breathing, evident marks of fever, yellowness of urine, a swelling about the short ribs, and an unusual distension about the barren or womb. Here the symptoms of an acute and chronic distemper seem to be confounded.

As for the symptoms of the disease in sheep, in whom it forms one of the varieties of *rot*, we have seen no account of them any further than as they are confounded with those of the other varieties of rot, and, as such, they will be noticed when we come to treat of the rot in general. If this disease could be detected in its acute state, the cure would probably not be difficult; but when it appears in the chronic form, it is, we believe, seldom removed. 493 Hepatic rot in sheep.

When the bodies of such animals as have died of inflammation of the liver are opened, the liver has been found in various states of disease; sometimes it is harder and firmer than usual, and very frequently there are parts of it that are scirrhous and discoloured, resisting the knife when we attempt to cut through them. Sometimes the biliary ducts are almost bony, and there is commonly found in them, and sometimes in other parts of the liver, a species of worm called *fluke*; the *fasciola hepatica* 494

Diseases. *hepatica* of naturalists. Sometimes there are ulcers or abscesses formed in the liver, and frequently, especially in sheep, this organ is mortified or decayed.

495 The causes of this disease are very obscure; in horses and cattle it is said to be most common in hot seasons and warm climates, and that such of these animals as are fat are more exposed to its attacks. It may also be brought on by blows or bruises on the short ribs, by which the liver may have received some injury. In sheep it is said to be more common in dry weather, especially when the animals have but a scanty supply of food, and when they are of a costive habit. It is supposed by many, that this species of rot owes its origin to the flukes that we have described, as found in the liver after death; but, as these flukes have been found in the livers of sheep that had never been apparently affected with the rot, and, as they are frequently found in the livers of old sheep, this cause is probably rather fanciful; though when these animals are very numerous, or when they are situated in a very sensible part of the liver, they may excite a degree of irritation, and consequent inflammation, just as a great quantity of bots in the stomach of horses have been found to bring on inflammation of that organ.

In attempting the cure of this disease, when it is ascertained to be present, we must consider whether it is acute or chronic. When it occurs from injuries, it will probably be of the former kind, but in most other cases it will be chronic. Acute inflammation will require bleeding, purging, blisters, and low diet, as in all other cases of internal inflammation; but, in chronic hepatitis, the most likely remedy is mercury, which may be administered either internally, in the form of calomel or corrosive sublimate, or externally rubbed into the skin on some parts of the animal's body. This mercurial friction may be performed with tolerable ease on the sheep, by pulling off the wool from the inside of the thighs, and rubbing a drachm or two of the strongest mercurial ointment upon these parts every night, till the general system becomes affected, which may be known by the swelling of the gums, offensiveness of the breath, and increased flow of saliva from the mouth. This, however, would be an expensive and tedious cure; and if many of the flock appear affected, it would be better to kill them as fast as possible, before the disease has made such a progress as to render the animals lean. If a mercurial course should be attempted, the animals should be housed during the course, and should be kept on good nourishing food. Costiveness must be avoided in all these cases, by the administration of gentle clysters, or occasional doses of opening physic. A very good medicine, in all cases of liver complaints, is a ball composed of calomel and soap, as directed under jaundice, N°

9. Inflammation of the Stomach. Gastritis.

496 Inflammation of the stomach. The stomach may be inflamed, both in horses and cattle, from various causes; but this is a disease, the existence of which is not easily detected. Here also Mr Blaine has supplied the want of observed symptoms by analogy, and has supposed that there would *probably* be unsuccessful efforts to vomit; and, as the stomach is so essential an organ, the pulse would *probably* be affected even more than in inflammation of the bowels; that the animal would perhaps point to the left side about the tenth or eleventh rib; that there would be great distress evident in the countenance and manner, and that the loss of strength would be very great.

In cattle there are generally reckoned two species of inflammation of the stomach, one affecting the first stomach or paunch, and the other the third stomach or the manyplies. This latter is commonly denominated *lake-burn*. The symptoms of the disease in these animals are also very obscure, but they are probably similar to what have been described above.

If the reader looks back to N° 409. he will see detailed, a case that occurred to Mr Clark, in which inflammation of the stomach was observed, and detected after death; and though the symptoms there described are few, they are *probably* more characteristic of the disease in question, than any imaginary description which we can copy from writers who have never seen the complaint.

This disease is extremely dangerous, and will not admit of a cure, unless effectual means are taken at its commencement.

Inflammation of the stomach is commonly produced by some acrid irritating substance which the animal has swallowed, and this is the effect produced by most poisons. A large quantity of cold water drunk while the animal is in a violent perspiration, will also produce it. It not unfrequently accompanies inflammation of the bowels, which we are immediately to describe. It is said to be sometimes produced in cattle by the giving of too strong a dose of astringent medicines to cure the red water or bloody urine; and as we have seen in N° 409. it may sometimes be occasioned by bots.

The disease can only be cured by very copious bleeding, frequently repeated; by giving mucilaginous drinks, such as water gruel or linseed tea, applying a large blister just behind the short ribs, and the frequent administration of relaxing clysters. If poison has been swallowed, we must proceed as recommended under N° 407. though in most cases of inflammation of the stomach, it will be the most humane plan to effect a radical cure by shooting the animal through the head, or cutting his throat.

10. Inflammation of the Bowels. Enteritis. *Red Colic. Inflammatory Colic. Dry Braxy in Sheep.* Tranchée Inflammatoire ou Rouge, Fr.

This is a disease, to which all the domestic animals are subject, but it is attended with somewhat different symptoms, in the several species. 497 Inflammation of the bowels.

It is generally preceded by more or less fever. In horses, the first remarkable symptoms that appear, are a great degree of restlessness, with loss of appetite, thirst, with considerable heat, and dryness of the mouth. The animal evidently labours under violent pain, and is perpetually lying down and getting up again, scraping and stamping with his feet, with which he sometimes strikes his belly. When the belly is touched with the hand, the horse betrays extreme sensibility, and shrinks from the touch. The pulse is always increased in frequency, and is hard, giving the sensation of a cord below the finger. The skin feels unusually hot, all over the body, except at the ears, which are said to be cold. The tongue is commonly covered with a white fur. Costiveness is almost a constant symptom of this disease, and till

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till the inflammation is subdued, this continues very obstinate, or, if the animal dungs, it is in very small quantity, and the excrement is very hard. The urine is voided in very small quantities, and with great pain, especially towards the latter period of the disease. The symptoms go on with more or less rapidity, till the inflammation is subdued by the proper remedies, or till it terminate in the death of the horse.

Returning health may be expected when the heat of the body gradually lessens, while the pulse becomes full, regular, and of the natural frequency, when the horse dungs freely, and returns to his usual appetite, and cheerfulness. But when there appears a sudden relief from pain, with a soft, feeble, or irregular pulse, and a purging of offensive black matter comes on, mortification of the bowels has taken place, and the horse will expire in a few hours.

On opening the body, evident marks of high inflammation appear in many parts of the bowels, the outer or membranous and muscular coats of which will be found red, and in some parts black. The inflammation is frequently found to have extended to other parts, as the stomach, liver, or bladder; to some of which the guts will be frequently found adhering. On opening into the cavity of the bowels, these will be found greatly distended with air, and the great guts loaded with hardened excrement; and sometimes the inner membrane will appear highly inflamed, or even corroded, shewing evident marks of its having suffered considerable irritation, from some acrid substance.

Inflammation of the bowels is distinguished from colic, by the frequency and cord-like feeling of the pulse, by the presence of fever, by the tenderness of the belly, and by there being little or no remission of the pain. It is said that in colic the horse rolls much on his back, but is not so apt to do this in inflammation of the bowels. It will be seen by and by, that a long protracted colic frequently terminates in inflammation.

Inflammation of the bowels may be produced by acrid or poisonous substances taken into the stomach. It has been sometimes produced by giving hellebore to horses, as a purge; and it is said to arise sometimes from giving purgatives at improper times, or in too large a dose. It is very commonly brought on by giving the horse cold water, when he is much fatigued, and so much overheated, as to be in a profuse sweat, or by dashing cold water upon him, by wading in cold water, or by standing in a draught of cold air, under similar circumstances of fatigue and sweating. Costiveness too long neglected, or entangled rupture, is also not an uncommon cause.

In the treatment of the inflammation of the bowels, as in all other internal inflammations, we must begin with copious and repeated bloodletting, after which a free evacuation of the bowels must be attempted by back-raking and the injection of softening clysters, such as warm water-gruel, mixed with half an English pint of castor oil. All acrid clysters must be avoided, as they will only tend to increase the inflammatory affection of the bowels, and even Glauber salts and other saline purgatives are scarcely proper, from the irritation they may produce. After bleeding and evacuating the bowels, warm fomentations applied to the belly may be of service, and the cloths should be applied as hot as possible. After the fomentation, the belly may be rubbed with some stimulating liniment, such as oil of turpentine, or essence of mustard. Firing has been recommended below the belly, as also frequent friction with the curry-comb, so as to irritate the skin, and almost make it bleed. Probably no medicine should be given by the mouth, farther than softening, diluting drinks, such as warm water-gruel or linseed tea. Food at the beginning of the disease is out of the question; but when the inflammation is a little relieved, the horse may have a bran mash. The body should be kept warm by clothing, and all exercise should be avoided.

Inflammation of the bowels in sheep is called *dry braxy* in Scotland, and of this disease we have an excellent account in Mr Findlater's survey of Peebles.

498 Dry braxy in sheep.

This disease is most fatal to young and robust sheep about six or seven months old, called in many parts of the island, *hogs*. It is more destructive upon some farms than others; and even upon these, in one season more than another. In a *hog fence*, or pasture capable of keeping 30 score of hogs, there is in some years, a loss from three to four score. This is a very serious matter, as each of these would sell in the spring, or beginning of summer, for half a guinea or 11s. This disease begins at those times when inflammatory disorders are most apt to prevail, in the months of October and November, and is produced by the common causes of inflammation, cold, exertion, external injury, &c. During these months, slight frosts set in, and the ground in the morning is often covered with hoar frost, or what is called in some parts of Scotland *rhine*. It is probable, that eating grass covered with hoar frost, may be one cause of the disorder. If so, moving the animals about, and preventing them from eating, until the frost is melted by the sun, may tend to prevent the disease.

This disease runs its course very rapidly. When the shepherd leaves his flock at night upon their laires, he sometimes observes a hog look dull, loitering behind, and restless; sometimes lying down and suddenly getting up again: and in the morning, he will often find it dead, or nearly so. At other times he will discover no apparent ailment among his flock; and in the morning, he may find one or two dead or dying. From this it appears that the disease is very acute.

This is further evinced by the appearances after death, when the carcases are opened. Their bellies are excessively swelled, and distended with a putrid air: the whole intestines being red and inflamed, gangrenous, and in some degree mortified. This putrid taint seems to be communicated to the whole carcase, as all the muscular parts, and fat, smell strongly of corruption. The hogs that die of this disease, are frequently fat and in good order, which shows that the disease is of short duration.

We have already mentioned the eating of grass, which is covered with hoar frost, as a very probable immediate cause of this disorder. But is there any predisposing cause?

In answer to this question, we shall adduce a fact which is well authenticated. Many parts of the western highlands of Scotland, had been for ages occupied by horses and horned cattle. At the introduction of sheep into those districts, the best grass was that which had sprung from the tath and excrements of these animals. During many years after these districts were converted into sheep farms, braxy remained unknown. It crept in

Diseases. in at last, and the severity of the disease was long in proportion to the length of time the pastures had been occupied by sheep.

From these we would infer that pasturing upon their own tath, is a predisposing cause of braxy among sheep; and that a frequent alteration of the species of stock, upon every sheep pasture, might serve to prevent the evil. This idea corresponds with the general laws of the Supreme Being, who certainly never intended that this earth should be monopolized by any particular species of animals; but has so ordered matters, that the happiness of individuals shall result from the happiness of the whole family of animated beings.

Hence it would appear a beneficial practice in store farmers, in place of one fence, to keep two or more enclosures of this description, and change the stock upon them every season. This we know to be contrary to general practice, and that what is called the hogs fence, is carefully guarded against the intrusion of every other animal.

Lambs, immediately after they are weaned are frequently sent to poor pasture, which is called *burning* them. Now this appears to be a very bad practice; for the consequence is, that they fall off considerably, before they get at the rich grass in the hog's fence, of which they eat too freely; and thus become disposed to the disease treated of. Children, and all domesticated animals, are carefully fed with nourishing food for a considerable time after they are weaned; and yet they fall off for some time. It would certainly be better to give the lambs the hogs fence at once, and use every precaution to prevent them from falling off.

As the disease is generally advanced to a dangerous height before it is observed, we fear that medicine affords but a very faint hope of cure. The disease being inflammatory, the shepherd should attempt to bleed the distressed creature as soon as possible; which he can easily do, by cutting off part of the tail, or by nicking it underneath, or by cutting off part of the ears. The animal should then be removed to a house or shed, and attempts made to produce evacuations. In brute animals, it is difficult to produce these by medicines administered by the mouth. The speediest and most effectual method, is by injections into the rectum or anus. Such injection may consist of a small handful of chamomile flowers, two spoonfuls of anisefeeds, and as much carraway seeds; to be boiled slowly in a Scotch mutchkin or English pint of milk and water, until the half is evaporated. The liquor should then be strained off, and two tea spoonfuls of castor oil added, or if this is not at hand, the same quantity of sweet oil may be used. This should be administered warm by an injection bag and pipe, or by an elastic gum bottle with a pipe properly fitted. Nothing can be easier, than to give a sheep a clyster in this way; and in all probability it will have a happy effect in evacuating the bowels and procuring relief.

If this does not appear very soon, it may be repeated an hour after, and a large spoonful of common salt added to the former ingredients. If, after all, the animal does not seem relieved, another clyster may be given, consisting of a small tea cupful of warm milk and water, to which are added from 20 to 25 drops of laudanum.

As there is a great distension of the stomach and bowels, arising from airs or elastic vapours, generated in the intestines, Mr Walker of Cumberland, in a treatise he wrote upon the diseases of brute animals, has suggested a remedy for this disorder, which has often proved successful in his district. It consists in pushing down their throats a flexible tube, such as Dr Monro has recommended, and which has proved successful in relieving cows that had over gorged themselves with red clover early in the season (see N° 405.). This seems a probable means of affording temporary relief, and every shepherd that has the care of the hog flock, should be furnished with one of these tubes, adapted to the size of the sheep, for trying the experiment upon those that labour under the disease.

"In regard to the quality of pasture (adds Mr Findlater) as a cause of *sickness*, Tweeddale farmers seem of opinion that it arises from the *foulness of the grass* at the root in the hogs fences, which are never eaten bare. Some, therefore, take care to have the land to be saved for the hog fence, once eaten as bare as possible early in summer, by the black cattle upon the farm, or by old sheep.

"It seems ascertained in Tweeddale, that land which has been in use to be pastured by older sheep, when converted into a hog fence, is not liable for some time to produce sickness. Two accidental experiments occurring in which this practice took place, in consequence of new arrangements in the farms of Harehop in Eddlestone parish, and of Lyne in Lyne parish, confirm this conclusion. It is farther confirmed by an experiment of Mr Murray, tenant in Flemington mill. About 20 years ago, he bought in different parcels of lambs for hogs, and laid them upon the hog fence of his hog farm of Broughton-haup, in Broughton parish. In one of the parcels of much higher condition than the rest, the sickness broke out to such extent, that they were dying at the rate of two or three daily; so that the whole parcel seemed in imminent risk. He transferred this whole parcel to the farm of Fingland in Newlands parish, where only old sheep were kept, putting them on some of the lower pasture of that farm, which had been hained for feeding the crock ewes, and transferring a proportional quantity of these ewes to Broughton-haup hog fence. Not one of the lambs died upon Fingland. To the same effect, it deserves attention, that in small farms, not admitting of distinct hirsling, where, of course, old and young sheep pasture mixed together, hogs are very little liable to sickness, though perhaps worse in other respects.

"From November at smearing time till Christmas (1797) two facts with regard to the mode of cure have been stated to me, and which I am disposed to think authentic. In the farm of Drummelzier, parish of Drummelzier, three hogs (out of four upon which the experiment was tried) recovered, upon bleeding, and having poured down their throats, a decoction of tobacco; about a finger's length of twist tobacco boiled in water till the water has diminished to a gill, being the dose for each. In the farm of Broughton-haup, parish of Broughton, within the same space of time, nine or ten (out of 16 or 17 upon whom the experiment was made) recovered upon bleeding, and having an injection of tobacco smoke administered from a common tobacco pipe, by kindling the tobacco, inserting the pipe shank into the anus and blowing: the experiment, however, was not so successful

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ful in some later instances. I have long ago seen a ewe cured by bleeding, and injection of Glauber salts from a common clyster-bag and pipe. When braxy breaks out, it might be useful, where attainable, to lay the hogs, nightly, upon dry ground, if the hog fence is wet, the chilliness of wet ground contributing no doubt to the production of inflammation. Clover foggage or turnips might be good preventives from, inducing a lax habit. *"

* *Findlater's Survey.*

499 Dysentery, or molten grease.

II. DYSENTERY. *Molten-grease* or *Body-founder, Break-shaw*, (in sheep). Gras fondu, Fr.

Dysentery is the other disease that, with catarrh, forms Dr Cullen's order of profluvia; but as there are evident marks of inflammation of the bowels observed on inspecting the bodies of such animals as have died of this complaint, we have placed it immediately after inflammation of the bowels, in which we have followed M. Pinel and some other late writers.

This disease is not uncommon in the horse, and probably it is still more frequent in cattle and sheep. It very commonly begins with some degree of fever, as a trembling, dryness of the mouth, loss of appetite, a great degree of weakness, drooping of the head and ears, sometimes a copious sweating, but more commonly dryness and heat of the skin. There is usually a heaving of the flanks, and the animal turns his head towards them, as if griped. There are frequent dejections from the anus, but these seldom consist of the natural excrement, but of a mucous, slimy discharge, accompanied with a peculiar fatty substance like soft suet. There is evidently much distress during these evacuations, and sometimes the fundament appears excoriated. It is not uncommon to see blood pass with the stools, generally in streaks, but sometimes in such a quantity as to tinge the whole discharge of a red colour; and in the latter stages of the disease there generally appear membranous, filmy substances, which have been compared to soaked leather. These substances have been supposed to be the inner membrane of the bowels that has been eroded and thrown off by the violence of the purging; but they are merely coagulable lymph, such as is very commonly thrown off from inflamed surfaces. The pulse, towards the beginning of the disease, is commonly hard and full, but as the complaint goes on it becomes quick, small, and sometimes irregular. The animal is very stiff, and much averse to motion, and if the disease continues long, there usually comes on a swelling of the legs.

When animals that have died of this disease are dissected, the inner coat of the bowels is found inflamed, in some places covered with coagulable lymph, such as we have described as being thrown out in the discharge, and not unfrequently ulcerated in various parts, sometimes mortified and corroded.

This disease does not appear so dangerous among the inferior animals in this climate, as in warmer countries; but it sometimes proves fatal, or terminates in a weakness of the bowels and scouring, that are not easily removed. If the fever is but little or soon abates, if the animal appears not to labour under much pain, and if the discharge of natural excrement soon returns, the disease will probably terminate favourably in a short time; but if there is great pain and fever, with excessive weakness, and if the mucous discharges continue very frequent, and mixed with much blood, the danger is considerable.

It is necessary to distinguish this complaint from the common purging or scouring, with which it is very generally confounded. It must therefore be observed, that in scouring, there is no fever, whereas this is common in dysentery; that the discharge in scouring, though thin, has almost always the appearance of excrement, is not bloody, and is scarcely ever mixed with fatty matter.

Dysentery is more common in hot weather, and in hot seasons, than at other times; but is very commonly produced by the sudden application of cold, especially to the legs or belly, while the body is overheated and fatigued: hence swimming in autumn, drinking large quantities of cold water while in a profuse sweat, or other sudden changes from heat to cold, have commonly produced it. It is said to be frequently brought on by riding a horse very hard in hot weather. Mr Lawrence says that when a boy, he rode a horse that had a great deal of loose gross flesh about him, 21 miles in a warm summer morning, and thus brought on an attack of *molten grease*. It is also not an uncommon disease among post horses.

From the appearance of the fatty matter in the discharge that takes place in this complaint, the older writers on farriery were induced to give it the name of *molten grease*, conceiving that a principal part of the disease consisted in a melting down of the fat of the animal, which being conveyed by the absorbents into the circulation, is thrown out by the exhalants on the bowels, and carried off with the dung. Mr Blaine laughs very heartily at this idea, and seems to pride himself on the discovery, that what has been mistaken for fat, is nothing more than an increased secretion of the mucus of the intestines, and is as liable to a horse with little fat, as to one with much. Mr Lawrence, on the other hand, argues strenuously that this matter is really greasy, and says, that "with respect to the evidence of sense, had Mr Blaine ever seen a horse under the discharge of molten grease, he might have found on experiment, that part of the discharges in question is inflammable and liquefiable, which are not the characters of albumen, but of real grease; and, (continues Mr Lawrence) viewing the matter through the medium of experience, I can see no sort of improbability in a colliquation of loose, substantial, internal fat, by sudden inflammation, and its consequent effusion and discharge by an unusual emunctory. Gibson gives an instance which convinced him (apparently incredulous before) of the possibility of a horse's grease being melted. He found the fat melted and turned into an oil, and drawn off from its proper cells into the blood vessels. He says farther, this disease is not unlike the greasy diarrhœa which happens to men." Not having ourselves seen a case of dysentery in horses, we are not prepared to decide the difference between these two champions of the old and new school, but as Mr Lawrence is very worthy of credit in whatever has passed under his own observation, we have no doubt that this debated substance is of a fatty nature.

As it seems certain that dysentery is of an inflammatory nature, it is proper to begin the cure by bleeding, especially if the horse is plethoric, or if the pulse is full and hard. It will then be proper to clear the bowels by

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by a laxative clyster, and to give internally a drench composed of five or six ounces of Glauber's salt dissolved in a quart of water-gruel, or the drench N° 26 of the receipts; and this may be repeated every three or four hours. This will probably, in the course of the day, produce a plentiful discharge of excrement, and when the bowels appear well cleared, the horse may have a warm mash, be covered up warm, and perhaps a perspiration will be brought on, which, if the disease is slight, will probably complete the cure. If the disease should continue, an English pint, or pint and a half, of castor oil may be given, and clysters, composed of water-gruel, or starch boiled in water, should be given warm very frequently. When by these means a pretty copious discharge of excrement has been produced, the horse may have a ball composed of two drachms of opium, and half an ounce of ipecacuanha, or a drachm of emetic tartar, washed down with a quart of good porter. If there is considerable pain, it may be advisable to foment the belly for half an hour at a time, with flannels wrung out of a warm decoction of poppy heads. During this treatment the horse should be kept clothed, and currents of air in the stable should be avoided. When the disease is subdued, as the horse will probably remain very weak, it will be proper to revive him by nourishing diet, and cordial and strengthening remedies.

The appearances of dysentery in cattle are not unlike those that occur in the horse, only that perhaps in them there is not so much of the *gras fondu*. The disease among these animals is commonly called *fardel-bound*. The treatment is the same as above described.

500 Breakshaw in sheep.

This disease is not uncommon in sheep, by the name of *breakshaw*; but shepherds very commonly confound it with diarrhœa or purging. Mr Loch of Rachan, very properly distinguishes between them, and observes that the *breakshaw* is analogous to dysentery in the human species, and occurs most commonly in the end of wet summers. The discharge is thin and greenish (Mr Loch supposes from the wet grass becoming acid in the stomach, and turning the gall green); it is more or less mixed with blood, sometimes florid, sometimes black and grumous; the animal pines for a week or two and dies, though sometimes he recovers. The cure commonly employed by Mr Loch's herd, is warm milk poured down the animal's throat; but Mr Loch proposes to try, in addition to this, nitre in half drachm doses, with chalk or some other absorbent powder, and 20 or 30 drops of laudanum twice or thrice a day, with frequent injections of warm milk and water. This plan seems best adapted to the latter stages of the disease. According to Mr Gillespie of Glenquich (quoted by Mr Findlater), this disease is often produced by overheating, when the sheep are hunted by dogs, in folding them, &c. or when otherwise scared and terrified. It is stated by Mr Gillespie to be considerably infectious; and he considers tarring part of the flock to be the best means of checking the infection, under the idea that the smell of the tar will overcome that of the contagion,

501 Inflammation of the kidneys.

12. Inflammation of the Kidneys. Nephritis. *Strain of the Kidneys*.

This disease is not uncommon among horses and cattle; but it is more frequent in the former, as they are more exposed to those causes that appear generally to produce it.

The symptoms of this disease in horses, are tolerably well marked. The horse stands wide with his hind-legs, appears dull, and expresses considerable pain, often looking at his flanks. When pressure is made on the loins the horse flinches, and is evidently much distressed; the pulse is hard and full, and commonly more frequent than natural. When both kidneys are inflamed, little or no urine is secreted, and what little is evacuated is generally bloody; but when only one kidney is inflamed, the other continues to secrete urine, but the natural quantity is on the whole much diminished, and there is commonly considerable pain during the evacuation.

Inflammation of the kidneys is liable to be confounded with inflammation of the neck of the bladder, and the best means of distinguishing them, is to pass the hand up the fundament, by which the state of the bladder beneath may be easily ascertained. If the bladder be considerably distended with urine, the inflammation is almost certainly seated in the neck of the bladder; but if the bladder be shrunk and empty, the disease is probably situated in the kidneys. It must be allowed, however, that this mark of discrimination will not hold good till the disease of the kidneys is pretty far advanced, as it very commonly happens that when a gland is inflamed, its secretion is at first increased. At the commencement of the disease, therefore, the symptoms which we have enumerated, especially the sensibility which the horse evinces on touching his loins, are chiefly to be depended on. It must be remarked, that one of the kidneys has been found diseased, and even purulent, after death, when it shewed no marks of inflammation during life. This disease is attended with considerable danger, and unless the inflammation be speedily removed, matter will be formed, which, if it does not pass off by the urinary pipes into the bladder, will find a passage into the belly, or behind the peritoneum, and produce hectic fever and consumption, or the kidney may mortify, and death will soon follow.

The kidneys may become inflamed, either from external injury, or from irritating substances that pass through them in the course of the circulation. Inflammation of these organs is frequently produced by placing the saddle too far back upon the loins, and riding hard for a long time while it is in this position. It is sometimes the effect of throwing cold water upon the body while it is in a sweat; but according to Mr Blaine and Mr Feron, it is most frequently produced by the indiscriminate use of strong diuretic medicines.

In the treatment of this disease, we must vigorously employ the means that we have so often recommended for the cure of internal inflammations; bleeding in its full extent, emollient clysters, and the production of external inflammation: but it is necessary in this disease to caution the practitioner against the use of blisters, as the matter of cantharides, when taken into the circulation, and carried to the kidneys, will considerably increase the inflammation and distress. A good substitute for blisters of cantharides would be, to pour hot water on the loins, so as to raise a blister on each side, which, however cruel it may appear, could not produce so much pain, as the animal already feels from the disease. It has

has been recommended, to excite a degree of inflammation in the external part of the loins, by means of firing; but probably the hot water will do as well, and is leſs painful. No medicine ſhould be given by the mouth, that is in the leaſt heating or irritating; and nitre, turpentine, balſam of copaiva, &c. ſo warmly recommended by moſt of the writers on farriery, would only ſerve to aggravate the diſeaſe. The horſe may drink frequently of water gruel, linſeed tea, or ſuch other mild, mucilaginous liquors; and if he ſeems to require food, bran maſhes will be the moſt proper article of diet. If there is much coſtiveneſs, purgative clyſters may be given, or in caſes of neceſſity, ſix or ſeven drachms of ſocotorine aloes in a ball. All exerciſe muſt be avoided, and the horſe ſhould have a good bed of litter, on which he may lie down when fatigued.

13. Inflammation of the Bladder. Cyſtitis.

502 Inflammation of the bladder.

The bladder may be inflamed either in its body, or in its neck, and the ſymptoms differ ſomewhat in theſe two varieties. When the body of the bladder is inflamed, there is produced ſuch a degree of irritation, that the bladder becomes incapable of retaining its contents for any length of time; and the animal is perpetually making ſmall quantities of urine. He alſo makes frequent attempts to dung. On paſſing the hand up the fundament, the bladder will be found very hot and ſenſible; and in this variety of the complaint, as in inflammation of the kidneys, it is empty and collapſed.

When the neck of the bladder is inflamed, there is at firſt a ſuppreſſion of the urine, but afterwards it is continually paſſing off in drops; and on examining the bladder by the fundament, it will be found more or leſs diſtended, according to the continuance of the complaint. There is uſually conſiderable fever in both caſes. The pulſe is hard and full at the beginning of the diſeaſe, but after this has continued for ſome time, the pulſe becomes ſmall and oppreſſed.

Inflammation of the bladder takes place more frequently in male than in female animals; but it is ſaid to be ſometimes produced in the latter, at leaſt in mares, by paſſing ſome irritating ſubſtance up the urethra, in order to make them horſy. Both caſes of this diſeaſe are attended with conſiderable danger; but the latter is generally the moſt dangerous; but in a mare a cure is generally eaſier than in a horſe.

The treatment of this complaint differs little from that of the inflammation of the kidneys, and chiefly conſiſts in bleeding, the frequent uſe of ſoftening clyſters, low diet, and the production of external inflammation by any other means than the uſe of cantharides bliſters. If the bladder be found conſiderably diſtended, it will be neceſſary to evacuate the urine, either by the means of a catheter, which may be eaſily paſſed up in a mare, or by making an opening into the bladder; for performing which in the male, Mr Feron gives the following directions. "It happens that the urethra is ſo conſtructed, that it is not in our power to introduce an inſtrument immediately into the bladder, without performing an operation; for the urethra of the horſe forms two curvatures or angles, before it reaches the bladder, and therefore it is not poſſible to introduce an inſtrument into the bladder, which will preſerve its curvity all the way. We therefore introduce a ſtaff of a pliable wood, or whalebone, to the angle at the os pubis, as near the rectum as poſſible with ſafety; we make a cut upon it, and then introduce the female catheter, or ſome ſimilar tube, without however removing the ſtaff to prevent our loſing the inciſion, taking care to avoid the inſtrument's paſſing into the cellular membrane, inſtead of entering the bladder. If ſuch an accident was likely to happen, it is adviſable not to attempt the operation, but to continue and inſiſt upon all the emollient remedies.

"We may alſo puncture the bladder with a trocar, by the rectum, or through the inferior part of the abdomen.

"In either caſe we are likewiſe directed by Mr Coleman, to make the puncture as near the os pubis as poſſible, that we may not wound the peritonium anteriorly. By this method the operation recommended through the rectum may be performed without expoſing, or opening the cavity of the abdomen" *.

In the female an opening may be eaſily made into the bladder, with a trocar, introduced by the vagina. It has been recommended in the mare, to throw up an injection of ſome oily or mucilaginous fluid, to ſupply the place of mucus, in ſheathing the bladder from the irritation of urine. As in the inflammation of the kidneys, every thing that can heat or irritate the urinary organs muſt be carefully avoided.

* *Feron's Farriery*, p. 189.

14. Cords.

It is well known in moſt breeding countries, that a great many calves die every year, of an unknown diſeaſe, with which they are affected very ſhortly after birth. The common name which this diſeaſe receives in Scotland, is *the cords*; and while its fatal and widely extended effects are the ſubject of juſt regret, the diſeaſe itſelf is looked on as incurable, and no pains are taken to inveſtigate its nature, ſymptoms and cauſes, and no remedies ſuggeſted, as a cure or preventive. Whatever be its nature, this diſeaſe is exceedingly dangerous, and ſo extremely rapid, (terminating frequently in a night's time), that all means of relief are commonly uſeleſs even before it is obſerved. 503 Cords.

Almoſt all calves, that are ſaid to have died of *the cords*, appear, when they are opened up, exceedingly red, and the ſmall leaders, or ligaments, are conſiderably ſwelled, and have ſome reſemblance to ſtrings paſſing through the internal parts, from which probably the diſeaſe has its name. Every ſymptom indicates a conſiderable degree of plethora, if not a very high degree of inflammation.

It is commonly obſerved, that calves are moſt liable to be affected during the firſt days, or weeks, after they are calved. If they outlive five or ſix weeks, they are ſeldom in any danger.

Calves that ſuck their mothers, we believe, it will be found, are not ſo liable to the diſeaſe, as thoſe who are fed by the hand.

The greateſt number of calves who fall a ſacrifice to this diſeaſe, if not the whole of them, are thoſe who are cloſely confined to the houſe from their birth, without ever being expoſed to the free open air without doors. It is a well known fact, that calves who are dropt without, and remain in the fields, are in little or no danger. Cows that are laid on to graze for beef frequently turn out to be in calf; and it is no uncommon thing to ſee them drop their calves in the midſt of froſt and ſnow, and yet theſe

Diseases. these young creatures, if they can once get to their feet, without being frozen to the ground, are hearty and well. Calves, lambs, and foals, require exercise and fresh air; and nature directs them to take a great deal. It is astonishing to see with what force and vigour, (paticularly the calf), and how long, they will run. But this free, unconstrained, and severe exercise without doors, seems to be the very thing that makes them thrive, and to be necessary to their very existence.*

The great object is to prevent this disease; and the following method of treating the new-born calves, practised by a correspondent of the Farmers Magazine, seems to be attended with complete success.

The time when this gentleman's cows are bulled is regularly noted down in a book; and when they are near calving, they are watched frequently night and day. As soon as the calf is dropped, it is received into a large basket or skull, made of willows, with a handle at each end, and plenty of clean straw in it. It is then carried by two persons to the stall in the calf-house, where it is gently rubbed with straw. The calf-house is next to the cow-byre; and is fitted up with stalls like a stable, about three feet wide, and about five feet long. Every stall shuts in by itself, with a door and hinges, for fear of the calf lying back too far, to choke itself in its binding. As soon as the mother has had a little rest after calving, she is milked, and a little of the milk given to the calf as early as possible. If the weather is cold, and the mother long in giving milk, it is taken to the fire, and warmed in a pan until it is blood-warm, and then given to the calf; about six or eight gills, according to the size of the calf, and repeated four times in 24 hours. As the calf gathers strength, the quantity may be increased; but too much milk at one time is as bad as too little, until it is a month or six weeks old. When the calf is able to stand, it is tied to a stake; as it is more in the power of the servant to give it milk in that situation, than when going about loose. If a calf gets cold milk, it is sure to bring on a trembling; and the *cords* or some other malady follows; which he has often seen exemplified amongst the neighbouring young stock †.

* *Farm. Mag.* vol. iv. 59.

† *Ib.* p. 296.

504 Farcy.

15. Farcy. Le Farcin, Fr.

We shall conclude this chapter with a brief account of two diseases; or rather, as it should seem, of two modifications of the same disease, that frequently take place in the horse, to whom they are almost peculiar; though something like them is occasionally found in other animals. We shall hereafter take notice of what farriers call the water farcy, which we consider as similar to *anasarca* in the human body; but the disease we are about to describe, appears to be rather a peculiar inflammatory affection of the absorbent vessels below the skin. There seems to be two varieties of farcy, acute and chronic; or rather a mild and a malignant variety.

The commencement of farcy appears to be rather obscure, and probably it is seldom observed in the beginning of the inflammation. The first appearances that are described by writers, are a number of swellings, that rise in almost every part of the body, particularly the head, neck, and extremities. The lymphatic vessels below the skin appear like knotted cords; and this appearance is found to be owing to a distension and inflammation that take place in these vessels, especially at their valves, where the knots are produced. As the disease proceeds, these knotted swellings burst, and ulcers are formed, which are very difficult to heal. The formation of these ulcers may be considered as terminating the mild stage, and commencing the malignant form of the disease; in which the horse loses his appetite, grows lean and weak, and commonly has a degree of hectic fever. If the progress of the disease has not been arrested, a swelling takes place in the head and nose, and there comes on from the latter a copious discharge of a peculiar glairy mucus, which shews that the disease has degenerated into *glanders*, under which name we shall proceed to describe it; and shall afterwards consider the nature, causes, and treatment of both. Diseases.

16. Glanders. Le Morve, Fr.

According to Mr Blaine, the usual symptoms of *glanders* are an increased secretion of the mucus of the nose, which is at first thick, and like the white of an egg. He has seen it continue so, while at other times it becomes purulent; but there is usually a degree of viscidity and glueiness about the matter, that as it were fixes the sides of the nostrils together, and is strongly characteristic of this disease. On examining the nostrils, there may generally be perceived a number of ulcerated surfaces, very similar to shankers that occur in the venereal disease. These ulcers do not always appear soon; but they are produced in all virulent cases, and never fail to appear when the disease terminates fatally. They are at first small, and disposed in lines along the lymphatic vessels; but as the ulceration proceeds, it becomes more extensive, till the whole inner surface of the nostrils is affected, and at length the bones of the nose are affected, and become carious. When the ulcers have continued for some time, the matter changes its glairy appearance, and becomes bloody and offensive; and this is more particularly the case when the bones become diseased. In the latter stages of the complaint, the emaciation and weakness of the animal are greatly increased; he becomes affected with a short tickling cough; the hair grows dry and harsh, and falls off on the slightest touch, and thus the horse gradually pines away. 505 Glanders.

Sometimes only one side of the head is affected, but more commonly both at the same time.

The best account of the appearances of glanders on dissection, has been given by M. Chabert, in a work which he published in 1785, on the means of ascertaining the existence of glanders, and of preventing their effects. From the numerous bodies which he opened, M. Chabert has drawn up the following general account of the morbid appearances.

The lungs are generally more affected than any other of the viscera; we find them often swelled and filled with hydatids, tubercles, and obstructions. The bronchial glands are very often swelled and ulcerated, and this is sometimes the only injury that we can perceive on dissections. The membrane that lines the bronchia and the wind-pipe, is most commonly inflamed and ulcerated; the bronchia are filled with a thick matter, that commonly resembles what the animal discharges by the nostrils. The internal surface of the bones that form the different cavities of the nose, and the grisly partition of the nostrils, are often carious, and covered with purulent matter; and the membrane which lines the nostrils

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nostrils is ulcerated. The spleen, the liver, and the kidneys, are also sometimes considerably diseased; and the ulcerated state of the kidneys, not unfrequently appears during life, by the purulent matter that is discharged with the urine. On opening the head, we sometimes find the brain softer and more flaccid than in a healthy animal. There is often a great quantity of serum in its cavities, and the glands are much swelled.

The glanders is liable to be confounded with several of those diseases, in which an unusual discharge proceeds from the nostrils; as catarrh, strangles, and consumptions; but chiefly with the two former. It may be distinguished from catarrh, by the absence of fever in the early stage; by the matter discharged from the nostrils being thick and glairy from the first; whereas, in catarrh, there is almost always considerable fever in the beginning, and the discharge is at first watery. In a common cold the general health is also more or less affected, and from the first there is usually a cough and loss of appetite; whereas, these symptoms scarcely ever come on in glanders, till the disease has subsisted for a considerable time. Glanders may be distinguished from strangles by the high fever which commences the latter, and by the swelling and speedy suppuration of the glands of the mouth and throat.

506 Of these two affections, glanders is the most dangerous; as farcy, when taken at its commencement, may frequently be removed; but we believe the instances of a perfect cure in glanders are very rare.

The causes of these complaints are very obscure. It is said that farcy may be brought on by the same causes that predispose to mange, as want of cleanliness, hard work, and low diet; and there is no doubt, that this disease, as well as glanders, is contagious. Glanders, besides being produced by contagion, may also be the termination of several disorders, as of catarrh, strangles, and consumption, however different from these diseases in their commencement.

The nature of glanders is not well understood, although, of late, many ingenious men have investigated the subject, and made considerable discoveries. It is not certain when the disease was first known. Mr Lawrence dates it from the same period with the *Lues Venerea*; but there seems no doubt that the disease was known to the ancients, though we do not know by what name it was called. Vegetius speaks of a disease which he calls *humiditas*, which Mr Blaine supposes to be the same with our glanders; but which the learned Camper considers as analogous to the murrain, See N° 466. Blundevil, and after him Markham, give the following description of its rise, progress, and completion. "Of cold first cometh the pose, (that is stoppage of the head), and the cough, and then the glanders, and last of all the mourning of the chine." The two Messieurs Lafosse, made, as we have seen, several discoveries with respect to glanders, especially the father, who, in 1749, demonstrated before the academy of sciences at Paris, that the seat of the disease is wholly in the pituitary membrane; and he proposed curing it by injecting the whole of this membrane through openings made with the trepan, into the frontal, nasal, and maxillary sinuses. Lafosse divided the disease into several species; but it appears that all these may be reduced to two, the mild and malignant, or the chronic and acute; the chronic being that in which the running of the nose is trifling, and of a transparent colour, with no appearances of ulceration in the nostrils; while in the acute or malignant variety, there is considerable ulceration; the discharge is very offensive; there is a swelling below the under jaw, and the bones of the nose are carious.

The best of the English writers on farriery appear to have known little or nothing of the disease more than the symptoms. Dr Bracken considered it as not contagious, and Gibson gives but a poor account of it, for which he seems indebted to Snape.

"The late professor of the veterinary college (says Mr Blaine), published his remarks on this disease, but it is evident that he knew little or nothing relating to it, but what he gained from Lafosse, and consequently his opinions offered nothing new. The present professor has prosecuted the inquiries relative to it much farther, and by an extensive course of experiments has thrown very considerable light on the nature of the disease; and though we are not yet much more successful in attempts at the cure, yet we have less reason to despair. By Mr Coleman's experiments it is proved beyond a doubt that farcy and glanders are specifically the same disease, but affecting different parts: to establish this, horses have been inoculated with the matter of farcy, and glanders has been produced; which put the matter beyond a doubt. Farther, Mr Coleman produced glanders in a sound animal by the inoculation with the matter of glanders. This M. St Bell asserted could not be done. Farcy has likewise been produced by the same means, but it appears that it was some time before it could be effected; but it has been produced by Mr White. It cannot therefore be inferred, that because the farcy and glanders are so different in their apparent situations they are distinct diseases: every poison has its preference of parts; and likewise the same poison, under different modifications affects different parts.

Mr Coleman is of opinion, that in glanders, the whole circulating fluids are affected. To prove this, he bled an ass from the jugular vein till he was to all appearance dead, when he introduced the blood from the carotid artery of a horse labouring under glanders, till the ass was reanimated. In a few days the most malignant glanders appeared. I believe another ass was inoculated from this, which became glandered. This experiment, I think, (adds Mr Blaine), throws great light on this complaint, and indeed on pathology in general; and we may hence be led to hope, that internal remedies may be more useful than external, which have been thought to be the only means by which we could hope for a cure; for provided we could destroy the poison existing in the blood, and keeping up the action in the part; the action, or at least the specific part of it, might cease in the affected part, and we might induce a healing process by the usual means. As such, our only hope must consist in exciting a new action in the system, whereby the glanderous one will be suspended, till by the continuance of the new action the virus of glanders is completely expelled by the change the fluids naturally undergo*."

The treatment of these diseases will differ according to their state and degree of malignity. For the cure of

* *Blaine's Outlines*, vol. ii. p. 525.

Diseases. of farcy, blisters are much extolled by Mr Feron, and the actual cautery, is very generally employed to destroy the swellings of the lymphatics, and to excite these vessels into greater action. To assist this purpose, diuretics are to be administered, and the horse should take as much exercise, especially draught labour, as he will bear without considerable fatigue. Two remedies have of late been employed internally, when the system becomes considerably affected; these are verdigrise, and corrosive sublimate. Mr Feron directs the former to be given in the following manner. A ball composed of one drachm of verdigrise, and a quarter of an ounce of common turpentine, is to be given every night and morning, gradually increasing the quantity of verdigrise till the horse can take from three drachms to half an ounce in the course of the day. If the animal becomes costive, he is to have a clyster night and morning, and a purgative ball of seven drachms of aloes, and half a drachm of calomel once a week. After having gone through a regular course of physic, he is to have the following balls. An ounce of green copperas (E) in powder is to be mixed up with Venice turpentine, and a sufficient quantity of linseed powder, to make eight balls, one of which is to be given every morning, while costiveness is to be avoided as before directed.

In giving the corrosive sublimate, we should begin with a small dose (see STIMULANTS), and gradually increase it so long as the stomach will easily bear it. As mercury in some form seems to be the best remedy that can be employed in these affections, calomel, or the common blue pill, may be given instead of the corrosive sublimate, if the latter should occasion much disorder, or if the horse is very much weakened. During this course the animal must be supported by nourishing diet, but should frequently have a change of succulent vegetable food. Mr Blaine speaks of a horse that was so far reduced (by glanders, we suppose) as not to be able to stand, and who was drawn into a field of tares, and suffered to take his chance; the consequence was that when he had eaten all within his reach, he was able to rise and search for more, and eventually recovered.

The treatment recommended above has, it seems, often been successful in farcy, and the same internal remedies have been recommended in glanders, but we believe they have been employed with little success. Mr Feron advises to draw blood in the beginning of glanders, while the disease is still local, and to keep the animal upon warm mashes of bran, putting the same into a nose-bag, for the purpose of fomenting the nostrils. He is then to go through a course of gentle physic, while strict attention is paid to the necessary direction of the food, exercise, dressing, cleanliness, and water. The water must be always warm, and made white with bran or gruel. After this course, he recommends balls made of opium, arsenic, and sulphur, or of extract of hemlock, calomel, &c. avoiding costiveness during their exhibition. He thinks it necessary to insert two rowels, one below the under jaw near the swelling, and another under the chest; and he recommends frequently syringing the nostrils with a lotion made of two ounces of spirit of wine, and the same quantity of vinegar, mixed with a gallon of water; or with a solution of corrosive sublimate. According to this gentleman, if the disorder is attacked in its infancy, it will generally submit to the above course of treatment; but if the disorder is so far advanced as to exhibit the symptoms of virulence, which we have described as constituting the acute or malignant stage of it, it will increase in opposition to all art, and it will be necessary to take away a life that every degree of assiduity would not render worth preservation.

As the farcy is probably contagious, and the glanders in most cases is certainly so, it is proper, as soon as a horse is affected with either of these diseases, to keep him in a separate stable, and to take care that he does not come near any other horses; and no part of his harness, or furniture should be used for any other horse, till it has been well washed with soap and water, and exposed for a long time to the pure air.

Glanders is considered by Dr Darwin, and some other writers, as a contagious catarrh, and in some cases it certainly is so; but when it is the consequence of farcy, or of dangerous chronic diseases, it appears to be an affection of a peculiar kind. Mr Lawrence considers the glanders as so perfectly incurable, that he recommends the *collarmakers knife* as the easiest, cheapest, and most infallible remedy.

CHAP. III. *Of Lethargic or Comatose Diseases.*

1. APOPLEXY. Vertige, Fr. *Staggers*, *Sleepy Staggers*, *Lethargy*, or *Vertigo*.

Staggers is one of the most comprehensive terms in farriery; and under it are confounded almost every affection of the brain, or all those diseases in which there take place giddiness, unusual heaviness, drowsiness, or convulsions. We have already seen the term applied to inflammation of the brain, and we have no doubt that many cases are described as *staggers*, which are really instances of *epilepsy*. Of this kind we consider the case so humorously related by Mr Lawrence in his treatise on horses, vol. ii. p. 406. "Walking up Fleet-street, I observed a crowd of people wonderfully diverted with the agonies of a cart-horse beating himself almost to pieces, in, I think, the most violent convulsions I ever witnessed. He threw himself repeatedly upon the foot-path, and was very near going headlong into a shop, &c." 507 Apoplexy, or Staggers.

Mr Feron, who in general keeps very clear of the errors of ordinary farriers, which he often ridicules with much success, has confounded *inflammation of the brain* and *apoplexy*, under the general name of *staggers*, considering them as both inflammatory, and merely modifications of the same disease. Even Mr Blaine, who, as Mr Lawrence expresses himself, seems upon every occasion eager to catch the *dernier goût* of science, has described

(E) Mr Feron directs green *copper*: but we suppose this is merely a typographical error, for copperas, or sulphate of iron; and we have therefore ordered it by this name, as sulphate of iron is a good tonic, and may be very properly employed in this disease.

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described staggers under the name of *lethargy*, and does not even mention its identity with apoplexy in the human body.

We consider *staggers* properly so called, as the same with *apoplexy;* the appearances, the causes, and the treatment of both are the same, making allowance for some slight variations in the structure and economy of the different animals whom they affect.

This complaint sometimes comes on suddenly; but in general it is preceded by symptoms that mark a considerable determination of blood to the head, such as heaviness, drowsiness, insensibility, (see N° 317) occasional fits of giddiness, (see N° 318.) and partial blindness, (see N° 321.). There seems no doubt that the horse is sometimes affected with headache, which appears by the animal's hanging down his head and drooping his ears, by the eyes being dull and watery, by dropping of urine, and costiveness. These symptoms often precede an attack of apoplexy, though they are sometimes only signs of a disordered stomach.

When a fit of staggers comes on, the animal falls suddenly, and is perhaps convulsed for a few minutes, but more commonly appears quite insensible. The pulse during the fit is usually slower than natural, and much oppressed; the breathing is slow, heavy, and laborious, and there is evidently an increased accumulation of blood in the vessels of the head. The animal remains for a longer or shorter time in the fit, and sometimes he never recovers; but, in general, in eight or ten minutes, the fit goes off, and the animal rises. Sometimes after a fit of the staggers, the animal appears for a time more active and lively than before; but very often he remains heavy and sleepy, especially after repeated attacks, and sometimes a paralytic affection of some of the limbs is the consequence of the fit.

Apoplexy may be distinguished from inflammation of the brain, by the fever, restlessness, and fiery appearance of the eyes, that never fail to usher in the latter complaint. We would distinguish it from *epilepsy*, by the foaming at the mouth, and strong convulsions, by which this latter is always accompanied.

An apoplectic fit may be the consequence of an overloaded or otherwise disordered stomach; and is no uncommon termination of several diseases, as *epilepsy*, *locked jaw*, &c. But it is generally the consequence of too much fullness of blood, brought on by a full diet, attended by idleness or want of exercise. It is more common to old than to young animals, especially such as have large heads and short necks. For the immediate and many of the exciting causes of this complaint, see APOPLEXY, MEDICINE *Index*.

A fit of apoplexy is often produced in an animal that is predisposed to it, by some sudden or violent exertion, such as drawing a heavy load, &c.

The means of preventing apoplexy when an attack of it is threatened, have been already explained (in N°. 317, 318, and 427.) When a fit of *apoplexy* takes place, if the animal is full of blood, which generally happens, it will be proper to bleed, from the temporal artery, or jugular vein, to an extent proportioned to the state of the animal. If the animal appears weak, bleeding should not be attempted; but the determination of blood to the head may be effectually checked by making pressure upon the *carotid artery*, taking care at the same time, not to include the jugular veins. Mr Coleman recommends tying up the carotid arteries in dangerous cases of staggers, and Mr Feron says, that he has often repeated this experiment with success. The bowels should be emptied in the usual manner, as soon as possible; and a strong stimulating clyster should be injected. When the animal comes to himself, if fat and plethoric, he should have a good strong purgative ball, and afterwards some gentle diuretic medicines. He should be kept quiet for some hours after the fit; but when the physic has properly wrought, he should have gentle exercise, which must be gradually increased, according as he is able to bear it; and great care should be taken to keep the bowels open, and to prevent too great an accumulation of blood.

2. PALSY. Paralysis. *Thortor-ill*, (in sheep.)

The inferior animals sometimes become *paralytic*, 508 Palsy.
and we have seen that a palsy in the hind legs is one of the principal symptoms of the *distemper* in dogs. A paralytic disorder is not uncommon among sheep, and is called by shepherds the *thortor-ill.* It sometimes arises from their having eaten some poisonous or narcotic plants, but is very generally the effect of great weakness produced by want of proper nourishment. The best remedy seems to be white vitriol, given three times a day; and the food should be of the most wholesome and nourishing kind.

We had intended in this chapter to consider pretty much at large, the various cases of suspended animation, or *asphyxia*, such as *drowning*, *hanging*, *suffocation* from fixed air or other noxious gases, and *torpor* from cold; but this article has already swelled to an unexpected length, and we have yet much important matter on our hands. We must therefore refer our veterinary readers to the article MEDICINE; as the means to be there directed for restoring suspended animation in man will, with some little modification, apply to similar cases in the domestic animals.

CHAP. IV. *Of Spasmodic Diseases.*

1. LOCKED-JAW. Tetanus. *Stag-evil.* Mal de Cerf.

It has been remarked in N° 10. that horses are ex- 509 Locked
tremely subject to the locked-jaw, which proves one of jaw.
the most obstinate and fatal diseases by which they are affected. It seems also occasionally to appear among cattle, but it occurs to them much less frequently than to horses. We do not know that any writer has described this disease in the horse better than Mr Gibson, whose description we shall therefore copy, though it is expressed in rather an uncouth style.

" As soon as a horse is seized in this manner, his head is raised with his nose towards his rack, his ears pricked up, and his tail cocked, looking with an eagerness, as an hungry horse when hay is put down to him, or like an high-spirited one, when upon his mettle; in so much that those who are strangers to such things, when they see a horse stand in this manner, will scarce believe any thing of consequence ails him; and I have seen such persons greatly surprised when they have been told of the danger. But they are soon convinced, when they see other symptoms come on apace; that his neck grows

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grows ſtiff, cramped, and almoſt immoveable; and if a horſe in this condition lives a few days, ſeveral knots and ganglions will riſe on the tendinous parts thereof; and all the muſcles both before and behind, will be ſo pulled and cramped and ſtretched, that he looks as if he was nailed to the pavement, with his legs ſtiff, wide, and ſtraddling; his ſkin ſo tight on all parts of his body, that it is almoſt impoſſible to move it; and if trial be made to make him walk, he is ready to fall at every ſtep, unleſs he be carefully ſupported; his eyes are ſo fixed with the inaction of the muſcles, as gives him a deadneſs in his looks. He ſnorts and ſneezes often, pants continually with ſhortneſs of breath; and this ſymptom increaſes till he drops down dead, which generally happens in a few days, unleſs ſome very ſudden and effectual turn can be given to the diſtemper."

This diſeaſe is generally primary or idiopathic; but it is ſometimes ſymptomatic. The pulſe is not always much affected; there is ſeldom any fever, and the internal functions are ſeldom impaired till towards the latter ſtages of the diſeaſe.

We have not many accounts of the appearances that have been diſcovered on diſſecting horſes which have died of this diſeaſe. In two diſſections by M. Huzard, the bowels within the belly, eſpecially the ſtomach and large inteſtines, were conſiderably inflamed; the liver was full of black and fluid blood, and in one caſe a conſiderable quantity of blood had eſcaped into the cavity of the belly; the ſubſtance of the liver was very tender, as if it were decompoſed or rotten. The other viſcera of the belly, and the heart and lungs, were in their natural ſtate. On opening the head, conſiderable marks of inflammation appeared in the brain, the *choroid plexus* was diſtended with blood, and in one caſe the maxillary and frontal ſinuſes of the right ſide were full of black blood; the *dura mater* was inflamed, and its veſſels, as well as thoſe of the brain, were turgid with blood; the ventricles of the brain contained a quantity of ſerous fluid. In one of the caſes the inflammation had extended even to the perioſteum on the right ſide, which was much redder than that on the left.

It is difficult to ſay whether the diſeaſe depended on an inflammatory affection of the brain, or whether this was the conſequence of the violent ſpaſmodic contraction of the muſcles during the height of the diſeaſe: but we are inclined to think the latter was the caſe.

Inſtances of recovery from this diſeaſe in horſes are very rare; we ſhall preſently give one from Mr Gibſon, which is rather remarkable. A cautious opinion ought therefore to be given in every caſe of locked-jaw.

This affection may be produced by various cauſes, particularly from wounds, where the nerve is partially divided; from cold, when the body is in a profuſe ſweat. It may ariſe alſo from internal irritation, as from worms, which, in Mr Gibſon's opinion, are a very common cauſe of it. Probably it more frequently proceeds from wounds, as a puncture in the foot or any other part; and it has certainly often been brought on by the barbarous operations of *docking* and *nicking*. There ſeems no doubt that the brain is the principal ſeat of the affection.

In the treatment of locked-jaw, it is neceſſary to uſe ſome vigorous meaſures as early as poſſible; but unhappily no method hitherto adopted has proved ſucceſsful, even in a few caſes. Opium, aconite, hellebore, &c. have been tried in the veterinary college in very large doſes, but without any beneficial effects. From conſidering it as a diſeaſe of the brain, trepanning has been uſed, with the view of making preſſure on the brain, and this has ſometimes appeared to take off the ſpaſm of the muſcles; but as ſoon as the preſſure was removed, the ſpaſms returned with nearly equal violence. An infuſion of tobacco, to the amount of two pounds, has been given by Mr Coleman, but the ſymptoms appeared to be aggravated. Mr Feron recommends bleeding, and immerſing the animal in a warm bath at 90° of Fahrenheit, ſo as to keep the whole body covered with the water for two or three hours, which he has known to be ſucceſsful; but the horſe muſt afterwards be clothed and kept very warm. The moſt probable means to relieve the animal ſeem to be giving opium in large doſes by way of clyſter, frequently repeated, and rubbing the whole body frequently with ſome ſtimulating linement, ſuch as oil of turpentine and tincture of cantharides. Mr Blaine recommends a clyſter compoſed of a ſtrong decoction of poppy heads, with two ounces of camphor diſſolved in brandy; or if this be thought too expenſive, one with two ounces of ſpirit of hartſhorn and four ounces of oil of turpentine, mixed with two or three yolks of eggs, and a pint of ale. The cold bath is found one of the moſt effectual remedies in the human body, and we ſhould conceive that it is more likely than any other means to do good in the horſe; but it will be neceſſary to rub him as dry as poſſible after throwing the water over him.

If it is aſcertained that the diſeaſe proceeds from a punctured or lacerated wound, it will be proper immediately to ſcarify the wounded part, ſo as, if poſſible, completely to divide the affected nerve, as in ſome caſes where this has been done, the ſpaſms have been removed. It muſt be confeſſed, however, that even this has frequently failed. If it has proceeded from a punctured wound in the foot, Mr Blaine thinks it adviſable to take up the nerves of that foot on each ſide; for though this might occaſion temporary lameneſs, yet, if the horſe were ſaved, this might be removed in a few weeks. 510

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The following caſe related by Mr Gibſon, in his laſt work on the diſeaſes of horſes, is very inſtructive; even though it ſhould be contended that the cure was effected by nature, and not by Mr Gibſon's remedies.

A young troop horſe was ſuddenly ſeized with this kind of convulſion, which was firſt diſcovered as he was leading out to water, at the afternoon's watering time. "I happened, (ſays Mr Gibſon), to be then preſent, and perceived him come reeling along with his noſe turned out, his eyes fixed and immoveable, with all the other ſigns that uſually attend this fatal diſtemper; and when he came to the trough he could not reach the water becauſe of the cramp and ſtiffneſs of his neck; and when it was held to him in a pail, could not drink, though he ſhewed an eagerneſs for it; his mouth being ſhut up ſo cloſe, that it was ſcarce poſſible to put a knife between his teeth. When we found it impoſſible to adminiſter any kind of medicine, till by rubbing his cheeks, jaws, and temples, and his whole neck, for a conſiderable time, we made a ſhift, with great difficulty, to thruſt down part of a calomel ball, on the end of a ſmall ſtick, and then to put into his noſtrils, a very ſmall portion of a ſtrong cephalic drink, thinking by that me-to convey the ball downwards into his ſtomach, which however had but little effect, any farther than this, that he had not ſuch ſudden fits and agitations as I have ſeen in others in the like circumſtances, but continued more quiet; neither did his fever increaſe, as uſually happens when the diſtemper is gaining ground; but all this while his mouth continued ſo much ſhut, that he could neither eat nor drink for three weeks; only by continually rubbing his jaws and neck, he would ſometimes make a ſhift to ſuck a handful of ſcalded bran, or ſometimes a little oat-meal, moiſtened with warm water; but in ſo ſmall a quantity, that it is poſſible he might have ſtarved, if other methods had not been taken to keep him alive.

"I have often obſerved, that the forcing the jaws open by violent means, puts a horſe into ſuch agonies, that it rather increaſes than abates the ſymptoms; and therefore I contrived to give him both food and phyſic by the fundament, through a pipe fourteen inches long, by which he ſeemed to receive great benefit; for we could perceive the ſymptoms to abate daily. His flanks grew more quiet, he ſtood more ſtill, and free from ſudden fits and ſtartings; all which ſymptoms are uſual in the continuance and increaſe of the diſtemper. The clyſters were contrived in the following manner.

"Rue, pennyroyal, and chamomile flowers, of each a handful; ſavin and box, of each a handful; garlic, an ounce; caſtor and aſſafœtida, of each half an ounce.

"In making this clyſter, the herbs are to be boiled firſt, in two quarts of water, in a covered veſſel, the ſpace of ten or fifteen minutes, with the caſtor and aſſafœtida cut in ſmall pieces, and tied in a rag; not only to ſave the caſtor from waſte, but that it may be ſqueezed into ſeveral clyſters. Then the garlic to be added, and continued, cloſe covered, over the fire the ſpace of ten minutes longer; after this the liquor to be poured off into a pan, or any other convenient veſſel; then add of linſeed oil and treacle, of each four ounces, with half an ounce of unrectified oil of amber; the treacle and the oils are to be mixed with the decoction, when it is put into the bag.

"This clyſter was repeated once a-day for a fortnight; and by way of diet, was given every day three or four quarts of milk, boiled with oat meal and water, a bag with a long pipe being left in the ſtable for that purpoſe. He retained every thing that was adminiſtered that way, which he generally ſucked up of himſelf without force. This perhaps was in ſome meaſure owing to the nature of this univerſal convulſion which cauſes ſuch irregular motions in the midriff and muſcles of reſpiration, as in ſome meaſure inverts the natural motion of the guts; and for the ſame reaſon horſes in this condition ſeldom dung, but ſtale often; and when they dung, it drops from them in a manner inſenſibly, and often no more than one or two balls at a time: and therefore as this horſe could receive little or no ſuſtenance by the mouth, I was determined to make trial how far he might receive nouriſhment by way of injection backwards; whether a thin diluted food thrown into the ſtraight gut, and from thence over into the ſmall guts, by the help of a long pipe, might not find a paſſage into the blood through the lacteals, eſpecially the experiments of this kind made on the human body, both in adminiſtering food and phyſic, particularly in giving the bark, by way of clyſter, in agues and intermitting fevers, which has been found ſucceſsful where the ſtomach was not able to bear its auſterity. It was upon this footing that I treated him in the manner I have deſcribed, which I imagined was not altogether without effect; for he ſcarce ate in three weeks what was ſufficient to ſuſtain him one day; ſo that it was impoſſible for him to have lived, had he not been ſupported by what was thrown into his bowels; and though by this means he loſt his fleſh very ſenſibly, yet he ſtill retained a good deal of vigour and vivacity. He had two men conſtantly to look after him, and theſe relieved by others, who had orders to rub his whole body often, which greatly helped to relax his ſkin, and remove the crampneſs of his muſcles; and though he had not for the firſt fortnight recovered the uſe of his jaws, yet we obſerved him daily to move with leſs ſtiffneſs, and often to lick in his manger, as if he craved after food. He alſo breathed with leſs difficulty, and had ſeveral other good ſigns. This encouraged me to try another experiment with opium, from the known quality of that drug in relaxing the animal fibres; which I therefore thought might be of ſervice to remove the contractions of the muſcles about his mouth and jaws, which all this while continued in ſome meaſure obſtinate, and without ſome powerful relief, might prove fatal, even though the original cauſe was in a great meaſure taken away; therefore I cauſed an ounce of crude opium to be diſſolved in one of his clyſters, which was followed with theſe circumſtances, that the horſe ſoon lay down, began to point his ears backwards and forwards, and could move his neck pretty freely, and his mouth was ſo far at liberty, that he took his drink with little or no difficulty, and could eat hay and bran ſufficient to ſuſtain him. He likewiſe moved his whole body ſo readily, that we could walk him an hour every day; and that I might follow what I imagined had been ſo ſucceſsfully begun by the opiate clyſter, I ordered him ſome days after an ounce of the common Matthew's pill, which contains about two drachms of opium, and the ſame quantity of aſſafœtida, made into a ball, which was given at his mouth, and waſhed down with a hornful of gruel, which was done with great eaſe, his mouth being grown pretty pliable. This ball being once more repeated, he recovered daily, being continued for ſome time in the uſe of the drinks, which were now adminiſtered only twice a-week, with a good rubbing; and as ſoon as he began to recover his fleſh, he was gently purged. By theſe means he was perfectly cured, without any other ill effect than a blemiſh upon one eye, cauſed by the violent and ſtrong contraction of the muſcles during the convulſions, which indeed were as bad as any I ever ſaw, even where they proved the moſt fatal."

We have related the above caſe thus particularly, in the author's own words, becauſe we have ſcarcely ever ſeen a caſe of locked-jaw in horſes ſo well deſcribed, both as to its progreſs and treatment. Whatever might have been the cauſe that produced the complaint in this horſe, it was evident that it did not depend upon any congeſtion of blood in the head, and Gibſon judged very properly in not employing bleeding, purging, and rowels, which appear to have been the indiſcriminate practice of farriers in his time; and which might be very proper where the convulſions proceed originally from

from the head. Gibſon ſays, that he has ſeen the farriers in ſuch caſes put a rowel on each ſide of the neck, one on the belly, one on the forehead, and one on each ſide. It appears, however, that this practice met with but little ſucceſs, as in this complaint the ſkin is drawn ſo tight in all parts that the rowels ſeldom ſuppurate kindly, but very commonly produce a mortification, and thus increaſe the animal's diſtreſs.

2. Epilepsy, or Falling-ſickneſs. *Convulſions.*

511 We have already ſtated our opinion, that ſeveral caſes that are commonly called ſtaggers are really inſtances of epilepſy, and we have no doubt that ſeveral ſtrange convulſive diſorders that are deſcribed as affecting domeſtic animals may be referred to the ſame head. Of this kind we conſider the ſkipping complaint among lambs deſcribed by Mr Lawrence: "I remember in former days, (ſays he), on the borders of Suffolk, ſeveral ſcores of lambs were ſeized with an uncommon malady, leaping and jumping about the fold-yard in a ſtrange manner; and a dung-heap being raiſed to the level of the eaves of a low tiled barn, a number of the lambs ran ſkipping up to the top of the roof, as though they had been poſſeſſed by more devils than Mary Magdalen, or even the nuns of Loudun. The whole pariſh wiſely concluded they were bewitched, and a wretched and aged pauper became the object of their ſuſpicions and their deadly hatred. I do not preciſely recollect, but I fear the brutal, ſenſeleſs, and infernal ſuppoſed preventive of witchcraft was recurred to, burning one of the poor animals alive." We ſhould be diſpoſed to account for ſo many animals being ſeized with it at once, on the principle of imitation, juſt as we have ſeen a number of children at ſchool fall into fits from ſeeing one of their number affected with epilepſy. The treatment of this complaint muſt be regulated by the ſtate of the body at the time. If this is plethoric, bleeding, purging, and low diet, will be neceſſary; if it is weak, a ſtrengthening plan muſt be adopted.

3. Canine Madness. Hydrophobia. *Rabies Canina.* La Rage, Fr.

512 Canine madneſs.

Of this moſt dreadful malady, the nature of which is ſo little underſtood, and of which the cure ſtill remains a deſideratum in medicine, the accounts hitherto given are very imperfect.

Our principal object ſhould certainly be to aſcertain the origin and progreſs of the ſymptoms, as they appear in the dog, in whom the diſeaſe appears to originate. The account of theſe ſymptoms, as given by different authors, is exceedingly contradictory. The beſt account that we have ſeen is that of Meynell of Quorndon in the county of Leiceſter, and which is publiſhed by Dr Arnold in his account of a caſe of hydrophobia. Before we give Mr Meynell's view of the ſymptoms, we ſhall quote a paſſage from that part of Mr Lawrence's treatiſe on horſes, in which he ſpeaks of canine madneſs. The paſſage is as follows. "The diagnoſtics of canine madneſs are, hunger and thirſt, without power to eat or drink; trembling, eyes fierce and flaming, hanging of the ears and tail, which is bent inwards; lolling of the tongue, foaming, barking of the dog at his own ſhadow, panting, running a ſtraight and heedleſs courſe againſt any thing in his way, biting with violence; other dogs fly him by inſtinct.

By comparing the above diagnoſtics with the following account of Mr Meynell's, it will be ſeen how little dependance is to be placed on the deſcription of thoſe who have not written from their own actual obſervation. We doubt not that Mr Lawrence derives his account from what he conceived to be the beſt information, and he is therefore not accountable for his errors.

According to Mr Meynell, the firſt ſymptom of canine madneſs in dogs appears to be a failure of appetite in a ſmall degree, that is, the dog does not eat his uſual food with his uſual eagerneſs, though, if better food be offered him, he may eat it greedily. A diſpoſition to quarrel with other dogs comes on early in the diſeaſe. A total loſs of appetite generally ſucceeds, though dogs ſometimes eat and lap water the day before their death, which generally happens between ſeven and ten days after the firſt ſymptoms have appeared. A mad dog will not cry out on being ſtruck, or ſhow any ſign of fear on being threatened; though he will, very late in the diſeaſe, appear ſenſible of kind treatment. A mad dog, in the height of the diſorder, has a diſpoſition to bite all other dogs, animals, or men. When not provoked, he uſually attacks only ſuch as come in his way; but having no fear, it is peculiarly dangerous to ſtrike at or provoke him. 513 Mr Meynell's account of the ſymptoms.

Mad dogs appear to be capable of communicating the infection early in the diſorder, and as ſoon as they begin to quarrel with and bite other dogs.

The eyes of mad dogs do not look red or fierce, but dull, and have a peculiar appearance, which is eaſily diſtinguiſhed by ſuch as have been uſed to obſerve it, but which is not eaſy to be deſcribed.

Mad dogs never bark, but occaſionally utter a moſt diſmal and plaintive howl, expreſſive of extreme diſtreſs, and which they who have once heard can never forget. So that dogs may be known to be going mad without being ſeen, when only this diſmal howl is heard from the kennel.

Mad dogs do not foam or froth at the mouth, but their lips and tongue appear dry and foul or ſlimy.

Mad dogs are generally ſufficiently ſenſible to know thoſe to whom they have been accuſtomed.

Mr Meynell is confident that dread of water is not a ſymptom of this diſeaſe in dogs.

Though mad dogs generally refuſe both food and drink, in the latter ſtage of the diſorder, yet they never ſhow any *abhorrence* or *dread of water*, will paſs through it without difficulty, and lap it eagerly to the laſt. But it is remarkable, that though they will lap water for a long time, and eagerly, and do not ſeem to experience any uneaſineſs from it, yet they do not appear to ſwallow a ſingle drop of it; for however long they may continue lapping it, no diminution of quantity can be perceived.

He has never known a dog ſhew ſymptoms of the diſeaſe in leſs time after the bite than ten days; and he has known many inſtances of dogs having died mad as late as eight months after the bite. The ſymptoms generally appear between three and eight weeks after the bite.

A dog had been bitten, and confined by accident, and

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and not from any suspicion of danger, for a whole year, so as to have no communication with any other dog all the time; and went mad at the end of that period.

Mr Meynell makes the following additional observations. "I am persuaded that the disorder never originates from hot weather, putrid provisions, or from any other cause but the bite. For however dogs may have been confined, however fed, or whatever may have been the heat of the season, I never knew the disorder commence, without being able to trace it to that cause; and it was never introduced into the kennel but by the bite of a mad dog. I do not say that I am certain that the disorder never originated from any cause except the bite; but I say that I never knew a dog go mad that I had no reason to believe had been bitten.

"Some dogs, in the last stage of the disorder, have a locked jaw.

"I do not recollect ever to have heard a dog bark after I have perceived symptoms of madness upon him.

"I consider an *unusual disposition to quarrel with other dogs as a certain sign of beginning madness;* and it is the only one I know.

"I believe the disorder always comes on so gradually that mischief may be prevented by proper care.

"I believe after symptoms have ever appeared, they never go entirely off; and that the disease, though sometimes very slow in its progress, always terminates in death.

"Dogs known to have been bitten frequently escape, but I believe not near so frequently as men.

"Almost all the mad dogs that I have seen have been confined.

"The hairs of a mad dog do not stand erect more than those of other dogs.

"I do not know that there is any thing remarkable in the manner of a mad dog's carrying his head or his tail.

"I do not know that there is any thing fierce in the appearance of the eyes of a mad dog. I believe I should know a mad dog to be mad from the appearance of his eyes, but I cannot describe this appearance.

"I do not know that a dog in the beginning of this disorder, is disposed to sneak away growling, or to shun the society of other dogs; but if I observed any thing particular in the manner of a dog, I should certainly confine him.

"I do not believe that dogs are more afraid of a mad dog than they are of any other dog that seems disposed to attack them."

(Mr Daniel was witness to an instance of this innate dread of a mad dog in other dogs, at Bradwell in Essex, where he was hunting with the reverend H. Bate Dudley. Mr Dudley walked his hounds to the water to swim them; he had himself swam over to an island about a hundred yards from the shore, and most of the hounds had followed him, but some of them could not be compelled to do so. At this juncture an alarm of a mad dog was given, who had been pursued many miles, and done variety of mischief in his progress; he seized one of the hounds that would not go into the water, and the remainder to the number of seven or eight immediately upon his approach to them, took to the water and swam across to those in the island *).

* *Daniel's Rural Sports.*

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"There are two kinds of madness, both of which I have known to originate from the bite of the same dog. Among huntsmen, one is known by the name of *raging* the other by that of *dumb madness*. In dumb madness, the nether jaw drops, and fixes; the tongue hangs out of the mouth, and slaver drops from it. In raging madness, I believe the mouth is shut, except when the dog snaps or howls, and that no moisture drops from it." *

* *Arnold on Hydrophobia.*

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The following facts and observations upon the consequences of the madness among Earl Fitzwilliam's hounds, perhaps mark the attack and symptoms of this disorder more accurately than any other description of a similar accident.

In the night of the 8th of June 1791, the man who slept in the kennel was unusually disturbed by the hounds fighting; he got up to quiet them several times, and always found the same hound quarrelling. Noticing the riotous behaviour of this particular hound, and at the same time an appearance of stupidity in him, he was induced to suppose that he was going mad, and accordingly confined him in a place by himself, after which the pack was quiet the remainder of the night. When the huntsman came to the kennel in the morning, he was told what passed, and the supposed mad hound shewn to him; his appearance was suspicious; some meat was given to him, part of which he ate, although there was an apparent difficulty in swallowing. Two days passed in suspense; but at the end of the third, his disorder was confirmed; and at the end of the fifth day he died mad. Immediate preparations were made for confining 42 couple of hounds separately, until the month of September, which was rigidly adhered to. By this means, Mr Hopkinson, a medical gentleman of Peterborough had an opportunity wherein he very skilfully and exactly minuted the symptoms and progress of this disease.

Six hounds went mad in the following order.

N° 1 attacked	July 1st.
2	August 3d.
3	September 3d.
4	Ditto 4th.
5	November 10th.
6	December 8th.

The hounds were first taken from their chains in September, and exercised for about half an hour together, not more than four or five couple at a time, and not trusted out of the sight of the attendant. When this exercise was over, they were again confined separately, and fed at separate troughs. In the beginning of October, they were taken out ten couple at a time; at the latter end of that month, twenty couple; still observing the same caution with respect to separate confinement after they returned from exercise. In the beginning of November they were hunted, but were chained up, as at first, after hunting, until the third week of that month, when they were let loose in different apartments of one, two, three, four, and five couple together. This regulation was continued till the month of June 1792, as the huntsman, who has had much experience in this disease did not deem them safe under a year.

The only remedy employed was mercurial ointment; and all the hounds, except the bitches that were in whelp, Diseases. whelp, underwent two frictions, so as to produce in some of them a violent salivation.

Mr Hopkinson remarks, that from the above statement it seems that the disorder is as virulent, as to the power of inoculation (by which process it is always communicated) at its commencement, as at the advanced stage of it; for all the six dogs that went mad were probably infected on the 8th of June, within a few hours of each other.

It is a common opinion, that when a dog is bitten by one that is mad, a few weeks confinement, sea-bathing, or the popular nostrums, are either of them sufficient to prevent his taking the disease, and from spreading its mischievous effects; but in this case, there was a fair opportunity of proving that there is no security after six months, perhaps not after twelve; that mercury has no certain power to prevent it; and it appears that the huntsman had repeatedly employed all the popular remedies, without any effect whatever. He had also observed nearly the same progress of the disease in several packs of hounds, where no expence had been spared, for every medicine in use, sea-bathing &c. In the present instance, there was this remarkable difference, that no internal medicine had been given, and the huntsman never knew fewer hounds attacked with the disease.

The result of the huntsman's experience in the preventive plan is therefore in favour of a separate confinement; for whenever he had depended on medicine, and not on the above plan of treatment, the disease had made dreadful havock.

There is reason to suppose that the hound which first went mad, was not bitten by any other dog, but that it was in him a spontaneous disease. The whole pack were examined very attentively, and bites found upon four couple, one of which was seen fighting with the mad hound twice; he underwent a longer confinement than the rest: however, none of them were attacked by the disease, and it is singular that no bites were discovered upon the six hounds that went mad. The infection taking place or not, is therefore perhaps the result of chance; yet, although no bites were perceived upon the hounds which went mad, there is every ground to conclude they were bitten, but that the wounds being small, were concealed by the hair. Mr Daniel suggests, that most probably there were bites within side of the lips, or jaws, where the venomous saliva might be more fatally and quickly absorbed into the habit, than where the teeth had to penetrate through the thick outer skin of the dog.

Mr Hopkinson continues his remarks with respect to the symptoms of madness in dogs, and states that those which distinguish the attack of the hydrophobia, are in general a loathing of food, although this is not universal, as they will sometimes eat solid food, but refuse liquid. The first and only symptom that N° 3. had of the disease, was eating his own excrement when food stood by him; the feeder knowing this to be contrary to what the dog would do if he were well, he immediately confined him. For a day or two he was in some doubt whether his suspicions were well founded; but he proved right, for the dog died raving mad upon the fifth day.

At the commencement of the disorder, the mad dog has a particular tendency (if loose) to lick and smell the penis and fundament of another dog; this should be looked upon as a very suspicious symptom. The huntsman speaks of this as an almost never failing one.

There seems for the first two or three days, to be intervals of sense; and during that time they usually recognise their master, their eyes look clear and well, their tongues moist, and of the proper colour; but if a dog is loose at this time, he will in general bite every thing he meets with. He will sometimes, during this stage of the disease, leave his home for several hours, spread his disorder by biting men and beasts, and return home again. The mad dog, when confined, seldom survives the fifth day from the first attack; if suffered to run about, there is reason to believe his death is hastended by a day or two. At the end of the third or fourth day, his appearance is much altered, his eyes are sunk, his tongue black and dry, he makes horrid howlings, and seems much disturbed; indeed the concluding scene is dreadful to witness. In the first stage of the canine madness, it is difficult for a person not conversant with the disposition of dogs in general, and of the mad dog in particular, to ascertain whether the dog is really mad or not; even Lord Fitzwilliam's huntsman was doubtful for a day or two respecting the hound mentioned in this account, as being the first attacked with the disease; however, in the advanced stage of it, no one can be mistaken.

It is the generally received opinion, that mad dogs will not take the water; but in the summer of 1791, there occurred in the neighbourhood of Petersborough, two instances of mad dogs, when closely pursued, swimming a large navigable river. A doubt might have arisen, as to their being mad, but that two hogs went mad from the bite of one, and the other was pursued for many miles by Lord Fitzwilliam's huntsman, who, from his experience in the disease, was not likely to be mistaken. Both dogs completely swam the river *.

* *Daniel's Rural Sports.*

515 Of all the remedies that have been employed for the cure of this dreadful disorder, none seems so likely to be successful as the cold bath. This remedy was recommended about 200 years ago by the Seigneur d'Esparron, in his "Fauconnerie," and he gives a curious instance of its success in the cure of a mad dog. "I will relate, (says he) what happened to a gentleman of my acquaintance. He discovered that some of his dogs had been bitten by a mad dog; and after some time, several of them betrayed symptoms of the disease. These he ordered to be killed; but it happened that one which was a great favourite was seized, and he desired his servant to throw him into the river. By chance, the dog in coming up from the bottom, got entangled in the roots of a tree by the cord with which he had been tied, but in such a manner that his nose just remained above the water. In this situation he remained for three days, at the end of which period he got loose and returned to the house, to the great astonishment of his master; and here I afterwards saw him, as chearful and healthy as before. I have no doubt (continues d'Esparron) that if mad dogs could be plunged into water without danger of their biting, they would all recover; and I believe that if the same practice were pursued with men, which might easily be done, many an unfortunate wretch might be saved. The danger of being bitten might be prevented by first putting a muzzle on the animal, and he might then be retained

tained in the water, as long as may be judged prudent or neceſſary. *"

* D'Eſparron Fauconnerie, p. 290

Another writer, Defouilloux, who publiſhed a work on hunting in 1583, recommends plunging into ſalt-water ſuch dogs as have been bitten, for the purpoſe of preſerving them from the effects of the diſeaſe.

As the effect of remedies when the complaint once appears is ſo uncertain, it ſhould be our principal object to uſe all the preventive means in our power. When, therefore, it is diſcovered that an animal has been bitten by one that is mad, the wounded part ſhould immediately be cut out, where this can be done with ſafety, or at leaſt ſhould be deeply ſcarified to the very bottom of the bite. The wound ſhould then be repeatedly waſhed with ſoap and water, or with a ſolution of ſoda poured upon it in a ſtream from a conſiderable height; and afterwards the wound ſhould be ſeared to the bottom with a hot iron; or where this cannot conveniently be done, a quantity of aquafortis, or oil of vitriol, ſhould be poured into it, ſo as to deſtroy all the remains of the virus or poiſon. If the part bitten be the ear, it ſhould be cut off and ſeared. After theſe means, it will be proper to plunge the animal once a day into cold water, or where convenient into the ſea; and he ſhould be ſtrictly watched, that if theſe means ſhould have proved unſucceſsful, the earlieſt appearance of the diſeaſe may be perceived.

Dr Arnold, to whom we are indebted for Mr Meynell's account of the ſymptoms of madneſs in dogs, gives the following advice with reſpect to the method of treating a dog that is ſuſpected of being mad.

516 "Though every dog that is bitten does not receive the diſorder, yet, as the time of its appearance after the bite is ſo very uncertain, and as a great proportion of thoſe that are bitten do actually receive it, and as there is no criterion by which we can aſcertain whether a dog has or has not received the infection, but the breaking out of the diſorder, it is earneſtly to be wiſhed, that all owners of dogs would immediately deſtroy, or ſecure for a great length of time, every dog known, or but ſuſpected, to have been bitten by a mad dog.

"It is alſo earneſtly to be wiſhed, that all perſons poſſeſſing dogs would immediately tie up or deſtroy ſuch of their dogs, whether known to be bitten or not, as ſhall begin to be diſordered in any way, of which the nature and cauſe is not perfectly obvious; and eſpecially if there be the ſmalleſt reaſon to ſuſpect that the dog was bitten, and that the diſorder is really an incipient madneſs.

"It is ſtill more to be wiſhed that they would immediately deſtroy all dogs known to be in any ſtage of madneſs, if it be at the ſame time known that they have not yet bitten any other animal, and particularly no perſon whatſoever; and that no dog that has bitten any animal or perſon be deſtroyed as a mad dog if it can be avoided, but that every dog be ſecured and tied up, that it may be certainly known whether he be mad or not. If he has the ſymptoms of confirmed madneſs, they will plainly diſcover themſelves, and he will die in ten days and leſs; if he is not, he may be ſafely enlarged in the ſpace of a fortnight, and the perſon bitten will be freed from the moſt diſtreſſing apprehenſions." *

* Arnold on Hydrophobia.

517 Worming of dogs.

Before we diſmiſs the ſubject of canine madneſs, it will be expected that we ſhould take ſome notice of the operation of worming dogs, ſo celebrated among huntſmen and breeders of dogs, as a ſuppoſed preventive of this dreadful malady. This operation is as old as the days of Pliny, and has ever ſince been more or leſs eſteemed among the vulgar. But neither the operation itſelf, nor its effect, ſeem to have been well underſtood. The idea of a worm being lodged in the tongue of the puppy, the extraction of which is to prevent the animal from going mad, is truly ridiculous; and as ſuch has been deſervedly laughed at by ſenſible people in all ages. But though it is neither a worm that is extracted, nor is the extraction a preventive of madneſs, it ſeems, however, pretty well aſcertained, that the performing of this operation is productive of conſiderable advantage, in preventing the dog from doing miſchief, even though he ſhould run mad. It ſeems, that in dogs who have been wormed, and are afterwards ſeized with hydrophobia, the tongue ſwells to ſuch a degree as to prevent the animal from cloſing his jaws upon the object which he attempts to bite. The following obſervations of a late ingenious and entertaining writer on the ſubject are entitled to much attention.

Very ſtrong proofs have been adduced of its utility; nor is it natural to imagine, that ſo eaſy and effective an operation would have been omitted, had no more virtue been attributed to it than it really poſſeſſes; and, wherein it failed, the abſolute prevention of madneſs was ſaid to be the conſequence; whereas the fact was and is, that taking out the worm hath nothing to do with annihilating the diſorder, although it will moſt certainly hinder the dog, ſeized with it, from doing any hurt to man or beaſt. A late author aſſerts, he had three dogs that were wormed, bit by mad dogs at three ſeveral periods, yet, notwithſtanding they all died mad, they did not bite to do any miſchief. that being determined to make a full experiment, he ſhut one of the dogs up in a kennel, and put to him a dog he did not value; the mad dog often run at the other to bite him, but his tongue ſo ſwelled, that he could not make his teeth meet. The dog was kept in the kennel until the mad one died, and was purpoſely preſerved for two years afterwards, to note the effect, but he never ailed any thing, although no remedies were applied to check any infection that might have been received from the contact of the mad dog.

Mr Daniel has had various opportunities of proving the uſefulneſs of worming, and inſerts three of the moſt ſtriking inſtances, under the hope of inducing its general practice.

A terrier bitch went mad that was kept in the kennel with 40 couple of hounds: not a ſingle one was bitten, nor was ſhe ſeen to offer to bite. The bitch being of peculiar ſort, every attention was paid to her, and the gradations of the diſeaſe (which were extremely rapid) minutely noted. The hydrophobia was faſt approaching before ſhe was ſeparated from the hounds, and ſhe died the ſecond day after. At firſt warm milk was placed before her, which ſhe attempted to lap, but the throat refuſed its functions; from this period ſhe never tried to eat or drink, ſeldom roſe up, or even moved; the tongue ſwelled very much, and long before her death the jaws were diſtended by it.

A ſpaniel was obſerved to be ſeized by a ſtrange dog, and was bit in the lip; the ſervant who ran up to

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Diseases. part them, narrowly ecaped, as the dog twice flew at him; a few minutes after the dog had quitted the yard, the people who had pursued gave notice of the dog's madness, who had made terrible havock in a course of ten miles from whence he had set off. The spaniel was a great favourite, had medicine applied, and every precaution taken; upon the fourteenth day he appeared to loathe his food, and his eyes looked unusually heavy; the day following he endeavoured to lap milk, but could swallow none; from that time the tongue began to swell, he moved himself but seldom, and on the third day he died. For many hours previous to his death, the tongue was so enlarged, that the fangs or canine teeth could not meet each other by upwards of an inch.

The hounds were some years after parted with, and were sold in lots. A madness broke out in the kennel of the gentleman who purchased many of them; and although several of these hounds were bitten and went mad, only one of them ever attempted to bite, and that was a hound from the duke of Portland's, who, in the operation of worming, had the worm broke by his struggling, and was so troublesome that one half of it was suffered to remain; the others all died with symptoms similar to the terrier and spaniel, viz. a violent swelling of the tongue, and a stupor rendering them nearly motionless, and both which symptoms seemed to increase with the disease.

The idea that worming prevents a dog from receiving the infection when bitten should be exploded; but the foregoing facts show how far it may be recommended for the restriction of a malady horrid in its effects where a human being is concerned, and which to the sportsman and the farmer is attended with such dangerous and expensive consequences.

We cannot pretend to say, what it is that the wormers of dogs take away from the tongue; but we cannot suppose, that Mr Daniel, though he calls it a worm, really believes that it is so. The following are his directions for performing the operation.

"The *worming* of whelps should be previous to their being sent out to quarters; this operation is to be performed with a *lancet*, to slit the thin skin which immediately covers the worm; a small *awl* is then to be introduced under the centre of the worm, to raise it up; the further end of the worm will with very little force make its appearance, and with a cloth taking hold of that end, the other will be drawn out easily. Care must be taken that the *whole* of the worm comes away without breaking; and it rarely breaks, unless cut into by the lancet, or wounded by the awl." *

* *Daniel's Rural Sports.*

518 Colic.

4. Colic. Colica. *Spasmodic* or *Flatulent Colic*, *Gripes*, *Bats*, *Trot*, or *Gulliom*. Tranchée, Fr.

This is one of the most painful disorders with which horses are affected; and it seems to occasion them as much distress as inflammation in the bowels, with which it is very commonly confounded by ordinary farriers.

In this disease the horse expresses his pain, by frequently lying down and rolling on his back, and after having remained a short time in this position, starting up again. The hair is staring, and there are sometimes cold sweats. He frequently makes attempts to stale, looks anxiously at his flanks, and sometimes strikes his belly with his hind feet. There is seldom any fever in this disease; and when it does occur, it is only after the disease has existed for some time. The pulse is seldom affected; but when the pain is very great, it is a little quicker than natural. The belly commonly feels hard and tense. Colic is almost always accompanied with costiveness, though griping pains not unfrequently attend severe scouring.

If the above symptoms are attentively examined, they will commonly serve to distinguish this disease from inflammation of the bowels. It is generally observed, that the pain in colic returns only at intervals, and the extremities are seldom cold. It must not be overlooked however, that when colic continues for a considerable time, it may terminate in inflammation, so that the distinguishing symptoms mentioned here and in N° 497. are to be depended on, only in the early stage of the disease.

Cattle are extremely subject to colic; but it is said to be more common in young than in old cattle. The symptoms do not differ from what we have described, only that it is said, that these animals, when affected with gripes, strike their heads and horns against every thing in their way.

Colic is easily removed, when the proper remedies are employed, before any symptoms of inflammation make their appearance; but if the remedies be delayed till inflammation takes place, the cure is very precarious.

Colic is very commonly the consequence of neglected costiveness, and by this it is always increased. It may be ascribed to improper food, especially such as is apt to produce flatulence or sourness in the stomach or bowels; by drinking cold water immediately after eating; and by exposure to cold, during violent sweating.

As it is not always easy to distinguish flatulent colic from inflammation, it is the safest plan to begin the treatment by bleeding, to the extent of three or four English quarts; and the appearance of the blood will generally inform us whether it will be necessary to repeat the operation. See N° 162. The next circumstance to be attended to, is the evacuation of the bowels by back-raking and softening clysters. In general, after this operation, a large quantity of air will be evacuated, and considerable relief will be afforded. After these means have been employed, some stimulating aromatics, such as oil of turpentine, oil of aniseed, essence of peppermint, or some of the other stimulants enumerated in N° 285, and 286, should be given by the mouth; and if these do not procure relief, it will be proper to give a ball containing half an ounce of calomel, and immediately after it, a drench of peppermint water, with five or six drachms of laudanum. The cure will be considerably assisted by rubbing the belly gently with a warm cloth; and the animal should be gently trotted, for a considerable time, while led by the halter. Warm fomentations to the belly have been recommended; but if there is a considerable accumulation of air in the stomach and bowels, these would do harm by increasing the expansion of the air, and thus adding to the animal's distress; for it must be remembered, that a horse cannot easily belch up wind by the mouth; and where there is any obstruction backwards, every thing that can increase the expansion

Diseases. expansion of the confined air, must do harm. On the contrary, every thing that is capable of diminishing the volume of air, may probably relieve the pain. It might be worth while to try how far the application of cold to the belly would be attended with advantage; and this might easily and safely be effected, by bathing the belly with strong spirit of wine, which speedily evaporating, will considerably diminish the temperature of the belly. It will be proper, where the disease continues obstinate, to administer warm softening clysters, every hour or two; as well for the purpose of obviating costiveness, as for removing the spasmodic constriction of the bowels. We are assured, that where most other means have failed, of procuring relief in flatulent colic, this has been obtained by means of the smoke of tobacco drawn up the fundament. The simplest way of administering this remedy, is to introduce the small end of a tobacco pipe, after having filled the bowl and lighted it; when the smoke will insensibly be drawn up by the action of the horse's bowels.

Chap. V. *Of Dropsical Diseases.*

519 Dropsy. Our domestic animals are sometimes affected with dropsy; and this may be either diffused through the cellular membrane below the skin; or the water may be contained within one or more of the cavities, as the head, the chest, and the belly.

520 Water farcy. External dropsy, or what medical writers call *anasarca*, and farriers *water farcy*, is not common, unless it accompanies a dropsical collection within the body. It sometimes affects particular parts, as the legs, the sheath, or the lips; and at other times it is diffused over the whole cellular membrane. It is known by the swelling of the part, which is cold, and retains the impression of the finger for some time. The urine is generally more sparing and of a deeper colour than is natural; and the animal appears considerably weak. This disease, when it has proceeded to any considerable height, and when the animal is much debilitated, is not easily removed; but when it is slight, and of no long standing, it will in general yield to remedies.

All the species of dropsy more commonly affect old than young animals; and such as are debilitated by any previous cause, are more subject to it. It is said that horses are more likely to become dropsical in spring and autumn when they are moulting.

The cure of general dropsy is to be attempted by the use of diuretic medicines, accompanied with a nourishing diet, gentle exercise, and frequent friction all over the body, especially over those parts where the accumulation of fluid is situated. The action of the diuretics must be assisted by a sufficient quantity of drink; and it will be proper to give the animal some of the more powerful strengthening remedies, such as white vitriol, oak bark, logwood, &c.

521 1. Dropsy of the Head. Hydrocephalus. *Sturdy. Turnsick.*

Dropsy of the head seldom affects horses or cattle; but a peculiar collection of water in the head is very common among sheep, in whom it is called the *Sturdy*, or *Turnsick*. One of the best accounts of this disease that we have seen is that which is given in the second appendix to Mr Findlater's survey of Peebles, which we shall give nearly in the words of the author.

This disease is peculiarly incident to young sheep, or hogs, of a year or eighteen months old. It consists of a collection of water generally formed upon the external surface of the brain, immediately below the skull; and sometimes, though not often, in the center or ventricles of the brain. When the water forms in the last mentioned parts, we apprehend it is almost universally mortal.

The disorder is first discovered, by the animal not keeping up with the rest of the flock, and by its appearing dull and stupid. It is afterwards observed to go round in a giddy manner; and at length it appears blind, and the pupil of the eye seems wide and relaxed. It may continue a long time in this situation before it dies; and it is believed that sheep sometimes recover of this disease without any thing being done for them. They are often in good order when they die, as they continue to feed tolerably well, until near the last period. Though some recover, with or without means, perhaps it may be most advisable to kill them early in the disease, provided they be in good order, as this local distemper does not affect the goodness of the mutton.

When the collection of water is on the outside of the brain, it is often cured by thrusting a sharp wire up the animal's nostrils, until it reaches the water, and opens a passage for it to run off. In other cases, it is cured by an operation which some shepherds perform very dexterously. The water is contained in a bladder, or vesicle, (a *hydatid*) generally about the size of a walnut. The part of the skull immediately above where it is situated, feels softer than other parts. This the shepherd discovers, by pressing with his thumb and fingers, upon different parts of the fore and upper parts of the skull. The bone here has become thinner, and feels soft; from which he is certain that the watery collection is formed. After the disease has gone on a considerable time, and he judges it ripe for the operation, he raises the scalp, and lays the bone bare to a sufficient breadth, with a sharp knife; he then discovers more accurately the extent of the thin soft part of the bone, and with a strong and sharp-pointed knife, he makes a circular incision in the skull, raises up, and takes out the part. He then sees the clear thin bladder underneath, which he lays hold of with a small hook, or the point of a needle, and gently draws it out; taking all possible care that it be not broken, or the water spilled, which would prove unfavourable to recovery. He finds a considerable hollow in the brain where the bag was situated, over which he brings the flap of skin that was raised, so as to cover it as neatly as possible. Over the whole he applies a plaster of tar, and leaves the rest to nature. This operation frequently proves successful.

Mr Findlater remarks, that in Tweeddale, one case in three, where a perforation is made by the pointed wire, or the trepan, usually ends favourably. Of late it has been the custom among the shepherds of that district, to bore into the skull of sheep affected with the sturdy, with a common gimblet; and however rough or apparently dangerous the operation, it seems frequently to prove successful. The perforation is made by boring from the root of the nostril, in an oblique direction

Diseases. direction to the root of the horn on the opposite side of the head.

2. Water in the Chest. Hydrothorax.

522 Dropsy of the chest. This complaint appears but seldom in the inferior animals: but it may take place from excessive debility; and according to Mr Blaine, it is sometimes the consequence of inflammation in the lungs. Here however this writer is probably mistaken, and confounds water in the chest with *empyema*, or a collection of matter within the chest, which is not an uncommon termination of *pneumonia*.

When dropsy in the chest does occur, the animal labours under a difficulty of breathing, especially when lying down; and the pulse is feeble, and commonly irregular. The urine is scanty and high coloured. If the collection of water is pretty considerable, it may be perceived by the sound that is produced, when the chest is struck with the hand; but this is often a deceitful sign, and should not be tried till a long time after the animal has drunk; as, for some time after drinking, the water that remains in the stomach will, when the ribs are struck, produce a sound that might lead us to suppose there was water in the chest.

This complaint commonly proves fatal, both in man and animals, and probably there is no means of cure except by evacuating the water, by an opening into the chest; an operation which is always precarious, and commonly as dangerous as the disease which it is intended to relieve. If it is determined however to try the experiment, the opening should be made between the seventh and eighth rib, near the breast bone, on that side of the chest where the water is supposed to be accumulated. In making the opening, the skin should be drawn tight towards the edge of the seventh rib; when a cut is to be made in the place above directed, with a sharp knife, not cutting too boldly, but rather scratching with the point of the knife, till the skin and the muscles are completely divided. After this, a pipe must be introduced through the opening, and fastened by a bandage round the animal; some soft linen or a piece of sponge being placed over the opening, after as much water as possible has run off, to suck up the remaining moisture, and exclude the air.

3. Water in the Belly. Ascites.

523 Dropsy of the belly. This is the most common species of dropsy, and is known by the general symptoms of dropsy that have been described in N° 319. and 320. attended with an unusual swelling of the belly; while the skin is cold, and very tight. When the belly is struck with one hand, while the other is held upon the opposite side, a fluctuation may be perceived, much more distinctly than in the last species.

It is brought on by the usual causes of dropsy that we have already mentioned, and is not an uncommon consequence of jaundice and other chronic disorders. It is not quite so dangerous as dropsy in the chest, but it is very apt to return after having been removed.

The treatment should be begun with diuretics, and now and then a mercurial purge, while the body is strengthened by tonic medicines, nourishing diet, and gentle exercise. If the accumulation of water becomes very great, it may be easily evacuated, by making a puncture into the belly, and introducing a pipe as in the last case. Mr Lawrence has gone into the mistake generally committed, of supposing that little drink should be given in cases of dropsy. It is now well ascertained that moderate drinking considerably increases the efficacy of diuretic medicines.

Chap. VI. *Of Anomalous Diseases.*

1. Diabetes. *Profuse Staling*, or *Pissing-evil.*

It sometimes happens, that horses or cattle make a much greater quantity of urine than is natural; so that the quantity evacuated exceeds the quantity of fluid drunk by the animal. Probably this disease occurs more frequently among cattle than among horses, though it is scarcely mentioned by the writers on cattle medicine, and the account that is given of it by veterinary writers is extremely imperfect. Mr Blaine describes the urine, as being five or six times the natural quantity, as milky or watery, and depositing a sediment which has the taste and appearance of sugar. As we have never observed a case of this disease in horses or cattle, we cannot say how far this description of the urine is correct; but if the urine evacuated by these animals in *diabetes* resembles the human urine in the same disease, it is clear and almost colourless, has the smell and taste of honey, deposits little sediment, but on being evaporated, leaves a thick substance like treacle. 524 Profuse staling.

Considerable thirst accompanies this disease; and when it has continued long, the animal becomes extremely weak and emaciated. The skin is usually dry and harsh, the pulse is small and quick, and the appetite in the early part of the disease is much increased.

This complaint commonly proves fatal; few instances of a recovery having been observed in man; and we do not know that any successful case in any of the domestic animals is on record.

The causes of *diabetes* are very obscure, especially in the inferior animals; it seems to be the consequence of great weakness, and some unusual action of the digestive organs. The various theories that have been given in explanation of this disease, as far as relates to the human body, will be noticed in the article Medicine and if we shall meet with an opportunity of examining the disease in horses or cattle, we will endeavour to give a more accurate account of it, under Veterinary *Art.*

In the treatment of *diabetes* in horses, &c, the method proposed by Dr Rollo for the cure of this disease in man, has been recommended, and we believe adopted, by Mr Coleman; with what success we cannot say. This method consists in making the animal abstain as much as possible from vegetable food; and giving him broth and balls made of flesh, mixed up with paste of wheat flour. He should have as little drink as possible. Astringent remedies are commonly employed in these cases, such as Japan earth, alum, white vitriol, muriate of iron, oak bark. See receipts, N° 29.

2. Black-Quarter, Quarter-Ill, or Black Spald.

There is a disease that proves very fatal in some districts to calves or cattle of a year to two old, the nature of which is little understood, but it seems nearly allied 525 Quarter-ill.

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allied to the *Hawkes* or *Hacks*, described in N° 428. Mr Lawrence considers the disease as appearing under various forms, to which he gives the following names; *shewt of blood; vomit of blood; blood in the back; blood in the legs*, or *crateuch; blain in the tongue*, or *overflow of blood; striking-in*, or *rising of the blood; higham*, or *iron-striking; joint murrain*, or *garget; black quarter; quarter-evil; black leg*.

We have given as a synonym the name of *black spald*, because we consider the disease so called in Scotland, as nearly, if not entirely, the same with the *black quarter* of the writers on cattle medicine. As we have not seen the disease, we shall copy what Mr Lawrence says of it, in his treatise on cattle.

"All our animals, oxen, sheep, and pigs, I have observed, are subject to sanguineous effusion or overflow of the blood, on being put in a low and weak state, to rich or succulent keep. They very commonly drop on a sudden, and die in the blood, as it is termed; when the carcases putrify almost immediately, and are totally lost. Pigs which die in this way, have their skins so universally suffused with the blood, that they appear enveloped, or rather shrouded in Morocco leather. In oxen, chiefly young cattle, nature commonly finds a vent for the disease, in an eruption on the leg, quarter, or shoulder, attended with *pneumatosis* or a collection of air in the cellular membrane, or, as it is commonly termed, between the flesh and the skin; whence the crepitating or crackling noise, which is heard on pressure. Another termination of the disease, is, by a deposition of matter upon the joints, whence the term of joint garget or murrain. I know not whether I am correct in referring the *crateuch* to this class, which is said, in Scotland, to be a swelling and lameness in the legs; but the old writers particularly mention *blood in the legs. Blane* or *garget in the tongue*, attended with inflammation and vesicles or bladders in that part, is said to be a symptom of the disease, and also to arise from heat and fatigue.

"This disease has swept off great numbers of yearling and two-year-old cattle, and become indeed endemial in certain districts, where any such scourge was unknown, it is said, previously to the introduction of artificial grasses, with the full feeding on which the animals become surfeited: thus the improvident use of good produces evil. The breeders being alarmed at the ravages occasioned by this murrain, which generally carried off the forwardest and best of the cattle, no wonder that the fertile brains of cow-doctors, were put into intestine motion, and that the ideas of the favourite engines, the knife or fire, were whirled uppermost. In effect, some skilful leech introduced the following most extraordinary operation, as a preventive of the disease in question; which I apprehend in the contemplation, either of physiology or common-sensology, could have no better prophylactic or preventive view, than shaving the animal would have; which I beg leave to recommend in the stead, as at least free from cruelty. The ill-starred beast is cast, bound to a stake, all his four legs are cut open from the claws upwards to the height of several inches, in order to find among the tendons and ligaments a strong blood vessel of a bluish colour, which said offending vessel, guilty of the original sin of producing joint murrain, being caught with a crooked needle, is cut away. It is great pity, for the sake of hypothetical uniformity, that the above-said blood-vessel had not been called a worm, since the brains of so many of our cattle folk have been infested with worms from very high antiquity *".

After much jocose, but rather coarse ridicule of methods that have been proposed for the cure of this disease, Mr Lawrence thus proceeds. "Prevention of this malady is the only cure worth notice: because, after the attack, the very nature of the case renders all remedy either uncertain, or of very little profit, even if successful, on account of the expence of time and money. With this view the young cattle must not be pushed so forward in condition; and indeed the same precaution may be useful in some degree, with respect to the full aged. A piece of short or inferior keep should be reserved, as a *digesting place*, in which the cattle may be occasionally turned to empty and exercise themselves. Those observed to advance very fast may be bled monthly for several months: of the efficacy of which practice, however, I have by no means so good an opinion as that of giving medicines which prevent internal obstruction. I am well aware of the difficulty, or rather total impracticablity, of such measures with a number of cattle in the field, or I am convinced, that occasional purges, or alterative medicines, would prevent those diseases which seem to take their rise in over repletion and accumulation. Six drachms, daily, of equal parts, sulphur and antimony, in fine powder, would be sufficient for a young beast; but to be of any permanent use, it must be continued at least a month; or salt might be of use. Rowelling also might be an efficacious preventative. Keep two rowels or setons open in each beast during several months." †

In the 5th vol. of the Farmers Magazine, is the following communication from a practical farmer respecting the cure of this complaint.

"The first cure for this complaint that I ever saw performed, was on an ox of four and a half years of age. As he was going in the plough, I observed him a little lame in one of the hinder feet. At first I thought he had trampled upon a stone; but as it still grew worse, I soon suspected it was the quarter-ill; the more so, as there was a good year-old died of that disorder three weeks before. By the time he was got to the byre, the crackling between the skin and the flesh was very perceptible on the top joint of the off-side hinder leg. As our blacksmith had some skill among live stock, he was instantly sent for. The first thing he did was to take a little blood from a vein in the neck. He then pulled the skin from the flesh on the side that seemed most pained, still keeping the beast walking as much as possible. He then caused cold water to be poured in large quantities on the part affected, still rubbing and keeping the skin loose on the affected part. Finding the skin to adhere much to the flesh, he then made three cuts with a penknife, two inches long, into which he rubbed salt and water. In this manner he continued four hours; the one time driving him, then pouring on water, rubbing in salt, and loosening the skin from the flesh. By this time he was not near so cripple, and began to take his food. We were ordered, however, to keep him in motion all night, and in the morning he was well for his food, and never had any more signs of the disease. Since that time I have followed the blacksmith's practice, and have often been successful. Only instead of pouring water on the place, I fasten a rope

* *Lawrence on Cattle*, p. 584.

† *Ibid.* p. 588.

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3. On the Rot in Sheep. *General or True Rot.* Hydropic Rot.

526 Rot in sheep. The name of the rot in sheep, and the ravages that are annually made by it among the flocks of most sheep districts, are familiar to every one; but little pains have been taken to fix the precise meaning of the word, and the particular disease, to denote which it should be exclusively employed. Some of those who appear to have paid particular attention to the subject, have yet followed the example of shepherds and farmers, in confounding under the name of *rot*, several diseases which differ considerably in their nature, causes, and method of treatment. Two medical men who have lately published; the one, Dr Dickson, on the General Management of Sheep, as connected with practical agriculture; the other, Dr Harrison, on this particular subject of the *rot*, have still considered it as one disease. In the second appendix to Mr Findlater's Survey of Peebles, and in the fourth number of the Edinburgh Medical and Surgical Journal, the distinction of the rot into three different morbid affections, is, however, clearly marked; and there seems no doubt that these three diseases are very similar to consumption, hepatitis or inflammation of the liver, and scurvy, in the human body. The first of those which we have briefly noticed in N° 490. under the name of *pulmonic rot*, is distinguished by cough, hectic fever, wasting of flesh, and in many cases by the formation of a watery swelling below the chin. The second, mentioned by the name of *hepatic rot* in N° 493. is characterized by a degree of fever accompanied by inflammation, and thickening of the outer coat of the liver, or some diseased state of the biliary ducts or pipes, connected with the presence of flukes in the liver, if not sometimes produced by them. The third species has been called *general rot*, as in this the whole system is more or less affected; *true rot*, because it appears to be the most common of the three, and to be that to which the name seems more peculiarly applicable; and *hydropic rot*; because, if the animal is suffered to live, the disease commonly terminates in partial or general dropsy. This species is what we are now to consider; and after having given as clear an account of it as we can collect from the descriptions that have been lately published, we shall make a few observations on the causes, treatment, and prevention of the *rot in general*, endeavouring as much as possible to discriminate between the three varieties.

527 Symptoms of general rot. It is probable that the first symptoms of the rot have seldom been observed. The earliest marks of the disease of which writers give an account, are, falling off in flesh, and an unusual dullness and heaviness. The flesh feels loose and flabby, especially about the loins; and if pressure is made about the hips, a crackling is sometimes perceptible. It is said that those who are accustomed to handle the ears and legs of sheep, may in the earliest stage of rot discover symptoms of *low fever*, but probably this is the case only in *pulmonic* and *hepatic rot*. Now, or soon afterwards, the countenance looks pale, as do the gums and tongue. On parting the fleece, the skin is found to have lost its fine rosy colour, and is become of a pale red. As the disease advances, the skin appears dappled with yellow and black spots. The eyes have a peculiar appearance; they lose their lustre, and look like the eyes of dead fish. Mr Findlater says, that in Tweeddale, the principal mark of rottenness is taken from the appearance of the eye in the corner next the nose, when the eyeball is turned so as to look away from the nose; as the flesh that adheres to the eyeball below the eyelids, in the corner next the nose, is in a sound sheep of a florid red colour; whereas in a rotten sheep, the flesh is of a dull appearance, and of a yellowish red colour, resembling that of a rotten egg, when the white and the yolk are confounded together. When the disease has continued long, the breath becomes fetid, the gums spongy, the teeth and sometimes the horns loose, the animal is commonly affected with a scouring, the fleece looks torn and ragged, and the wool separates from the skin with a slight pull. Great weakness and emaciation attend the latter stage of the disease; and these continually increase till the animal dies, or till dropsy comes on, which always terminates fatally.

The principal appearance on dissection is presented by the liver, which is found in various states, according to the progress or severity of the disease. When a sheep is killed a few days after contracting the rot, the thin edge of the small lobe of the liver appears of a transparent white or bluish colour, and this colour spreads to a greater extent according to the severity of the complaint. Sometimes it does not extend more than an inch from the edge; at others it occupies a considerable part of the lobe. In severe cases, the whole external coat of the liver is found diseased, commonly assuming an opaque colour interspersed with lines or patches of a darker red. The upper part of the liver is sometimes found speckled like the back of a toad, to which it is said to bear a striking resemblance. Very commonly the liver is found full of hard knots, and sometimes there are ulcers in various parts of it. Are not some of these appearances peculiar to the hepatic rot? When the liver of a sheep affected with the rot is boiled, it loses its consistency, and breaks down into small pieces; whereas it is well known that a sound liver becomes by the same process firm and solid.

When sheep have died suddenly in the first stage of this disorder, there may commonly be discovered a quantity of wheyish-coloured fluid in the cavity of the belly; and in these cases the outside of the liver is generally covered with a coat of coagulable lymph. This is one of the appearances described by Dr Harrison; and is similar to what is often observed in the belly of animals that have died of dropsy in the belly.

In stating the causes and treatment of *general rot*, we cannot perhaps do better than copy what is given on this subject in Mr Findlater's survey of Peebles, to which 528

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which we have already been so much obliged. "It arises from deficient or bad aliment, whether the food itself be bad and scanty, or the animal be incapable of digesting it properly. It is most common from the former cause, want of food; and the disease is much the same with scurvy among the human race. In addition to these causes, whatever tends to depress the spirits, frequently excites, or at least exasperates, the malady. It is said that soldiers in a garrison have been known to be seized with the scurvy on hearing bad news; and I doubt not but terrifying sheep with dogs, or other means, may produce or aggravate this disease. We may hence see what mischief a fox chase, or any exhibition of that sort, is calculated to bring upon a flock of sheep. The disease is also said to be produced by feeding upon watered grass; and hence shepherds, in many parts of Scotland, are careful to keep off their sheep from the tender grass produced by the occasional overflowing of rivulets. Feeding also in marshy and damp pastures, is known to be a powerful cause of the rot.

"The only means of cure are, a supply of good and wholesome food, and invigorating the stomach by permitting the animal to feed on those stimulating and aromatic herbs which are agreeable to its taste. It is believed that on dry sweet pastures, where there is a sufficient quantity of furze and broom, juniper, and other shrubs that are palatable to sheep, the rot is seldom heard of. When ground is sown down for sheep pasture, parsley, thyme, peppermint, and other aromatic herbs, should be sown with the grass seeds, as these plants serve both to prevent and to cure the rot. In addition to these means of cure, every thing that tends to annoy or depress the animal in its weakly state ought to be avoided.*

* Findlater's Survey, p. 404.

529 The following facts with respect to the production of rot, considered as a general disease, are chiefly taken from Dr Harrison's Inquiry.

Poor, clayey, and loamy lands are most subject to rot.

Grounds that are always dry, or always under water, and such as are always sufficiently wet to preserve a constant running of water, were never known to suffer from the rot.

Ponds of living water are equally safe; but when attempts to drain lands have been made, and have not fully succeeded, sheep which feed on such lands are very much exposed to the rot.

Grounds newly laid down for pasture, or ploughed fields that have been exhausted by repeated crops, where the sward is thin, and where the water remains in plashes for want of proper outlets, are peculiarly subject to the rot.

Marshes that are overflowed by the sea, and boggy situations, especially in Ireland, are seldom known to rot.

Lands that have been limed, and many soils that are chiefly composed of calcareous matter, are considered as very likely to produce the rot.

Ewes that are with lamb, or are giving suck, are less liable than other sheep to be affected with the rot.

Eight causes have been assigned for the production of rot, viz.

1. A vitiated dew. It is stated in the survey of Lincolnshire, that a shepherd, who when young, was shepherd's boy to an old man that lived at Nettlam near Lincoln, a place famous for the rot, declared his persuasion that sheep took the rot, only in a morning before the dew was well off. His master's shepherd always kept his flock in fold till the dew was gone, and with only this attention his sheep were kept sound when all his neighbours lost their flocks. Dr Harrison remarks, that if this cause were just, the rot should appear equally on all lands.

2. The disease has been attributed to a grust or earthy sediment that adheres to the grass after wet weather, or after the overflowing of running water.

3. It has been supposed to be owing to the luxuriant and quick growing herbage that is produced in hot moist seasons. But all luxuriant pastures do not produce the rot.

4. It has been attributed to the sheep grazing on some particular herbs, such as the butterwort (*pinguicula vulgaris*), the white rot (*hydrocotyle vulgaris*), round-leaved sundew (*drosera rotundifolia*), and long-leaved sundew (*drosera longifolia*); but these plants do not grow on every rotting soil.

5. The disorder has been imputed to flukes in the liver. We have already stated our opinion, that flukes may produce the hepatic rot.

6. The rot has been supposed to depend on the infection of *sheep-pox*. This opinion seems to have arisen from a confusion of terms.

7. M. Daubenton considered the disease to be produced by poverty of food, and too much water. There is no doubt that these causes commonly produce the last species of rot which we have mentioned.

530 Dr Harrison's theory of the rot.

8. Dr Harrison is of opinion that the rot is always generated by the exhalation or effluvia produced by the action of the sun's rays on soils that are partially covered with stagnant water. After adducing a number of ingenious arguments in support of his opinion, Dr Harrison sums up the amount of his doctrine in the following manner.

"From the various circumstances enumerated, I think I am justified in attributing the rot in sheep and other animals to paludal effluvia; but with respect to their nature and constitution, it is very difficult to form any rational judgment, as they have hitherto eluded the most subtle and delicate inquiries. It must, however, be admitted, *si causa latet, vis est notissima*; and consequently the subject, from its great importance to the public in general, is entitled to a serious investigation.

"Without heat and moisture, no deleterious vapours can be generated; and yet it is equally certain, that both these causes are insufficient to produce either a recurrent fever, or the rot, since they are confined to particular situations. Other auxiliaries are therefore necessary; and I am inclined to believe that vegetable or earthy particles, and probably both, are required, as well as heat and moisture, to constitute the noxious emanations or gasses called *miasmata paludum*.

"Probably it will be found, on further inquiry, that a great variety of animal and vegetable effluvia are extricated in different places; and that many disorders should be attributed to them, which are at this time imputed to other causes.

"Poisonous vapours are extremely active and sudden in their effects, of which proofs may be found in the history

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history of every contagious and endemic disorder. We have, therefore, no reason to be surprised, that sheep and animals are so immediately affected by pasturing in moist places, where these effluvia are copiously produced in hot weather. Other causes operate slowly, and require such a long-continued application, that I do not think the rot can be induced by them, though I am of opinion, that by occasioning general weakness, they make the constitution more susceptible, and lay it more open to morbid impressions. In the human body, we know that fatigue, cold, fasting, and other debilitating causes, are efficacious auxiliaries, although of themselves they are totally inadequate to produce any contagious disorder. They, therefore, seem to contribute equally, and in the same manner, to facilitate the operations of marsh miasmata, upon the human body and other animals *."

It is said, that for a short time after contracting the *rot*, sheep feed more heartily than usual; and for this reason, butchers and graziers, when they wish to fatten sheep speedily for the market, not unfrequently turn them into a rotting pasture.

The prevention of the *rot* will be easily suggested by attending to the facts and observations that have just been given, as it consists in avoiding the causes that seem to produce it, and avoiding or correcting the soil where it is found most readily to take place. "It is confidently asserted, that decoctions of bitter herbs, with salt, have frequently preserved sheep from the *rot*. Salt is supposed to constitute a part of Fleet's celebrated nostrum; and we know that bitters are deservedly recommended to prevent intermittents, the dysentery and other disorders, which originate from exhalations.

"In Oxfordshire, Dr Lower has frequently known six or seven spoonfuls of strong brine, and stale urine, with soot steeped in it, to be given with great success. This is done at spring and fall of the year, when the dew is counted the most dangerous. This course of physic is continued eight or ten days, or till the sheep eat their meat heartily; and if they were taken in time, there seldom died any in a whole flock. For the same purpose, Ellis recommends the following medicine in his practical husbandry.

"Take a peck or better of malt, and mash it as though you would brew it into ale or beer, and make eleven or twelve gallons of liquor; then boil in it a quantity of shepherds purse, comfrey, sage, plantain, penny-royal, wormwood, and bloodwort; add yeast, and afterwards salt, to the mixture; then turn the liquor into a vessel. After April comes in, give seven or eight spoonfuls to every sheep, once in the week, if the weather be wet; and if dry, not so often *."

* *Harrison on the Rot*, p. 31.

* *Harrison on the Rot*, p. 41.

ERRATA.—N° 84. We have inadvertently hinted that Mr Feron's work on farriery has neither index nor table of contents. It has no table of contents, but it has an index.

N° 93. For 1803, read 1805.

N° 518. For *Trot*, read *Fret*.

I N D E X.

Bourgelat's

Farthing.

FARTHING, a ſmall Engliſh copper coin, amounting to one-fourth of a penny. It was anciently called *fourthing*, as being the fourth of the integer or penny.

FARTHING *of Gold*, a coin uſed in ancient times, containing in value the fourth part of a noble, or 20d. ſilver. It is mentioned in the ſtat. 9 Hen. V. cap. 7. where it is enacted, that there ſhall be good and juſt weight of the noble, half-noble, and farthing of gold.

FARTHING *of Land* ſeems to differ from FARDING-*deal*. For in a ſurvey-book of the manor of Weſt-Hapton in Devonſhire, there is an entry thus: A. B. holds ſix farthings of land at 126l. per annum. So that the farthing of land muſt have been a conſiderable quantity, far more than a rood.

Faſces.

FASCES, in Roman antiquity, axes tied up together with rods or ſtaves, and borne before the Roman magiſtrates as a badge of their office and authority.

According to Florus, the uſe of the faſces was introduced by the elder Tarquin, the fifth king of Rome; and were then the mark of the ſovereign dignity. In after times they were borne before the conſuls, but by turns only, each his day; they had each of them 12, borne by as many lictors. Theſe faſces conſiſted of branches,

branches of elm; having in the middle a securis or axe, the head of which stood out beyond the rest. Publicola took the axe out of the fasces, as Plutarch assures us, to remove from the people all occasion of terror. After the consuls, the pretors assumed the fasces. In the government of the decemvirs, it was the practice at first for only one of them to have the fasces. Afterwards each of them had twelve after the manner of the kings.

When the magistrates who by right had the axes carried before them, had a mind to show some deference to the people, or some person of singular merit, they either sent away the lictors, or commanded them to lower the fasces before them, which was called *submittere fasces*. Many instances of this occur in Roman history.

FASCETS, in the art of making glass, are the irons thrust into the mouths of bottles, in order to convey them to the annealing tower.

FASCIA, in antiquity, a thin sash which the Roman women wrapped round their bodies, next to the skin, in order to make them slender. Something of this sort seems also to have been in use amongst the Grecian ladies, if we can depend upon the representation given by Terence, Eun. act. ii. sc. 4.

Haud similis est virginum nostrarum, quas matres student
Demissis humeris esse—vincto corpore, ut graciles fiant.

FASCIA, in *Architecture*, signifies any flat member having a considerable breadth and but a smal projecture, as the band of an architrave, larmier, &c. In brick buildings, the juttings out of the brick beyond the windows in the several stories except the highest are called *facias* or *faciæ*.

FASCIA Lata, in *Anatomy*, a muscle of the leg, called also *semi-membranosus*. See ANATOMY, *Table of the Muscles*.

FASCIÆ, in *Astronomy*, the belts seen on the disk of the superior planets, Mars, Jupiter, and Saturn.—See ASTRONOMY, *passim*.

FASCIALIS, in *Anatomy*, one of the muscles of the thigh, called *sartorius*. See ANATOMY, *Table of the Muscles*.

FASCINATION (from the Greek βασκαινειν, to *fascinate* or *bewitch*), a sort of witchcraft supposed to operate either by the eye or the tongue.

Ancient writers distinguish two sorts of fascination, one performed by looking, or the efficacy of the eye. Such is that spoken of by Virgil in his third eclogue:

Nescio quis teneros oculus mihi fascinat *agnos.*

The second by words, and especially by malignant praises. Such is that mentioned by the same poet in his seventh eclogue:

Aut, si ultra placitum laudârit, baccare frontem
Cingite, ne vati noceat mala lingua futuro.

Horace alludes to both kinds in his first book of epistles:

Non istic obliquo oculo mea commoda quisquam
Limat, non odio obscuro, morsuque venenat.

FASCINATION of serpents, a faculty which these animals are supposed to possess of attracting birds from the air, and making them their prey. See OPHIOLOGY *Index*.

FASCINES, in *Fortification*, faggots of small wood, of about a foot diameter, and six feet long, bound in the middle, and at both ends. They are used in raising batteries, making chandeliers, in filling up the moat to facilitate the passage to the wall, in binding the ramparts where the earth is bad; and in making parapets of trenches to screen the men. Some of them are dipped in melted pitch or tar; and, being set on fire, serve to burn the enemy's lodgments or other works.

In corrupt Latin *fascenina*, *fascennia*, and *fascinata*, &c. are used to signify the pales, fascines, &c. used to enclose ancient castles, &c.

FASCIOLA, the FLUKE or GOURD WORM, a genus belonging to the order of vermes intestina. See HELMINTHOLOGY *Index*.

FASHION-PIECES, in the sea language, the aftmost or hindmost timbers of a ship, which terminate the breadth, and form the shape of the stern. They are united to the stern-post, and to the extremity of the wing-transom, by a rabbit, and a number of strong nails or spikes driven from without.

FAST, in general, denotes the abstinence from food, (see FASTING); but is more particularly used for such abstinence on a religious account.

Religious fasting has been practised by most nations from the remotest antiquity. Some divines even pretend its origin was in the earthly paradise, where our first parents were forbidden to eat of the tree of knowledge. But though this seems carrying the matter too far, it is certain that the Jewish church has observed fasts ever since its first institution. Nor were the neighbouring heathens, viz. the Egyptians, Phœnicians, and Assyrians, without their fasts. The Egyptians, according to Herodotus, sacrificed a cow to Isis, after having prepared themselves by fasting and prayer; a custom which he likewise ascribes to the women of Cyrene. Porphyry affirms, that the Egyptians, before their stated sacrifices, always fasted a great many days, sometimes for six weeks; and that the least behoved to be for seven days: during all which time the priests and devotees not only abstained from flesh, fish, wine, and oil; but even from bread, and some kinds of pulse. These austerities were communicated by them to the Greeks, who observed their fasts much in the same manner. The Athenians had the Eleusinian and Thesmophorian fasts, the observation of which was very rigorous, especially among the women, who spent one whole day sitting on the ground in a mournful dress, without taking any nourishment. In the island of Crete, the priests of Jupiter were obliged to abstain all their lives from fish, flesh, and baked meats. Apuleius informs us, that whoever had a mind to be initiated in the mysteries of Cybele were obliged to prepare themselves by fasting ten days; and, in short, all the pagan deities, whether male or female, required this duty of those that desired to be initiated into their mysteries, of their priests and priestesses that gave the oracles, and of those who came to consult them.

Among the heathens fasting was also practised before some of their military enterprises. Aristotle informs us, that the Lacedemonians having resolved to succour a city of the allies, ordained a fast throughout the

the whole extent of their dominions, without excepting even the domestic animals: and this they did for two ends; one to spare provisions in favour of the besieged; the other to draw down the blessing of heaven upon their enterprise. The inhabitants of Tarentum, when besieged by the Romans, demanded succours from their neighbours of Rhegium, who immediately commanded a fast throughout their whole territories. Their enterprise having had good success by their throwing a supply of provisions into the town, the Romans were obliged to raise the siege; and the Tarentines, in memory of this deliverance, instituted a perpetual fast.

Fasting has always been reckoned a particular duty among philosophers and religious people, some of whom have carried their abstinence to an incredible length. At Rome it was practised by kings and emperors themselves. Numa Pompilius, Julius Cæsar, Augustus, Vespasian, and others, we are told, had their stated fast days: and Julian the Apostate was so exact in this observance as to outdo the priests themselves, and even the most rigid philosophers. The Pythagoreans kept a continual lent; but with this difference, that they believed the use of fish to be equally unlawful with that of flesh. Besides their constant temperance, they also frequently fasted rigidly for a very long time. In this respect, however, they were all outdone by their master Pythagoras, who continued his fasts for no less than 40 days together. Even Apollonius Tyaneus, one of his most famous disciples, could never come up to him in the length of his fasts, though they greatly exceeded those of the ordinary Pythagoreans. The Gymnosophists, or Brahmans of the east, are also very remarkable for their severe fastings; and the Chinese, according to Father le Comte, have also their stated fasts, with forms of prayer for preserving them from barrenness, inundations, earthquakes, &c. The Mahometans too, who possess so large a part of Asia, are very remarkable for the strict observance of their fasts; and the exactness of their dervises in this respect is extraordinary.

Fasting was often used by the heathens for superstitious purposes; sometimes to procure the interpretations of dreams; at others, to be an antidote against their pernicious consequences. A piece of superstition prevails to this day among the Jews; who, though expressly forbidden to fast on Sabbath-days, think themselves at liberty to dispense with this duty when they happen to have frightful and unlucky dreams the night preceding, that threatened them with great misfortunes. On these occasions they observe a formal fast the whole day; and at night the patient, having invited three of his friends, addresses himself to them seven times in a very solemn manner, saying, "May the dream I have had prove a lucky one!" And his friends answer as many times, "Amen, may it be lucky, and God make it so!" After which, in order to encourage him, they conclude the ceremony with these words of Ecclesiastes, "Go eat thy bread with joy;" and then set themselves down to table. They have also added several fasts not commanded in the law of Moses, particularly three, in memory of sore distresses their nation has suffered at different times. The abstinence of the ancient Jews commonly lasted 27 or 28 hours at a time; beginning before sunset, and not ending till some hours after sunset next day. On these days they were obliged to wear white robes in token of grief and repentance; to cover themselves with sackcloth, or their worst clothes; to lie on ashes; to sprinkle them on their head, &c. Some spent the whole night and day following in the temple or synagogue, in prayers and other devotions, barefooted, with a scourge in their hands, of which they sometimes made a good use in order to raise their zeal. Lastly, in order to complete their abstinence, at night they were to eat nothing but a little bread dipped in water, with some salt for seasoning; except they chose to add to their repast some bitter herbs and pulse.

The ancients, both Jews and Pagans, had also their fasts for purifying the body, particularly the priests and such as were any way employed at the altars; for when nocturnal disorders happened to these, it was unlawful for them to approach all the next day, which they were bound to employ in purifying themselves. On this account, at great festivals, where their ministry could not be dispensed with, it was usual for them, on the eve thereof, not only to fast, but also to abstain from sleep, for the greater certainty. For this purpose the high priest had under officers to wake him, if overtaken with sleep; against which other preservatives were also made use of.

FASTERMANS, or Fasting-men, q. d. *homines habentes*, was used in our ancient customs for men in repute and substance; or rather for pledges, sureties, or bondsmen, who, according to the Saxon polity, were fast bound to answer for one another's peaceable behaviour.

FASTI, in Roman antiquity, the kalendar wherein were expressed the several days of the year, with their feasts, games, and other ceremonies.

There were two sorts of fasti, the greater and less: the former being distinguished by the appellation *fasti magistrales*, and the latter by that of *fasti kalendares*.

1. The *fasti kalendares*, which were properly and primarily called *fasti*, are defined by Festus Pompeius to be books containing a description of the whole year: i. e. ephemerides, or diaries, distinguishing the several kinds of days, *festi*, *profesti*; *fasti*, *nefasti*, &c. The author of these was Numa, who committed the care and direction of the fasti to the pontifex maximus, whom the people used to consult on every occasion. This custom held till the year of Rome 450, when C. Flavius, secretary to the pontifices, exposed in the forum a list of all the days on which it was lawful to work; which was so acceptable to the people, that they made him curule ædile.

These lesser fasti, or fasti kalendares, were of two kinds, *urbani* and *rustici*.

The *fasti urbani*, or fasti of the city, were those which obtained or were observed in the city. Some will have them thus called, because they were exposed publicly in divers parts of the city; though by the various inscriptions or gravings thereof on antique stones, one would imagine that private persons had them likewise in their houses. Ovid undertook to illustrate these fasti urbani, and comment on them, in his Libri Fastorum, Fasti, Fasting.

Fastorum, whereof we have the first six books still remaining; the last six, if ever they were written, being lost.

In the *fasti rustici*, or country fasti, were expressed the several days, feasts, &c. to be observed by the country people: for as these were taken up in tilling the ground, fewer feasts, sacrifices, ceremonies, and holidays, were enjoined them than the inhabitants of cities; and they had also some peculiar ones not observed at Rome. These rustic fasti contained little more than the ceremonies of the kalends, nones, and ides; the fairs, signs of the zodiac, increase and decrease of the days, the tutelary gods of each month, and certain directions for rural works to be performed each month.

2. In the greater fasti, or *fasti magistrales*, were expressed the several feasts, with every thing relating to the gods, religion, and the magistrates; the emperors, their birth-days, offices, days consecrated to them, and feasts and ceremonies established in their honour, or for their prosperity, &c. With a number of such circumstances did flattery at length swell the fasti; when they became denominated *Magni*, to distinguish them from the bare kalendar, or fasti kalendares.

Fasti was also a chronicle or register of time, wherein the several years were denoted by the respective consuls, with the principal events that happened during their consulates; these were called also *fasti consulares*, or *consular fasti*.

Fasti, or *Dies Fasti*, also denoted court days. The word *fasti fastorum*, is formed of the verb *fari*, "to speak," because during those days the courts were opened, causes might be heard, and the prætor was allowed *fari*, to pronounce the three words, *do*, *dico*, *addico*: The other days wherein this was prohibited were called *nefasti*: thus Ovid,

> *Ille nefastus erit, per quem tria verba silentur:*
> *Fastus erit, per quem lege licebit agi.*

These *dies fasti* were noted in the kalendar by the letter *F*: but observe, that there were some days *ex parte fasti*, partly *fasti*, partly *nefasti*; i. e. justice might be distributed at certain times of the day, and not at others. These days were called *intercisi*, and were marked in the kalendar thus; *F. P. fastos primo*, where justice might be demanded during the first part of that day.

FASTING, the abstaining from food. See Fast.

Many wonderful stories have been told of extraordidary fasting; great numbers of which undoubtedly must be false. Others, however, we have on very good authority, of which some are mentioned under the article Abstinence. Another we have in the

Fasting Woman. A full account of this very uncommon case is given in the Phil. Transf. Vol. LXVII. Part I. the substance of which follows: The woman, whose name was *Janet M'Leod*, an inhabitant of the parish of Kincardine in Rosshire, continued healthy till she was 15 years of age, when she had a pretty severe epileptic fit; after this she had an interval of health for four years, and then another epileptic fit which continued a whole day and a night. A few days afterwards she was seized with a fever, which continued with violence several weeks, and from which she did not perfectly recover for some months. At this time she lost the use of her eyelids; so that she was under a necessity of keeping them open with the fingers of one hand, whenever she wanted to look about her. In other respects she continued in pretty good health; only she never had any appearance of menses, but periodically spit up blood in pretty large quantities, and at the same time it flowed from the nose. This discharge continued several years; but at last it ceased: and soon after she had a third epileptic fit, and after that a fever from which she recovered very slowly. Six weeks after the crisis, she stole out of the house unknown to her parents, who were busied in their harvest work, and bound the sheaves of a ridge before she was observed. In the evening she took to her bed, complaining much of her *heart* (most probably her *stomach*, according to the phraseology of that country) and her head. From that time she never rose for five years, but was occasionally lifted out of bed. She seldom spoke a word, and took so little food that it seemed scarce sufficient to support a sucking infant. Even this small quantity was taken by compulsion; and at last, about Whitsunday 1763, she totally refused every kind of food or drink. Her jaw now became so fast locked, that it was with the greatest difficulty her father was able to open her teeth a little, in order to admit a small quantity of gruel or whey; but of this so much generally run out at the corners of her mouth, that they could not be sensible any had been swallowed. About this time they got some water from a noted medicinal spring in Brae-Mar, some of which they attempted to make her swallow, but without effect. They continued their trials, however, for three mornings; rubbing her throat with the water, which run out at the corners of her mouth. On the third morning during the operation, she cried out, "Give me more water;" and swallowed with ease all that remained in the bottle. She spoke no more intelligibly for a year; though she continued to mutter some words, which her parents only understood, for 14 days. She continued to reject all kinds of food and drink till June 1765. At this time her sister thought, by some signs she made, that she wanted her jaws opened; and this being done, not without violence, she called intelligibly for a drink, and drank with ease about an English pint of water. Her father then asked her why she would not make some signs when she wanted a drink? to which she answered, why should she when she had no desire. It was now supposed that she had regained the faculty of speech; and her jaws were kept open for about three weeks by means of a wedge. But in four or five days she became totally silent, and the wedge was removed because it made her lips sore. She still, however, continued sensible; and when her eyelids were opened, knew every body, as could be guessed from the signs she made.

By continuing their attempts to force open her jaws, two of the under foreteeth were driven out; and of this opening her parents endeavoured to avail themselves by putting some thin nourishing drink into her mouth; but without effect, as it always returned by the corners. Sometimes they thought of thrusting a little dough of oatmeal through this gap of the teeth, which she would retain a few seconds, and then return with something like a straining to vomit, without one particle

Fasting.

ticle going down. Nor were the family sensible of any thing like swallowing for four years, excepting the small draught of Brae-Mar water and the English pint of common water. For the last three years she had not any evacuation by stool or urine, except that once or twice a-week she passed a few drops of urine, about as much, to use the expression of her parents, as would wet the surface of a halfpenny. In this situation she was visited by Dr Mackenzie, who communicated the account of her case to the Royal Society. He found her not at all emaciated; her knees were bent, and the hamstrings tight, so that her heels almost touched her buttocks. She slept much, and was very quiet: but when awake, kept a constant whimpering like a new-born weakly infant. She never could remain a moment on her back, but always fell to one side or another; and her chin was clapped close to her breast, nor could it by any force be moved backwards.

The doctor paid his first visit in the month of October; and five years afterwards, viz. in October 1772, was induced to pay her a second visit, by hearing that she was recovering, and had begun to eat and drink. The account given him was most extraordinary. Her parents one day returning from their country labours (having left their daughter fixed to her bed as usual), were greatly surprised to find her sitting upon her hams, on the side of the house opposite to her bed-place, spinning with her mother's distaff. All the food she took at that time was only to crumble a little oat or barley cake in the palm of her hand, as if to feed a chicken. She put little crumbs of this into the gap of her teeth; rolled them about for some time in her mouth; and then sucked out of the palm of her hand a little water, whey, or milk; and this only once or twice a-day, and even that by compulsion. She never attempted to speak; her jaws were fast locked, and her eyes shut. On opening her eyelids, the balls were found to be turned up under the edge of the os frontis; her countenance was ghastly, her complexion pale, and her whole person emaciated. She seemed sensible, and tractable in every thing except in taking food. This she did with the utmost reluctance, and even cried before she yielded. The great change of her looks Dr Mackenzie attributed to her spinning flax on the distaff, which exhausted too much of the saliva; and therefore he recommended to her parents to confine her totally to the spinning of wool. In 1775, she was visited again, and found to be greatly improved in her looks as well as strength; her food was also considerably increased in quantity; though even then she did not take more than would be sufficient to sustain an infant of two years of age.

The following remarkable instances of animals being able to live long without food, are related by Sir William Hamilton in his account of the late earthquakes in Italy (*Phil. Trans.* vol. lxxiii). "At Soriano (says he), two fattened hogs that had remained buried under a heap of ruins, were taken out alive the 42d day; they were lean and weak, but soon recovered." Again, "At Messina two mules belonging to the duke de Belviso remained under a heap of ruins, one of them 22 days, and the other 23 days; they would not eat for some days, but drank water plentifully, and are now recovered. There are numberless instances of dogs remaining many days in the same situation; and a hen belonging to the British vice-consul at Messina, that had been closely shut up under the ruins of his house, was taken out the 22d day, and is now recovered; it did not eat for some days, but drank freely; it was emaciated, and showed little signs of life at first. From these instances, and those related before of the hogs at Soriano, and several others of the same kind that have been related to me, but which being less remarkable I omit, one may conclude, that long fasting is always attended with great thirst and total loss of appetite."

Fasting, Fastolf.

An instance of a similar kind, not less remarkable than either of the two preceding, we find in the Gentleman's Magazine for January 1785, communicated by a correspondent, as follows: "During the heavy snow which fell in the night of the 7th of January 1776, a parcel of sheep belonging to Mr John Wolley, of Matlock, in Derbyshire, which were pastured on that part of the East Moor that lies within the manor of Matlock, were covered with the drifted snow: in the course of a day or two all the sheep that were covered with the snow were found again, except two, which were consequently given up as lost; but on the 14th of February following (some time after the break of the snow in the valleys, and 38 days after the fall), as a servant was walking over a large parcel of drifted snow which remained on the declivity of a hill, a dog he had with him discovered one of the two sheep that had been lost, by winding (or scenting) it through a small aperture which the breath of the sheep had made in the snow; the servant thereupon dug away the snow, and released the captive from its prison; it immediately ran to a neighbouring spring, at which it drank for a considerable time, and afterwards rejoined its old companions as though no such accident had befallen it. On inspecting the place where it was found, it appeared to have stood between two large stones which lay parallel with each other at about two feet and a half distance, and probably were the means of protecting it from the great weight of the snow, which, in that place lay several yards thick: from the number of stones around it, it did not appear that the sheep had been able to pick up any food during its confinement. Soon afterwards its owner removed it to some low lands; but as it had nearly lost its appetite, it was fed with bread and milk for some time: in about a fortnight after its enlargement it lost its sight and wool; but in a few weeks afterwards they both returned again, and in the course of the following summer it was quite recovered. The remaining sheep was found dead about a week after the discovery of the other."

In the same publication † is recorded the death of one Caleb Elliot, a visionary enthusiast, who meant to have fasted 40 days, and actually survived 16 without food, having obstinately refused sustenance of every kind.

† Suppl. for 1789, Obituary, p. 1211.

FASTOLF, Sir John, a valiant and renowned English officer, a knight banneret and of the garter, who served in France under Henry IV. V. and VI. was descended from an ancient family in Norfolk, and was born about the year 1377. He was as much distinguished for his virtue at home as for his valour abroad; and became no less amiable in his private, than he had been admirable in his public character. He died in 1457, upwards of 80 years of age, as we learn

learn from his noted cotemporary William Caxton the first English printer. By an unaccountable mistake it has been asserted, that Shakespeare's Falstaff was drawn to ridicule this great man; and this has made judicious biographers more studious to preserve his reputation.

FAT, an oily concrete substance, deposited in different parts of animal bodies. See ANATOMY *Index*.

Strong exercise, preternatural heat, an acrimonious state of the juices, and other like causes, by which the oily parts of the blood are attenuated, resolved, or evacuated, prevent the generation of fat; labours of the mind also have this effect, as well as labour or intemperature of the body. Hence rest and plentiful food are sufficient to fatten brutes; but with men it is often otherwise. It is surprising how soon some birds grow fat; ortolans, it is said, in 24 hours, and larks still sooner.

Fats may be divided, from their consistence, into three kinds: (1.) The soft and thin, which grow perfectly liquid in a very small heat; (2.) The thick and consistent, which liquefy less readily; and, (3.) The hard and firm, which require a still stronger heat to melt them. The first is called *Pinguedo;* the second, *Axungia;* and the third, *Adeps*, as taken from the animal; and *Sebum*, or *Sevum*, when freed from the skins, &c. This use of the names, however, is not constant, some employing them differently.

A great number of fats have been kept in the shops, for making ointments, plasters, and other medicinal compositions; as hog's lard, the fat of the boar, the fox, the hare, dog, wild cat, Alpine mouse, beaver; that of hens, ducks, geese, storks; of the whale, pike, serpents, viper, &c. as also human fat.—In regard to all these kinds of substances, however, much depends upon the manner of purifying or trying, and of keeping them.

To obtain fat pure, it must be cut into pieces, and cleaned from the interposed membranes and vessels. It must then be cleansed from its gelatinous matter by washing with water, till the water comes from it colourless and insipid; it is afterwards to be melted with a moderate heat in a proper vessel with a little water; and it is to be kept thus melted till the water be entirely evaporated, which is known by the discontinuance of the boiling, which is caused by the water only, and which lasts till not a drop of it remains; it is afterwards to be put into an earthen pot, where it fixes; then it is exceedingly white, sufficiently pure for the purposes of pharmacy or chemical examination.

Fat thus purified has very little taste, and a weak, but peculiar smell. For its analysis and chemical properties, see CHEMISTRY *Index*.

One of the chief uses of fat probably is, to receive into its composition, to blunt and correct, a great part of the acids of the aliments, and which are more than are requisite to the composition of the nutritive juice, or which nature could not otherwise expel. This is certain, that the greater the quantity of aliments taken by healthy animals, above what is necessary for their nourishment and reproduction, the fatter they become. Hence animals which are castrated, which are not much exercised, or which are come to an age when the loss and production of the seminal fluid is less, and which at the same time consume much succulent aliment, generally become fatter, and sometimes exceedingly so.

Although fat be very different from truly animalized substances, and appears not easily convertible into nutritive juices, it being generally difficult of digestion, and apt to become rancid, as butter does in the stomachs of many persons; yet in certain cases it serves to the nourishment and reparation of the body. Animals certainly become lean, and live upon their fat, when they have too little food, and when they have diseases which prevent digestion and the production of the nutritive juice; and in these cases the fatter animals hold out longer than the leaner. The fat appears to be then absorbed by the vessels designed for this use, and to be transformed into nutritive juice.

FAT, in the sea language, signifies the same with broad. Thus a ship is said to have a fat quarter, if the trussing in or tuck of her quarter be deep.

FAT likewise denotes an uncertain measure of capacity. Thus a fat of isinglass contains from $3\frac{1}{4}$ hundred weight to 4 hundred weight; a fat of unbound books, half a maund or four bales; of wire, from 20 to 25 hundred weight; and of yarn, from 220 to 221 bundles.

FAT, or VAT, is used also for several utensils: as, 1. A great wooden vessel, employed for measuring of malt, and containing a quarter or eight bushels. 2. A large brewing vessel, used by brewers to run their wort in. 3. A leaden pan or vessel for the making of salt at Droitwich.

FATA MORGANA; a very singular phenomenon, mentioned by different philosophical writers and travellers, particularly by Brydone and Swinburne. They inform us that it is seen in the straits of Messina, and sometimes denominated the *castles of the Fairy Morgana*. The accounts of this phenomenon differ considerably from each other, and travellers are not unanimous as to the causes which are necessary for its production. It would perhaps be difficult to determine how far the imagination of those who have spoken of it may be considered capable of producing astonishment, yet the actual existence of such a phenomenon admits of no dispute.

The first chapter of Minasi, in his Dissertation on the Fata Morgana, speaks of this phenomenon in the following manner. When the rising sun shines from that point whence its incident ray forms an angle of 45° on the sea of Reggio, and the bright surface of the water in the bay is not disturbed either by the wind or the current, the spectator being placed on an eminence of the city, with his back to the sun and his face to the sea; on a sudden there appear in the water, as in a catoptric theatre, various multiplied objects, that is to say, numberless series of pilasters, arches, castles well delineated, regular columns, lofty towers, superb palaces, with balconies and windows, extended alleys of trees, delightful plains with herbs and flocks, armies of men on foot and horseback, and many other strange images, in their natural colours and proper actions, passing rapidly in succession along the surface of the sea during the whole of the short period of time while the above-mentioned causes remain.

"But if, in addition to the circumstances before described, the atmosphere be highly impregnated with vapour and dense exhalations, not previously dispersed by the action of the wind or waves, or rarefied by the sun, it it then happens that in this vapour, as in a curtain extended along the channel to the height of about 30 palms, and nearly down to the ſea, the obſerver will behold the ſcene of the ſame objects not only reflected from the ſurface of the ſea, but likewiſe in the air, though not ſo diſtinct or well defined as the former objects from the ſea.

"If the air be ſlightly hazy and opake, and at the ſame time dewy and adapted to form the iris, then the above-mentioned objects will appear only at the ſurface of the ſea, as in the firſt caſe, but all vividly coloured, or fringed with red, green, blue, and other priſmatic colours."

From this account of Minaſi it appears, that there are three different ſpecies of Fata Morgana; the firſt appearing at the ſurface of the ſea, denominated the *Marine Morgana;* the ſecond in the air, called the *Aërial Morgana*, and the third only at the ſurface of the ſea, or *Morgana* fringed with priſmatic colours. The ſame ingenious author attempted to trace the etymology of the word *Morgana*, which he thinks is derived from μωρος, *triſtis*, and γανοω, *lætitiâ afficio.* This ſplendid ſight affects all deſcriptions of men with ſuch joy, that they run towards the ſea, exclaiming *Morgana, Morgana!* This etymology of Minaſi may ſeem at firſt view to be a contradiction in terms; but it will appear moſt natural, when we conſider the joy which the Morgana inſpires, and the correſponding ſorrow or dejection which muſt be felt when it vaniſhes away. Our author informs us, that he beheld this magnificent appearance three times, and would rather behold it again than the "moſt ſuperb theatrical exhibition in the world."

In his phyſical and aſtronomical remarks on this phenomenon, he obſerves that the ſea in the ſtraits of Meſſina exhibits the appearance of a large inclined ſpeculum; that, in the alternate current or tide which flows and returns in the ſtraits for ſix hours each way, and is conſtantly attended by an oppoſite current along ſhore to the medium diſtance of about half a league, there are many eddies and irregularities at the time of the change of its direction; and that the Morgana uſually appears at this period. He aſcribes the effects produced by it to the ſuppoſed inclination of the ſurface of the ſea, and its ſubdiviſion into different planes by the contrary eddies. The effects produced in the air he conſiders as the reſult of ſaline and other effluvia ſuſpended in the air. Theſe appearances are produced by a calm ſea, and one or more ſtrata of ſuperincumbent air differing in refractive, and conſequently in reflective power, rather than from any conſiderable change in the ſurface of the water, with the laws of which we are much better acquainted than with thoſe of the atmoſphere.

To the above account we ſhall add the following, given by M. Houel, whoſe judgment and veracity render his authority highly reſpectable. "In fine ſummer days, when the weather is calm, there riſes above the great current a vapour, which acquires a certain denſity, ſo as to form in the atmoſphere horizontal priſms, whoſe ſides are diſpoſed in ſuch a manner, that when they come to their proper degree of perfection, they reflect and repreſent ſucceſſively, for ſome time (like a moveable mirror), the objects on the coaſt or in the adjacent country. They exhibit by turns the city and ſuburbs of Meſſina, trees, animals, men, and mountains. They are certainly beautiful aerial moving pictures. There are ſometimes two or three priſms, equally perfect; and they continue in this ſtate eight or ten minutes. After this, ſome ſhining inequalities are obſerved upon the ſurface of the priſm, which render confuſed to the eye the objects which had been before ſo accurately delineated, and the picture vaniſhes. The vapour forms other combinations, and is diſperſed in air. Different accounts have been given of this ſingular appearance; which for my part I attribute to a bitumen that iſſues from certain rocks at the bottom of the ſea, and which is often ſeen to cover a part of its ſurface in the ſtrait of Meſſina. The ſubtile parts of the bitumen being attenuated, combined, and exhaled with the aqueous globules that are raiſed by the air, and formed into bodies of vapour, give to this condenſed vapour more conſiſtence; and contribute, by their ſmooth and poliſhed particles, to the formation of a kind of aerial cryſtal, which receives the light, reflects it to the eye, and tranſmits to it all the luminous points which colour the objects exhibited in this phenomenon, and render them viſible."

FATE (*fatum*), denotes an inevitable neceſſity depending upon a ſuperior cauſe. The word is formed *à fando*, "from ſpeaking:" and primarily implies the ſame with *effatum*, viz. a word or decree pronounced by God; or a fixed ſentence whereby the Deity has preſcribed the order of things, and alloted to every perſon what ſhall befal him.

The Greeks called it ειμαρμενη, as it were a chain or neceſſary ſeries of things indiſſolubly linked together. It is alſo uſed to expreſs a certain unavoidable deſignation of things, by which all agents, both neceſſary and voluntary, are ſwayed and directed to their ends. See NECESSITY.

In this laſt ſenſe, fate is diſtinguiſhed into, 1. Aſtrological fate, ariſing from the influence and poſition of the heavenly bodies; which (it was ſuppoſed) gave laws both to the elements and mixed bodies, and to the wills of men. 2. Stoical fate, defined by Cicero an order or ſeries of cauſes, wherein, cauſe being linked to cauſe, each produces another, and thus all things flow from one prime cauſe. To this fate the Stoics ſubject even the gods.

Fate is divided by later authors into phyſical and divine. Phyſical fate is an order and ſeries of natural cauſes appropriated to their effects. By this fate it is that fire warms, bodies communicate motion to each other, &c. and the effects of it are all the events and phenomena of nature. 2. Divine fate is what is more uſually called *Providence.* See PROVIDENCE.

FATES, in mythology. See PARCÆ.

FATHEMITES, FATEMITES, or FATHIMITES, the deſcendants of Mahomet by Fathema, or Fatima, his daughter. They never enjoyed the caliphate of Mecca or Bagdad, but reigned in Barbary and Egypt. See the hiſtory of theſe countries.

FATHER, a term of relation denoting a perſon who hath begot a child. See PARENT and CHILD.

By the laws of Romulus, a father had an unlimited power over his children. Amongſt the Lacedemonians, as we learn from Ariſtotle's Politics, the father of three children was excuſed from the duty of mounting guard for the ſecurity of the city; and a father of four children was exempted from every public burden. The Poppæan law, amongſt the Romans, granted many valuable privileges to the fathers of three children; amongst which one was, that he should be excused from civil offices, and that the mother should have liberty, in her father's lifetime, to make a will, and manage her estate without the authority of tutors.

Natural FATHER, is he who has illegitimate children. See BASTARD; and LAW *Index*.

Adoptive FATHER, is he who takes the children of some other, and acknowledges them as his own. See ADOPTION.

Putative FATHER, is he who is only the reputed or supposed father. Joseph was putative father of our Saviour.

FATHER-*in-law*, is a person married to a woman who has children by a former husband, &c. to which children he is said to be a father-in-law.

FATHER is also used in theology for the First Person in the Trinity.

FATHER is also used in a figurative sense on divers moral and spiritual occasions. Thus, it is applied to the patriarchs; as we say Adam was the father of all mankind, Abraham the father of the faithful, &c.

FATHER, in church history, is applied to ancient authors who have preserved in their writings the traditions of the church. Thus St Chrysostom, St Basil, &c. are called *Greek fathers*, and St Augustine and St Ambrose *Latin fathers*. No author who wrote later than the 12th century is dignified with the title of *Father*.

FATHER, is also a title of honour given to prelates and dignitaries of the church, to the superiors of convents, to congregations of ecclesiastics, and to persons venerable for their age or quality. Thus we say, the right reverend father in God, the father general of the Benedictines, the fathers of the council of Nice, father of his country, &c.

FATHERLASHER, a species of fishes belonging to the genus cottus. See COTTUS, ICHTHYOLOGY *Index*.

FATHOM, a long measure containing six feet, used chiefly at sea for measuring the length of cables and cordage.

FATNESS. See CORPULENCY.—It is observed, that for one fat person in France or Spain, there are a hundred in England and Holland. This is supposed to be from the use of new malt liquors, more than from the difference of climates or degrees of perspiration. Indolence may cause fatness in some few constitutions; but, in general, those who are disposed to this habit will be fat in spite of every endeavour to the contrary, but that of destroying health.

FATUARII, in antiquity, were persons who, appearing inspired, foretold things to come. The word is formed of *Fatua*, wife of the god Faunus, who was supposed to inspire women with the knowledge of futurity, as Faunus himself did the men.—Fatua had her name from *fari*, q. d. *vaticinari*, "to prophesy."

FAVISSÆ, in antiquity, were, according to Festus and Gellius, cisterns to keep water in: but the favissæ in the Capitol at Rome were dry cisterns or subterraneous cellars, where they laid up the old statues, broken vessels, and other things used in the temple. These were much the same with what, in some of the modern churches, are called the *archives* and *treasury*.

FAUNA, a deity among the Romans. She was daughter of Picus, and was originally called *Marica*. Her marriage with Faunus procured her the name of *Fauna*, and her knowledge of futurity that of *Fatua* and *Fatidica*. It is said that she never saw a man after her marriage with Faunus, and that her uncommon chastity occasioned her being ranked among the gods afer death. She is the same, according to some, as *Bona Mater*.

FAUNALIA, in antiquity, Roman feasts celebrated in honour of the god Faunus, who was the same among the Romans with the *Pan* of the Greeks.

The Faunalia were held on the day of the nones of December; i. e. on the fifth day of that month. The principal sacrifice was a roe-buck; or rather, according to Horace, a kid, attended with libations of wine and burning of incense. It was properly a country festival, being performed in the fields and villages with peculiar joy and devotion. Horace gives us a very gay description thereof in the 18th ode of his third book:

> ——*Tener pleno cadit hædus anno:*
> *Larga nec desunt Veneris sodali*
> *Vina crateræ: vetus ara multo*
> *Fumat odore.*

Struvius in his Roman kalendar marks the feast of Faunus on the day of the ides of February, which is the 30th day of that month; and the Faunalia he places on the fifth of the ides of December, or the 9th of that month: and in chap. ix. he shews, that there really were two Faunalia; the one in February, mentioned by Ovid, Fast. lib. iv. ver. 246, the other on the 9th of December, mentioned by Horace in the place just cited.

FAUNS (FAUNI), among the ancients, were a species of demi-gods inhabiting the forests; called also *Sylvans* (*Sylvani*), and little differing from the Satyrs. They delighted more particularly in vineyards; and they generally appear as attendants of Bacchus, in the representations of Bacchanal feasts and processions.—They were represented as half men, half goats, having the horns, ears, feet, and tail of a goat, a very flat nose, and the rest human. Though the Fauns were held for demi-gods, yet they were supposed to die after a long life. Arnobius shows that their father or chief, Faunus himself, only lived 120 years.

FAUNUS, in fabulous history, a son of Picus who reigned in Italy about 1300 years before the Augustan age. His bravery, as well as wisdom, have given rise to the tradition that he was son of Mars. His great popularity, and his fondness for agriculture, made his subjects revere him as one of their country deities after death. He was represented with all the equipage of the satyrs, and was consulted to give oracles.

FAVONIUS, among the Romans, the wind which blew directly from the west.

FAVORINUS, an ancient orator and philosopher of Gaul, who flourished under the emperor Adrian, and taught with high reputation both at Athens and Rome. Many works are attributed to him; among the rest, a Greek miscellaneous history often quoted by Diogenes Laertius.

FAUSTUS. See FUST.

FAWKES, FRANCIS, an ingenious poet, had his school education at Leeds; from whence he was transplanted to Jesus College, Cambridge, where he took the degrees in arts. Entering early into holy orders, he he settled first at Bramham in Yorkshire, near the elegant seat of that name (Mr Lane's), which he celebrated in verse in 1745, in a 4to pamphlet anonymous. His first poetical publications were, Gawen Douglas's Description of May and Winter modernized. Removing afterwards to the curacy of Croydon in Surry, he recommended himself to the notice of Archbishop Herring, then resident there on account of his health, to whom, besides other pieces, he addressed an ode on his recovery in 1754, printed in Mr Dodsley's collection. In consequence, his grace collated him in 1755 to the vicarage of Orpington with St Mary Gray in Kent; and Mr Fawkes lamented his patron's death in 1757 in a pathetic elegy styled *Aurelius*, first printed with his grace's seven sermons, in 1763. He married about the same time Miss Purrier of Leeds. In April 1774, by the late Dr Plumtree's favour, he exchanged his vicarage for the rectory of Hayes. He was also one of the chaplains to the princess dowager of Wales. He published a volume of poems by subscription in 8vo, 1761; the Poetical Kalendar 1763; and Poetical Magazine 1764, in conjunction with Mr Woty; Partridge Shooting, an eclogue, to the honourable Cha. Yorke, 1767, 4to; and a Family Bible, with notes, in 4to, a compilation. But his great strength lay in translation, in which, since Pope, few have equalled him. Witness his fragments of Menander (in his Poems); his works of Anacreon, Sappho, Bion, Moschus, and Musæus, 12mo, 1760; his Idylliums of Theocritus, by subscription, 8vo, 1767; and his Argonautics of Apollonius Rhodius, by subscription also (a posthumous publication, completed by the Reverend Mr Meen of Emanuel College, Cambridge), 8vo, 1780. He died August 26. 1777.

FAWN, among sportsmen, a buck or doe of the first year; or the young one of the buck's breed in its first year.

FE, Fo, or *Fohi*, the name of the chief god of the Chinese, whom they adore as the sovereign of heaven. They represent him shining all in light, with his hands hid under his robes, to show that his power does all things invisibly. He has at his right hand the famous Confucius, and at his left Lanza or Lanca, chief of the second sect of their religion.

FEAL, a provincial term for sod or turf.

Feal-Dikes, a cheap sort of fence common in Scotland; built with feal or sod dug up by the spade from the surface of grass ground, consisting of the upper mould rendered tough and coherent by the matted roots of the grass thickly interwoven with it. If only a very thin bit of the upper surface is pared off with a paring spade, the pieces are called *divots*. These being of a firmer consistence, are more durable when built into dikes than feal, but much more expensive also.

FEALTY, in *Law*, an oath taken on the admittance of any tenant, to be true to the lord of whom he holds his land: by this oath the tenant holds in the freest manner, on account that all who have fee hold *per fidem et fiduciam*, that is, by fealty at the least.

This fealty, at the first creation of it, bound the tenant to fidelity, the breach of which was the loss of his fee. It has been divided into general and special: general, that which is to be performed by every subject to his prince; and special, required only of such as, in respect of their fee, are tied by oath to their lords. To all manner of tenures, except tenancy at will, and frank-almoign, fealty is incident, though it chiefly belongs to copyhold estates held in fee and for life. The form of this oath, by stat. 17 Edw. II. is to run as follows: "I A. B. will be to you my lord D. true and faithful, and bear to you faith for the lands and tenements which I hold of you; and I will truly do and perform the customs and services that I ought to do to you. So help me God."

FEAR, one of the passions of the human mind; (see PASSION). It is defined, an apprehension of impending evil, attended with a desire of avoiding it.

Fear in the extreme is called *fright* or *terror*. See FRIGHT.

FEAR, in Scripture, is used in various senses.

The *fear of God* is either filial or servile. The filial fear is a holy affection or gracious habit in the soul, whereby it is inclined to obey all God's commandments, and to hate and avoid evil. Slavish or servile fear is the consequence of guilt; it is a judicial impression from the sad thoughts of the provoked majesty of heaven; it is an alarm within that disturbs the rest of a sinner. Though this fear be in wicked men, yet it often proves preparative to faith and repentance.

Fear is likewise used for the *object* of fear. Thus it is said, "the *fear* of Isaac," to describe the God whom Isaac feared; (Gen. xxxi. 24.), and in Prov. i. 26. "I will mock when your *fear* cometh;" that is, the calamity you feared. God says, that he will send his *fear* before his people; that is, a dread wrought by him, in order to terrify and destroy the inhabitants of Canaan.

FEAR (*Metus*, *Pavor*, or *Timor*), was deified by the Pagans. Tullus Hostilius brought the worship of this deity to Rome. The Ephori of Sparta erected a temple to Fear, near their tribunal, to strike an awe into those who approached it. Fear was likewise worshipped at Corinth. The poets did not forget this imaginary deity. Virgil places her in the entrance of hell, in company with diseases, old age, &c. *Æn.* vi. 273. Ovid places her in the retinue of Tisiphone one of the furies, *Met.* iv. 483.

FEAST, or FESTIVAL, in a religious sense, is a ceremony of feasting and thanksgiving. The word is formed of the Latin *festum*, which some derive *à feriari* "to keep holiday;" others from the Greek εϛιαω, "I feast or entertain," of εϛια, "hearth, fire."

Feasts, and the ceremonies thereof, have made great part of the religion of almost all nations and sects; witness those of the Greeks, Romans, Hebrews, Christians, and Mahometans.

The first feasts among the Greeks were celebrated in solemn assemblies of the whole nation, on occasion of their games, as the Olympic, the Pythian, the Isthmian, and Nemæan: in process of time they had many others, the principal of which are enumerated in the course of this work.

The Romans also had abundance of stated feasts in honour of their deities and heroes; such were the Saturnalia, Cerealia, Lupercalia, Liberalia, Neptunalia, Consualia, Portumnalia, Vulcanalia, Palilia, Divalia, &c. See SATURNALIA, &c.

They had also feasts instituted occasionally; as Carmentalia,

Feaſt.

mentalia, Quirinalia, Terminalia, Floralia, Compitalia, Lemuria, Vernalia, beſide other moveable and occaſional ones: as to give thanks to the gods for benefits received; to implore their aſſiſtance, or to appeaſe their wrath, &c. as the Paganalia, Feralia, Bacchanalia, Ambarvalia, Amburbalia, Suovetaurilia, and divers others, particularly denominated *feriæ;* as Sementinæ, Latinæ, &c. See each of theſe feaſts, and *feriæ* in its proper place. The feaſts were divided into days of ſacrifice, and days of banqueting and feaſting; days of games, and days of reſt or *feriæ*.

There being but little hiſtory written, or at leaſt publiſhed in thoſe days, one end of feaſts was to keep up the remembrance of paſt occurrences.

The principal feaſts of the Jews were the feaſt of trumpets, that of the expiation, of tabernacles, of the dedication, of the paſſover, of pentecoſt, and that of purification. See Expiation, &c.

The modern Jews have other feaſts marked in their kalendar, of modern inſtitution. The Mahometans, beſides their weekly feaſt or Sabbath, which is kept on Friday, have two ſolemn feaſts, the firſt of which is called the *Feaſt of Victims*, and celebrated on the tenth day of the laſt month of their year; and the ſecond called *Bairam*. The Chineſe have two ſolemn feaſts in the year, in the memory of Confucius, beſides others of leſs note on the other days of the year.

Feaſts among us are either *immoveable* or *moveable*.

Immoveable Feaſts are thoſe conſtantly celebrated on the ſame day of the year; the principal of theſe are Chriſtmas day or the Nativity, the Circumciſion, Epiphany, Candlemas or the Purification, Lady Day or the Annunciation, called alſo the *Incarnation* and *Conception*, All Saints and All Souls; beſides the days of the ſeveral Apoſtles, St Thomas, St Paul, &c. which with us are feaſts, though not *feriæ*. See each feaſt under its proper article.

Moveable Feaſts are thoſe which are not confined to the ſame day of the year. Of theſe the principal is Eaſter, which gives law to all the reſt, all of them following, and keeping their proper diſtances from it; ſuch are Palm-Sunday, Good-Friday, Aſh-Wedneſday, Sexageſima, Aſcenſion Day, Pentecoſt, and Trinity-Sunday. See Easter, Sexagesima, Pentecost, Trinity, &c.

The four feaſts which the Engliſh laws take ſpecial notice of are, the Annunciation of the bleſſed Virgin Mary or Lady Day, the 25th of March; the nativity of St John the Baptiſt, held on the 24th of June; the Feaſt of St Michael the Archangel, on the 29th of September; and that of St Thomas the Apoſtle, on the 21ſt of December: on which quarterly days rent on leaſes is uſually reſerved to be paid (5 and 6 Edw. VI. cap. 3. 3 Jac. I. cap. 1. 12 Car. II. cap. 30.)

Beſides theſe feaſts which are *general*, and enjoined by the church, there are others *local* and *occaſional*, enjoined by the magiſtrate, or voluntarily ſet on foot by the people; ſuch are the days of thankſgiving for delivery from wars, plagues, &c. Such alſo are the vigils or wakes in commemoration of the dedications of particular churches. See Vigil, &c.

The prodigious increaſe of feaſt days in the Chriſtian church commenced towards the cloſe of the fourth century, and was occaſioned by the diſcovery that was then made of the remains of martyrs and other holy men, for the commemoration of whom they were eſtabliſhed. Theſe, inſtead of being ſet apart for pious exerciſes, were abuſed in indolence, voluptuouſneſs, and criminal practices. Many of them were inſtituted on a pagan model, and perverted to ſimilar purpoſes.

Feast *of Death*, or *Feaſt of Souls*, a ſolemn religious ceremony in uſe among the ſavages of America; ſome of whom thus teſtify their reſpect for the deceaſed every eight years; and others, as the Hurons and Iroquois, every ten years.

The day of this ceremony is appointed by public order; and nothing is omitted, that it may be celebrated with the utmoſt pomp and magnificence. The neighbouring tribes are invited to be preſent, and to join in the ſolemnity. At this time all who have died ſince the laſt ſolemn occaſion are taken out of their graves; thoſe who have been interred at the greateſt diſtance from the villages are diligently ſought for, and brought to this great rendezvous of carcaſes.

It is not difficult to conceive the horror of this general diſinterment; but it cannot be deſcribed in a more lively manner than it is done by Lafitau, to whom we are indebted for the moſt authentic account of thoſe nations.

"Without queſtion (ſays he), the opening of theſe tombs diſplays one of the moſt ſtriking ſcenes that can be conceived; this humbling portrait of human miſery, in ſo many images of death, wherein ſhe ſeems to take a pleaſure to paint herſelf in a thouſand various ſhapes of horror, in the ſeveral carcaſes, according to the degree in which corruption has prevailed over them, or the manner in which it has attacked them. Some appear dry and withered; others have a ſort of parchment upon their bones; ſome look as if they were baked and ſmoked, without any appearance of rottenneſs; ſome are juſt turning towards the point of putrefaction; whilſt others are all ſwarming with worms, and drowned in corruption. I know not which ought to ſtrike us moſt, the horror of ſo ſhocking a ſight, or the tender piety and affection of theſe poor people toward their departed friends: for nothing deſerves our admiration more than that eager diligence and attention with which they diſcharge this melancholy duty of their tenderneſs; gathering up carefully even the ſmalleſt bones, handling the carcaſes, diſguſtful as they are, with every thing loathſome, cleanſing them from the worms, and carrying them upon their ſhoulders through tireſome journeys of ſeveral days, without being diſcouraged from the offenſiveneſs of the ſmell, and without ſuffering any other emotions to ariſe than thoſe of regret, for having loſt perſons who were ſo dear to them in their lives, and ſo lamented in their death.

"They bring them into their cottages, where they prepare a feaſt in honour of the dead; during which their great actions are celebrated, and all the tender intercourſes which took place between them and their friends are piouſly called to mind. The ſtrangers, who have come ſometimes many hundred miles to be preſent on the occaſion, join in the tender condolence; and the women, by frightful ſhrieks, demonſtrate that they are pierced with the ſharpeſt ſorrow. Then the dead bodies are carried from the cabins for the general re-interment. A great pit is dug in the ground, and thither,

thither, at a certain time, each person attended by his family and friends, marches in solemn silence, bearing the dead body of a son, a father, or a brother. When they are all convened, the dead bodies, or the dust of those which were quite corrupted, are deposited in the pit: then the torrent of grief breaks out anew. Whatever they possess most valuable is interred with the dead. The strangers are not wanting in their generosity, and confer those presents which they have brought along with them for the purpose. Then all present go down into the pit, and every one takes a little of the earth, which they afterwards preserve with the most religious care. The bodies, ranged in order, are covered with entire new furs, and over these with bark, on which they throw stones, wood, and earth. Then taking their last farewell, they return each to his own cabin.

"We have mentioned, that in this ceremony the savages offer, as presents to the dead, whatever they value most highly. This custom, which is universal among them, arises from a rude notion of the immortality of the soul. They believe this doctrine most firmly, and it is the principal tenet of their religion. When the soul is separated from the body of their friends, they conceive that it still continues to hover around it, and require and take delight in the same things with which it formerly was pleased. After a certain time, however, it forsakes this dreary mansion, and departs far westward into the land of spirits. They have even gone so far as to make a distinction between the inhabitants of the other world; some, they imagine, particularly those who in their lifetime have been fortunate in war, possess a high degree of happiness, have a place for hunting and fishing, which never fails, and enjoy all sensual delights, without labouring hard in order to procure them. The souls of those, on the contrary, who happen to be conquered or slain in war, are extremely miserable after death."

Feast is also used for a banquet, or a sumptuous meal, without any immediate view to religion.

The use of the word, in this sense, arises hence; that a part of the ceremony of many of the ancient festivals, both those of the heathens and agapæ of the Christians, was good eating; though Mr Huet chooses to derive the word from *festinare*, which, in an ancient Latin version of Origen's Comment on Matthew, signifies "to feast:" *Ut veniens illuc Jesus festinet cum discipulis suis.*

Social or civil feasts were also expressed by the words *convivium* and *compotatio* or *concœnatio*. Cicero says, that in the Roman tongue, the word *convivium*, which means "people assembled at table," is more significant than the Greek word *compotatio* or *concœnatio*: the Roman, says he, expresses the conjunction of body and mind which ought to take place at an entertainment; the Greek denotes what relates to the body alone.

As food is necessary to our existence, it makes a bond of association among mankind. People at a feast, says one of the ancients, seem to form but one body, one soul. All nations, whether savage or civilized, have regarded the pleasure of the table as the occasion of the most agreeable society. This species of enjoyment (abstracting from its susceptibility of abuse) makes but one family of all that it brings together. It levels the distinctions introduced by policy or prejudice, and disposes men to regard one another as brethren. It is here that people feel the equality established by nature; here they forget the evils of life; they extinguish their hatred, and make their enmities cease. For this reason Aristotle considers as a breach of the social principle that custom of the Egyptians of eating apart, and praises the convivial repasts established by Minos and Lycurgus.

The Persians generally deliberated on business at table, but never determined or put their determinations in execution except in the morning before having eaten.

When the Germans, says Tacitus, wanted to reconcile enemies, to make alliances, to name chiefs, or to treat of war and peace, it was during the repast that they took counsel; a time in which the mind is most open to the impressions of simple truths, or most easily animated to great attempts. These artless people during the conviviality of the feast spoke without disguise. Next day they weighed the counsels of the former evening: they deliberated at a time when they were not disposed to feign, and took their resolution when they were least liable to be deceived.

People of rank among the Rhodians, by a fundamental law of the state, were obliged to dine daily with those who had the management of affairs, in order to deliberate with them concerning such things as were necessary or useful for the country; and on this account the principal ministers of the kingdom were obliged to keep open table for all who could be of use to the state.

Among the Romans, the place where they supped was generally the vestibule, that a more retired part of the house might not encourage licentiousness and disorder. There were several laws that restricted their meals to those vestibules.

When luxury reigned in Rome, they had superb halls for their entertainments. Lucullus had many, each of which bore the name of some deity; and this name was a mark which indicated to the servants the expence of the entertainment. The expence of a supper in Lucullus's hall of Apollo amounted to 50,000 drachmas.

The hall in which Nero feasted, by the circular motion of its walls and ceiling, imitated the revolutions of the heavens, and represented the different seasons of the year, changing at every course, and showering down flowers and perfumes on the guests.

The Romans did not, as we do, use but one table at their feasts; they had generally two; the first was for the services of animal food, which was afterwards removed, and another introduced with fruits; at this last they sung and poured out their libations. The Greeks and eastern nations had the same custom, and even the Jews in their solemn feasts and at sacrifices.

The Romans, in the time of Nero, had tables made of citron wood brought from Mauritania; they were varnished with purple and gold, and were raised on feet of carved ivory. It is said that they were more precious than gold. Dion Cassius affirms, that Seneca had 500 of these, which he made use of one after another; and Tertullian tells us that Cicero had but one. The Romans chose the king of the feast by a throw of the dice.

We

Feaſt.

We learn from Herodotus, that the ancients had neither cups nor bowls, but that they drank out of little horns tipt with ſilver or gold.

Under the reign of Charles V. of France, the cuſtom of placing the lights upon the table was not yet introduced. A number of domeſtics held the candles in their hands during the whole time of the repaſt.

The Greeks and Romans kept a domeſtic for the purpoſe of reading during their meals and feaſts. Sometimes the chief of the family himſelf performed the office of reader; and hiſtory informs us, that the emperor Severus often read while his family ate. The time of reading was generally at ſupper; and gueſts were invited to a reading as they are now a-days to play cards.

The Greeks, in their flouriſhing times, did not profane, according to their own expreſſion, the *holineſs* of the table; but rather adorned it with ingenious and elegant converſation: they propoſed moral topics, of which Plutarch has preſerved a collection.

Ancient philoſophers remark, that heroes rarely aſſembled convivially without bringing affairs of conſequence into diſcourſe, or deliberating upon thoſe that regarded either preſent events or future contingencies.

The Scythians, while at meat, uſed to make the ſtrings of their bows reſound, leſt their warlike virtus might be enfeebled or loſt in this ſeaſon of pleaſur.

When Rome was corrupted with luxury, ſingers, dancers, muſicians, ſtage-players, and people that told pleaſant tales, were brought into the hall to amuſe the gueſts.

Plutarch informs us, that Cæſar, after his triumphs, treated the Roman people at 22,000 tables: and by calculation it would ſeem that there were at theſe tables upwards of 200,000 perſons.

At the end of the feaſt the Romans drunk out of a large cup as often as there were letters in the name of their miſtreſſes.

Feaſting ſeems to have been the chief delight of the Germans, Gauls, Britons, and all the other Celtic nations; in which they indulged themſelves to the utmoſt, as often as they had an opportunity. "Among theſe nations (ſays an author who had carefully ſtudied their manners) there is no public aſſembly, either for civil or religious purpoſes, duly held; no birthday, marriage, or funeral, properly celebrated; no treaty of peace or alliance rightly cemented, without a great feaſt." It was by frequent entertainments of this kind that the great men or chieftans gained the affections and rewarded the ſervices of their followers; and thoſe who made the greateſt feaſts were ſure to be moſt popular, and to have the greateſt retinue. Theſe feaſts (in which plenty was more regarded than elegance) laſted commonly ſeveral days, and the gueſts ſeldom retired until they had conſumed all the proviſions and exhauſted all the liquors. Athenæus deſcribes an entertainment that was given by Arcamnes, a very wealthy prince in Gaul, which continued a whole year without interruption, and at which all the people of Gaul, and even all ſtrangers who paſſed through that country, were made welcome. At theſe feaſts they ſometimes conſulted about the moſt important affairs of ſtate, and formed reſolutions relating to peace and war; imagining that men ſpoke their real ſentiments with the greateſt freedom, and were apt to form the boldeſt deſigns, when their ſpirits were exhilarated with the pleaſures of the table. The converſation at theſe entertainments very frequently turned on the great exploits which the gueſts themſelves or their anceſtors had performed in war; which ſometimes occaſioned quarrels and even bloodſhed. It was at a feaſt that the two illuſtrious Britiſh princes, Cairbar and Oſcar, quarrelled about their own bravery and that of their anceſtors, and fell by mutual wounds, (*Oſſian*, vol. ii. p. 8, &c.)

Pelloutier Hiſt. Celt. l. ii. c. 12. p. 463.

As to the drink uſed at thoſe feaſts, particularly in Britain, it ſeems probable, that before the introduction of agriculture into the iſland, mead, or honey diluted with water, was the only ſtrong liquor known to its inhabitants, as it was to many other ancient nations in the ſame circumſtances. This continued to be a favourite beverage among the ancient Britons and their poſterity long after they had become acquainted with other liquors. The mead-maker was the eleventh perſon in dignity in the courts of the ancient princes of Wales, and took place of the phyſician. The following ancient law of that principality ſhows how much this liquor was eſteemed by the Britiſh princes.—"There are three things in the court which muſt be communicated to the king before they are made known to any other perſon: 1. Every ſentence of the judge; 2. Every new ſong; and, 3. Every caſk of mead." This was perhaps the liquor which is called by Oſſian the joy and ſtrength of ſhells, with which his heroes were ſo much delighted.—After the introduction of agriculture, ale or beer became the moſt general drink of all the Britiſh nations who practiſed that art, as it had long been of all the Celtic people on the continent (See Ale.) If the Phœnicians or Greeks imported any wine into Britain, it was only in very ſmall quantities; that moſt generous liquor being very little known in this iſland before it was conquered by the Romans. The drinking veſſels of the Gauls, Britons, and other Celtic nations, were, for the moſt part, made of the horns of oxen and other animals; but thoſe of the Caledonians conſiſted of large ſhells, which are ſtill uſed by ſome of their poſterity in the Highlands of Scotland.

The diſhes in which the meat was ſerved up were either of wood or earthen ware, or a kind of baſkets made of oſiers. Theſe laſt were moſt uſed by the Britons, as they very much excelled in the art of making them both for their own uſe and for exportation. The gueſts ſat in a circle upon the ground, with a little hay, graſs, or the ſkin of ſome animal under them. A low table or ſtool was ſet before each perſon, with the portion of meat allotted to him upon it. In this diſtribution, they never neglected to ſet the largeſt and beſt pieces before thoſe who were moſt diſtinguiſhed for their rank, their exploits, or their riches. Every gueſt took the meat ſet before him in his hands, and tearing it with his teeth, fed upon it in the beſt manner he could. If any one found difficulty in ſeparating any part of his meat with his hands and teeth, he made uſe of a large knife, that lay in a particular place for the benefit of the whole company. Servants, or young boys and girls, the children of the family, ſtood behind the gueſts, ready to help them to drink or any thing they wanted.

Feast.

As the ancient Britons greatly excelled and very much delighted in music, all their feasts were accompanied with the joys of song, and the music of harps. In the words of Ossian †, "whenever the feast of shells is prepared, the songs of bards arise. The voice of sprightly mirth is heard. The trembling harps of joy are strung. They sing the battles of heroes, or the heaving breasts of love." Some of the poems of that illustrious British bard appear to have been composed in order to be sung by the hundred bards of Fingal ‡ at the feast of Selma. Many of the songs of the bards which were sung and played at the feasts of the ancient Britons, were of a grave and solemn strain, celebrating the brave actions of the guests, or of the heroes of other times; but these were sometimes intermixed with more sprightly and cheerful airs, to which the youth of both sexes danced, for the entertainment of the company.

† Vol. ii. p. 9. vol. i. p. 37.

‡ *Ibid.* vol. i. p. 87. 209.

It has been often observed by authors, that there is no nation in the world comes near the English in the magnificence of their feasts. Those made at our coronations, instalments, consecrations, &c. transcend the belief of all foreigners; and yet it is doubted whether those now in use are comparable to those of our forefathers.

William the Conqueror, after he was peaceably settled on the throne of England, sent agents into different countries, to collect the most admired and rare dishes for his table; by which means, says John of Salisbury, this island, which is naturally productive of plenty and variety of provisions, was overflowed with every thing that could inflame a luxurious appetite. The same writer tells us, that he was present at an entertainment which lasted from three o'clock in the afternoon to midnight; at which delicacies were served up, which had been brought from Constantinople, Babylon, Alexandria, Palestine, Tripoli, Syria, and Phœnicia. These delicacies, we may presume, were very expensive. Thomas Becket, if we may believe his historian Fitz-Stephen, gave 5l. equivalent to 75l. at present, for one dish of eels. The sumptuous entertainments which the kings of England, and of other countries, gave to their nobles and prelates, at the festivals of Christmas, Easter, and Whitsuntide, in which they spent a great part of their revenues, contributed very much to diffuse a taste for profuse and expensive banqueting. It was natural for a proud and wealthy baron to imitate in his own castle the entertainments he had seen in the palace of his prince. Many of the clergy too, both seculars and regulars, being very rich, kept excellent tables. The monks of St Swithins, at Winchester, made a formal complaint to Henry II. against their abbot, for taking away three of the 13 dishes they used to have every day at dinner. The monks of Canterbury were still more luxurious: for they had at least 17 dishes every day, besides a dessert; and these dishes were dressed with spices and sauces, which excited the appetite as well as pleased the taste.

Great men had some kinds of provisions at their tables that are not now to be found in Britain. When Henry II. entertained his own court, the great officers of his army, with all the kings and great men of Ireland, in Dublin, at the feast of Christmas, A. D. 1171, the Irish princes and chieftans were quite astonished at the profusion and variety of provisions which they beheld, and were with difficulty prevailed upon by Henry to eat the flesh of cranes, a kind of food to which they had not been accustomed. In the remaining monuments of this period, we meet with the names of several dishes, as dellegrout, maupigyrnun, karumpie, &c. the composition of which is now unknown.

The coronation feast of Edward III. cost 2835l. 18s. 2d. equivalent to about 40,000l. of our money. At the installation of Ralph abbot of St Augustine, Canterbury, A. D. 1309, 6000 guests were entertained with a dinner, consisting of 3000 dishes, which cost 287l. 5s. equal in efficacy to 4300l. in our times. "It would require a long treatise (says Matthew Paris) to describe the astonishing splendour, magnificence, and festivity with which the nuptials of Richard earl of Cornwall, and Cincia daughter of Reimund earl of Provence, were celebrated at London, A. D. 1243. To give the reader some idea of it, in a few words, above 30,000 dishes were served up at the marriage dinner." The nuptials of Alexander III. of Scotland, and the princess Margaret of England, were solemnized at York, A. D. 1251, with still greater pomp and profusion. "If I attempted (says the same historian) to display all the grandeur of this solemnity,—the numbers of the noble and illustrious guests,—the richness and variety of the dresses,—the sumptuousness of the feasts,—the multitudes of the minstrels, mimicks, and others whose business it was to amuse and divert the company, those of my readers who were not present would imagine that I was imposing upon their credulity." The following particular will enable them to form a judgment of the whole. The archbishop of York made the king of England a present of 60 fat oxen, which made only one article of provision for the marriage feast, and were all consumed at that entertainment.

The marriage feast of Henry IV. and his queen Jane of Navarre, consisted of six courses; three of flesh and fowls, and three of fish. All these courses were accompanied and adorned with *suttleties*, as they were called. These *suttleties* were figures in pastry, of men, women, beasts, birds, &c. placed on the table, to be admired, but not touched. Each figure had a label affixed to it; containing some wise or witty saying, suited to the occasion of the feast, which was the reason they were called *suttleties*. The installation feast of George Neville, archbishop of York and chancellor of England, exceeded all others in splendour and expence, and in the number and quality of the guests. The reader may form some idea of this enormous feast from the following list of provisions prepared for it. In wheat, quarters, 300; in ale, tuns, 300; in wine, tuns, 100; in ipocrasse, pipes, 1; in oxen, 104; in wild bulls, 6; in muttons, 1000; in veals, 304; in porkes, 304; in swanns, 400; in geese, 2000; in cappons, 1000; in pigs, 2000; in plovers, 400; in quailes, 1200; in fowls, called rees, 2400; in peacocks, 104; in mallards and teales, 4000; in cranes, 204; in kids, 204; in chickens, 2000; in pigeons, 2000; in connies, 4000; in bittors, 204; in heronshaws, 400; in pheasants, 200; in partridges, 500; in woodcocks, 400; in curliews, 100; in egrits, 1000; in staggs, bucks, and roes, 500 and more; in pasties of of veniſon, cold, 4000; in parted diſhes of jellies, 1000; in plain diſhes of jellies, 3000; in cold tarts, baked, 4000; in cold cuſtards, baked, 3000; in hot paſties of veniſon, 1500; in hot cuſtards, 2000; in pikes and breams 308; in porpoiſes and ſeals, 12; ſpices, ſugared delicates, and waters, plenty. No turkeys are mentioned in this enormous bill of fare, becauſe they were not then known in England. Cranes, heronſhaws, porpoiſes, and ſeals, are ſeldom ſeen at modern entertainments.

One of the moſt expenſive ſingularities attending the royal feaſts in thoſe days conſiſted in what they called *intermeats*. Theſe were repreſentations of battles, ſieges, &c. introduced between the courſes, for the amuſement of the gueſts. The French excelled in exhibitions of this kind. At a dinner given by Charles V. of France to the emperor Charles IV. A. D. 1378, the following intermeat was exhibited: A ſhip with maſts, ſails, and rigging, was ſeen firſt: ſhe had for colours the arms of the city of Jeruſalem: Godfrey de Bouillon appeared upon deck, accompanied by ſeveral knights armed cap-a-pee: the ſhip advanced into the middle of the hall, without the machine which moved it being perceptible. Then the city of Jeruſalem appeared, with all its towers lined with Saracens. The ſhip approached the city; the Chriſtians landed, and began the aſſault; the beſieged made a good defence: ſeveral ſcaling ladders were thrown down; but at length the city was taken. Intermeats at ordinary banquets conſiſted of certain delicate diſhes introduced between the courſes, and deſigned rather for gratifying the taſte than for ſatisfying hunger.

At thoſe feaſts, beſides the ordinary drinks, ale and cyder, there were great quantities of wines of various kinds. Of theſe laſt, the following lines of a poet who wrote in the fourth century, contain an ample enumeration.

> Ye ſhall have rumney and maleſpine,
> Both ypocraſſe and vernage wyne;
> Mountreſſe and wyne of Greke,
> Both algrade and deſpice eke,
> Antioche and baſtarde,
> Pyment alſo, and garnarde,
> Wyne of Greke and Muſcadell,
> Both clare, pyment, and Rochell.

Some of theſe liquors, as ypocraſs, pyment, and claret, were compounded of wine, honey, and ſpices of different kinds, and in different proportions.

FEATHER, in *Phyſiology*, a general name for the covering of birds; it being common to all the animals of this claſs to have their whole body, or at leaſt the greateſt part of it, covered with feathers or plumage. See ORNITHOLOGY *Index*.

Feathers make a conſiderable article in commerce, particularly thoſe of the oſtrich, heron, ſwan, peacock, gooſe, &c. for plumes, ornaments of the head, filling of beds, writing pens, &c.

Geeſe are plucked in ſome parts of Great Britain five times in the year; and in cold ſeaſons many of them die by this barbarous cuſtom. Thoſe feathers that are brought from Somerſetſhire are eſteemed the beſt, and thoſe from Ireland the worſt.

Eider down † is imported from Denmark; the ducks that ſupply it being inhabitants of Hudſon's Bay, Greenland, Iceland, and Norway. Our own iſlands weſt of Scotland breed numbers of theſe birds, which turn out a profitable branch of trade to the poor inhabitants. Hudſon's Bay alſo furniſhes very fine feathers, ſuppoſed to be of the gooſe kind. The down of the ſwan is brought from Dantzic. The ſame place alſo ſends us great quantities of the feathers of the cock and hen. The London poulterers ſell a great quantity of the feathers of thoſe birds, and of ducks and turkeys: thoſe of ducks being a weaker feather, are inferior to thoſe of the gooſe; and turkeys feathers are the worſt of any. The beſt method of curing feathers is to lay them in a room, in an expoſure to the ſun; and when dried, to put them in bags, and beat them well with poles to get the dirt off.

† See the article *Down*.

FEBRIFUGE, an appellation given to ſuch medicines as mitigate or remove a fever.

FEBRUARY, in *Chronology*, the ſecond month of Numa's year, and under the protection of the god Neptune. This month is not found in the kalendar of Romulus, but was added to the year by Numa. It had its names from *Februa*, *Februaca*, or *Februalis*, all names of Juno, who preſided over the purifications of women; and in this month the Lupercalia were held in honour of Juno, and women were purified by the prieſts of Pan Lyceus at that feſtival. See LUPERCALIA.

February, in a common year, conſiſts only of 28 days; but in the biſſextile year it has 29, on account of the intercalary day added that year.

FECIALES, or FOECIALES, an order of prieſts or officers, conſiſting of 20 perſons, among the ancient Romans, appointed to proclaim war, negotiate peace, &c.

Feſtus derives the word from *ferio*, "I ſtrike;" as *ferire fœdus* ſignifies "to conclude a treaty;" and accordingly, inſtead of *feciales*, he would have it written *feriales*. Others derive it from *fœdus*, which was anciently written *fedus*; or from *fides*, "faith." Others from *facio*, *feci*, "I make," &c. becauſe they made war and peace. Voſſius chooſes to derive it from *fatu*, of the verb *fari*, "to ſpeak": in which ſenſe the *feciales* ſhould be the ſame with *oratores*; which ſentiment is alſo confirmed by the authority of Varro, who ſays they were called indifferently *feciales* and *oratores*.

The feciales were a ſort of heralds, who, when the Romans had any diſpute with their neighbours, were ſent firſt to demand the thing pretended to be uſurped, or require ſatisfaction for the injury alleged to be done. If an anſwer was not returned by them that was ſatisfactory to the people and the ſenate, they were deſpatched again to declare war, and the like in treating for peace; the feciales being the only perſons appointed to negotiate between the ſenate, &c. and the enemy.

Plutarch in the life of Numa, and Halicarnaſſeus (lib. ii.), obſerves, that they were firſt inſtituted by that prince. The latter adds, that they were firſt choſen out of the beſt families in Rome; that their office, which was reputed a ſort of ſacerdotium, or prieſthood, only ended with their life; that their perſons were ſacred and inviolable, as thoſe of other prieſts; that they were even charged to ſee the republic did not declare war unjuſtly; that they were to receive the complaints and

Fecundity, Fee.

and remonſtrances of nations who pretended to have been any way injured by the Romans; that if thoſe complaints were found juſt, they were to ſeize the criminals, and deliver them up to thoſe they had offended; that they were inveſted with the rights and privileges of ambaſſadors; that they concluded treaties of peace and alliance, and took care they were executed; and, laſtly, aboliſhed them, if they were found not to be equitable. Livy, lib. i. cap. 24. aſcribes their inſtitution to Ancus Martius, in the year of Rome 114.—Varro aſſures us, that in his time moſt of theſe functions of the feciales were ſet aſide; though Plutarch obſerves, that they had ſtill ſome authority in his time.

The feciales were crowned with *verbena*, "vervain," when they went to declare war. Their head was covered with a veil, over which the crown was applied. In this equipage they proceeded to the frontiers of the new enemy's country, and threw a bloody dart or javelin into the ground within the ſame. In Livy and other ancient authors we have the formula uſed in ſuch declarations.

FECUNDITY, the ſame with FERTILITY.

FEE, in *Law*, ſignifies a complete feudal property. Hence, where the bare liferent of any feudal ſubject is meant to be conveyed to A, and the abſolute property to B, that meaning is expreſſed thus; "to A in liferent, and to B in fee." See LAW, N° lxix. clxiv.

Fees are commonly divided into *abſolute*, otherwiſe called fees-ſimple; and *limited*, one ſpecies of which we uſually call fee-tail.

Blackſt. Comment.

I. Tenant in fee-ſimple (or as he is frequently ſtyled, *tenant in fee*), is he that hath lands, tenements, or hereditaments, to hold to him and his heirs for ever; generally, abſolutely and ſimply; without mentioning what heirs, but referring that to his own pleaſure, or to the diſpoſition of the law. The true meaning of the word *fee* (*feodum*) is the ſame with that of *feud* or *fief* †, and in its original ſenſe it is taken in contradiſtinction to *allodium*; which latter the writers on this ſubject define to be every man's own land, which he poſſeſſeth merely in his own right, without owing any rent or ſervice to any ſuperior. This is property in its higheſt degree; and the owner thereof hath *abſolutum et directum dominium*, and therefore is ſaid to be ſeized thereof abſolutely *in dominico ſuo*, in his own demeſne. But *feodum*, or *fee*, is that which is held of ſome ſuperior, on condition of rendering him ſervice; in which ſuperior the ultimate property of the land reſides. And therefore Sir Henry Spelman defines a feud or fee to be, The right which the vaſſal or tenant hath in lands to uſe the ſame and take the profits thereof to him and his heirs, rendering to the lord his due ſervices; the mere allodial property of the ſoil always remaining in the lord. This allodial property no ſubject in Britain has; it being a received and now undeniable principle in the law, that all the lands are holden mediately or immediately of the king. The king therefore only hath *abſolutum et directum dominium*; but all ſubjects lands are in the nature of *feodum* or *fee*, whether derived to them by deſcent from their anceſtors, or purchaſed for a valuable conſideration; for they cannot come to any man by either of thoſe ways, unleſs accompanied with thoſe feodal clogs which were laid upon the firſt feudatory when it was originally granted. A ſubject therefore hath only the uſufruct, and not the abſolute property, of the ſoil; or, as Sir Edward Coke expreſſes it, he hath *dominium utile*, but not *dominium directum*. And hence it is, that, in the moſt ſolemn acts of law, we expreſs the ſtrongeſt and higheſt eſtate that any ſubject can have, by theſe words, "he is ſeiſed thereof *in his demeſne*, as of fee." It is a man's demeſne, *dominium*, or property, ſince it belongs to him and his heirs for ever: yet this *dominium*, property, or demeſne, is ſtrictly not abſolute or allodial, but qualified or feodal: it is of his demeſne, *as of fee*; that is, it is not purely and ſimply his own, ſince it is held of a ſuperior lord, in whom the ultimate property reſides.

† See *Feodal* Syſtem.

This is the primary ſenſe and acceptation of the word *fee*. But (as Sir Martin Wright very juſtly obſerves) the doctrine, "that all lands are *holden*," having been for ſo many ages a fixed and undeniable axiom, the Engliſh lawyers do very rarely (of late years eſpecially) uſe the word *fee* in this its primary original ſenſe, in contradiſtinction to *allodium* or abſolute property, with which they have no concern; but generally uſe it to expreſs the continuance or quantity of eſtate. A *fee* therefore, in general, ſignifies an eſtate of inheritance; being the higheſt and moſt extenſive intereſt that a man can have in a feud: and when the term is uſed ſimply, without any other adjunct, or has the adjunct of *ſimple* annexed to it (as, a fee, or a fee-ſimple), it is uſed in contradiſtinction to a fee-conditional at the common law, or a fee-tail by the ſtatute; importing an abſolute inheritance, clear of any condition, limitation, or reſtrictions to particular heirs, but deſcendible to the heirs-general, whether male or female, lineal or collateral. And in no other ſenſe than this is the king ſaid to be ſeiſed in fee, he being the feudatory of no man.

Taking therefore *fee* in this its ſecondary ſenſe, as a ſtate of inheritance, it is applicable to, and may be had in, any kind of hereditaments either corporeal or incorporeal. But there is this diſtinction between the two ſpecies of hereditaments; that of a corporal inheritance a man ſhall be ſaid to be ſeiſed *in his demeſne, as of fee*; of an incorporeal one he ſhall only be ſaid to be ſeiſed *as of fee*, and not *in his demeſne*. For as incorporeal hereditaments are in their nature collateral to, and iſſue out of, lands and houſes, their owner hath no property, *dominium*, or demeſne, in the *thing* itſelf, but hath only ſomething derived out of it; reſembling the *ſervitutes*, or ſervices, of the civil law. The *dominium*, or property, is frequently in one man, while the appendage or ſervice is in another. Thus Gaius may be ſeiſed *as of fee*, of a way going over the land, of which Titius is ſeiſed *in his demeſne as of fee*.

The fee-ſimple or inheritance of lands and tenements is generally veſted and reſides in ſome perſon or other; though divers inferior eſtates may be carved out of it. As if one grants a leaſe for 21 years, or for one or two lives, the fee-ſimple remains veſted in him and his heirs; and after the determination of thoſe years or lives, the land reverts to the granter or his heirs, who ſhall hold it again in fee-ſimple. Yet ſometimes the fee may be in *abeyance*, that is (as the word ſignifies) in expectation, remembrance, and contemplation in law; there being no perſon *in eſſe*, in whom it can veſt and abide,

though

Fee.

though the law considers it as always potentially existing, and ready to vest whenever a proper owner appears. Thus, in a grant to John for life, and afterwards to the heirs of Richard, the inheritance is plainly neither granted to John nor Richard, nor can it vest in the heirs of Richard till his death, *nam nemo est hæres viventis:* it remains therefore in waiting, or abeyance, during the life of Richard. This is likewise always the case of a parson of a church, who hath only an estate therein for the term of his life; and the inheritance remains in abeyance. And not only the fee, but the freehold also, may be in abeyance; as, when a parson dies, the freehold of his glebe is in abeyance until a successor be named, and then it vests in the successor.

The word *heirs* is necessary in the grant or donation, in order to make a fee or inheritance. For if land be given to a man for ever, or to him and his assigns for ever, this vests in him but an estate for life. This very great nicety about the insertion of the word *heirs* in all feoffments and grants, in order to vest a fee, is plainly a relick of the feodal strictness: by which it was required, that the form of the donation should be punctually pursued; or that, as Craig expresses it, in the words of Baldus, *donationes sint stricti juris, ne quis plus donâsse præsumatur quam in donatione expresserit.* And therefore, as the personal abilities of the donee were originally supposed to be the only inducements to the gift, the donee's estate in the land extended only to his own person, and subsisted no longer than his life; unless the donor, by an express provision in the grant, gave it a longer continuance, and extended it also to his heirs. But this rule is now softened by many exceptions.

For, 1. It does not tend to devises by will; in which, as they were introduced at the time when the feodal rigour was apace wearing out, a more liberal construction is allowed: and therefore by a devise to a man for ever, or to one and his assigns for ever, or to one in fee-simple, the devisee hath an estate of inheritance; for the intention of the devisor is sufficiently plain from the words of perpetuity annexed, though he hath omitted the legal words of inheritance. But if the devise be to a man and his assigns, without annexing words of perpetuity, there the devisee shall take only an estate for life; for it does not appear that the devisor intended any more. 2. Neither does this rule extend to fines or recoveries, considered as a species of conveyance; for thereby an estate in fee passes by act and operation of law without the word *heirs:* as it does also, for particular reasons, by certain other methods of conveyance, which have relation to a former grant or estate, wherein the word *heirs* was expressed. 3. In creations of nobility by writ, the peer so created hath an inheritance in his title, without expressing the word *heirs;* for they are implied in the creation, unless it be otherwise specially provided: but in creations by patent, which are *stricti juris*, the word *heirs* must be inserted, otherwise there is no inheritance. 4. In grants of lands to sole corporations and their successors, the word *successors* supplies the place of *heirs;* for as heirs take from the ancestor, so doth the successor from the predecessor. Nay, in a grant to a bishop, or other sole spiritual corporation, in *frankalmoign*, the word *frankalmoign* supplies the place of *successors* (as the word *successors* supplies the place of *heirs*) *ex vi termini*; and in all these cases a fee-simple vests in such sole corporation. But, in a grant of lands to a corporation aggregate, the word *successors* is not necessary, though usually inserted: for, albeit such simple grant be strictly only an estate for life, yet as that corporation never dies, such estate for life is perpetual, or equivalent to a fee-simple, and therefore the law allows it to be one. Lastly, In the case of the king, a fee-simple will vest in him, without the words *heirs or successors* in the grant; partly from prerogative royal and partly from a reason similar to the last, because the king, in judgment of law, never dies. But the general rule is, that the word *heirs* is necessary to create an estate of inheritance.

Fee.

II. We are next to consider limited fees, or such estates of inheritance as are clogged and confined with conditions or qualifications of any sort. And these we may divide into two sorts: 1. *Qualified* or *base* fees; and, 2. Fees *conditional*, so called at the common law; and afterwards fees-*tail*, in consequence of the statute *de donis.*

1. A BASE or qualified fee, is such a one as has a qualification subjoined thereto, and which must be determined whenever the qualification annexed to it is at an end. As, in the case of a grant to A and his heirs, tenants in the manor of Dale; in this instance, whenever the heirs of A cease to be tenants of that manor, the grant is entirely defeated. So, when Henry VI. granted to John Talbot, lord of the manor of Kingston Lisle in Berks, that he and his heirs, lords of the said manor, should be peers of the realm, by the title of *Barons of Lisle;* here John Talbot had a base or qualified fee in that dignity; and the instant he or his heirs quitted the seigniory of this manor, the dignity was at an end. This estate is a fee, because by possibility it may endure for ever in a man and his heirs; yet as that duration depends upon the concurrence of collateral circumstances, which qualify and debase the purity of the donation, it is therefore a qualified or base fee.

2. As to fees-*conditional*, or fee-*tail*, see the article TAIL.

FEE also signifies a certain allowance to physicians, barristers, attorneys, and other officers, as a reward for their pains and labour.

If a person refuse to pay an officer his due fees, the court will grant an attachment against him, to be committed till the fees are paid; and an attorney may bring an action of the case for his fees against the client that retained him in his cause.

FEE also denotes a settled perquisite of public officers, payable by those who employ them.

The fees due to the officers of the custom-house are expressly mentioned in a schedule, or table, which is hung up in public view in the said office, and in all other places where the said fees are to be paid or received. And if any officer shall offend, by acting contrary to the regulations therein contained, he shall forfeit his office and place, and be for ever after incapable of any office in the custom-house.

The other public offices have likewise their settled fees, for the several branches of business transacted in them.

FEE *Farm*, a kind of tenure without homage, fealty, or other service, except that mentioned in the feoffment;

ment; which is usually the full rent, or at least a fourth part of it.

The nature of this tenure is, that if the rent be behind, and unpaid for two years, then the feoffor and his heirs may have an action for the recovery of the lands.

FEELERS, in *Natural History*, a name used by some for the horns of INSECTS.

FEELING, one of the five external senses, by which we obtain the ideas of solid, hard, soft, rough, hot, cold, wet, dry, and other tangible qualities. See ANATOMY *Index*.

FEET. See FOOT.

Feet-Bearer, the name of an officer in the courts of the ancient Anglo-Saxon and Welsh kings. He was a young gentleman whose duty it was to sit on the floor, with his back towards the fire, and hold the king's feet in his bosom all the time he sat at table, to keep them warm and comfortable †: a piece of state and luxury unknown in modern times.

† *Leges Wallicæ*, p. 58.

FEINT, in fencing, a show of making a thrust at one part, in order to deceive the enemy, that you may really strike him in another.

A simple feint is a mere motion of the wrist, without stirring the foot.

FELAPTON, in *Logic*, one of the six first modes of the third figure of syllogisms; whereof the first proposition is an universal negative, the second an universal affirmative, and the third a particular negative.

FELIBIEN, ANDRE, was born at Chartres in 1619, and went secretary under the Marquis de Fontenay Mareuil ambassador to the court of Rome in 1647. On his return, M. Colbert procured him the places of historiographer to the king, superintendant of his buildings, and of the arts and manufactures in France. He became afterwards deputy comptroller general of the bridges and dykes in that kingdom; and died in 1695. He wrote several pieces relating to the fine arts: the principal of which is his "Dialogues on the Lives and Works of the most eminent Painters."

FELICITAS, (FELICITY, or *Happiness*), was deified by the ancient Pagans. Lucullus built a temple to her. She had another erected by Lepidus. The Greeks paid divine worship to *Macaria*, daughter of Hercules, the same with *Felicitas*. This deity is often pictured upon medals, and generally with a cornucopiæ in one hand, and a caduceus in the other. The inscriptions are, *Felicitas Temporum*, *Felicitas Augusti*, *Felicitas Publica*, &c.

FELIS, a genus of quadrupeds belonging to the order of feræ, and class mammalia. See MAMMALIA *Index*.

FELLING *of* TIMBER.—Many circumstances are well known and constantly observed in the felling of timber for building, which, though to a hasty observer, they might appear trifling, yet prove, on experience, to be of the utmost consequence. One thing observed by M. de Buffon, which very greatly increases the solidity and strength of timber, is, that the trees intended to be felled for service should first be stripped of their bark, and suffered to stand and die upon the spot before the cutting. The sappy part or blea of the oak becomes by this means as hard and firm as the heart; and the real strength and density of the wood has been proved, by many experiments, to be greatly increased by it: nor is this a practice of any detriment to the proprietor, since the remaining stumps of these trees send up their young shoots as vigorously as if they had been cut down in their natural condition.

When any tree is to be cut down for timber, the first thing to be taken care of is a skilful disbranching of such limbs as may endanger it in its fall: many trees are utterly spoiled for want of a previous care of this kind. In arms of timber that are very great, it is always necessary to chop or sink in them close to the bole, and then meeting it with downright strokes, it will be severed from the tree without splitting. In felling the tree, take care always to cut it as close to the ground as possible, unless it is intended to be grubbed up: and the doing that is of advantage both to the timber and to the wood; for timber is never so much valued, if it be known to grow out of old stocks.

FELLOWSHIP, COMPANY, or *Distributive Proportion*, in *Arithmetic*. See ARITHMETIC.

FELO DE SE, in *Law*, a person that lays deliberately violent hands on himself, and is the occasion of his untimely death, whether by hanging, drowning, stabbing, shooting, or any other way.

FELON, in *Law*, a person guilty of felony. See FELONY.

FELONY, in the general acceptation of the law, comprises every species of crime, which occasions at common law the forfeiture of lands or goods. This most frequently happens in those crimes for which a capital punishment either is or was to be inflicted: for those felonies that are called *clergyable*, or to which the benefit of clergy extends, were anciently punished with death in all lay or unlearned offenders; though now, by the statute law, that punishment is for the first offence universally remitted. Treason itself, says Sir Edward Coke, was anciently comprised under the name of *felony*; and in confirmation of this we may observe, that the statute of treasons, 25 Edw. III. c. 2. speaking of some dubious crimes, directs a reference to parliament; that it may be there adjudged, "whether they be treason or *other* felony." All treasons, therefore, strictly speaking, are felonies; though all felonies are not treason. And to this also we may add, that all offences, now capital, are in some degree or other felony; but this is likewise the case with some other offences, which are not punished with death; as suicide, where the party is already dead; homicide by chancemedley, or in self-defence; and petit-larceny, or pilfering; all which are (strictly speaking) felonies, as they subject the committers of them to forfeitures. So that, upon the whole, the only adequate definition of felony seems to be that which is before laid down; viz. an offence which occasions a total forfeiture of either lands or goods, or both, at the common law; and to which capital or other punishment may be superadded, according to the degree of guilt.

To explain this matter a little farther: The word *felony*, or *felonia*, is of undoubted feodal original, being frequently to be met with in the books of feuds, &c. but the derivation of it has much puzzled the juridical lexicographers, Pratæus, Calvinus, and the rest: some deriving it from the Greek, φηλος, "an impostor or deceiver;" others from the Latin, *fallo*, *fefelli*, to counte-

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Felony.

nance which they would have it called *fellonia*. Sir Edward Coke, as his manner is, has given us a ſtill ſtranger etymology; that it is *crimen animo felleo perpetratum*, "with a bitter or galliſh inclination." But all of them agree in the deſcription, that it is ſuch a crime as works a forfeiture of all the offender's lands or goods. And this gives great probability to Sir Henry Spelman's Teutonic or German derivation of it: in which language, indeed, as the word is clearly of feodal original, we ought rather to look for its ſignification, than among the Greeks and Romans. *Fe-lon* then, according to him, is derived from two northern words: FEE, which ſignifies (we well know) the fief, feud, or beneficiary eſtate; and LON, which ſignifies price or value. Felony is therefore the ſame as *pretium feudi*, the conſideration for which a man gives up his fief; as we ſay in common ſpeech, ſuch an act is as much as your life or eſtate is worth. In this ſenſe it will clearly ſignify the feodal forfeiture, or act by which an eſtate is forfeited, or eſcheats to the lord.

To confirm this, we may obſerve, that it is in this ſenſe, of forfeiture to the lord, that the feodal writers conſtantly uſe it. For all thoſe acts, whether of a criminal nature or not, which at this day are generally forfeitures of copyhold eſtates, are ſtyled *feloniæ* in the feodal law: "*ſcilicet, per quas feudum amittitur.*" As "*ſi domino deſervire noluerit;—ſi per annum et diem ceſſaverit in petenda inveſtitura;—ſi dominum ejuravit*, i. e. *negavit ſe a domino feudum habere;—ſi a domino in jus eum vacante, ter citatus non comparuerit*:"—all theſe, with many others, are ſtill cauſes of forfeiture in our copyhold eſtates, and were denominated *felonies* by the feodal conſtitutions. So likewiſe injuries of a more ſubſtantial or criminal nature were denominated *felonies*, that is, forfeitures: as aſſaulting or beating the lord; vitiating his wife or daughter, "*ſi dominum cucurbitaverit*, i. e. *cum uxore ejus concubuerit*; all theſe are eſteemed felonies, and the latter is expreſsly ſo denominated, "*ſi fecerit feloniam, dominum forte cucurbitando.* And as theſe contempts, or ſmaller offences, were felonies or acts of forfeiture, of courſe greater crimes, as murder and robbery, fell under the ſame denomination. On the other hand, the lord might be guilty of felony, or forfeit his ſeignory to the vaſſal, by the ſame act as the vaſſal would have forfeited his feud to the lord. "*Si dominus commiſit feloniam, per quam vaſallus amitteret feudum ſi eam commiſerit in dominum, feudi proprietatem etiam dominus perdere debet.*" One inſtance given of this ſort of felony in the lord is beating the ſervant of his vaſſal, ſo as that he loſes his ſervice; which ſeems merely in the nature of a civil injury, ſo far as it reſpects the vaſſal. And all theſe felonies were to be determined, "*per laudamentum ſive judicium parium ſuorum*," in the lord's court; as with us forfeitures of copyhold lands are preſentable by the homage in the court-baron.

Felony, and the act of forfeiture to the lord, being thus ſynonymous terms in the feodal law, we may eaſily trace the reaſon why, upon the introduction of that law into England, thoſe crimes which induced ſuch forfeiture or eſcheat of lands (and, by a ſmall deflection from the original ſenſe, ſuch as induced the forfeiture of goods alſo) were denominated *felonies*. Thus it was that ſuicide, robbery, and rape, were felonies; that is, the conſequence of ſuch crimes was forfeiture; till by

Felony ‖ Felting.

long uſe we began to ſignify by the term of *felony* the actual crime committed, and not the penal conſequence. And upon this ſyſtem only can we account for the cauſe, why treaſon in ancient times was held to be a ſpecies of felony; viz. becauſe it induced a forfeiture.

Hence it follows, that capital puniſhment does by no means enter into the true idea and definition of *felony*. Felony may be without inflicting capital puniſhment, as in the caſes inſtanced of ſelf-murder, excuſable homicide, and petit-larceny: and it is poſſible that capital puniſhments may be inflicted, and yet the offence be no felony; as in caſe of hereſy by the common law, which, though capital, never worked any forfeiture of lands or goods, an inſeparable incident to felony. And of the ſame nature was the puniſhment of ſtanding mute, without pleading to an indictment; which at the common law was capital, but without any forfeiture, therefore ſuch ſtanding mute was no felony. In ſhort, the true criterion of felony is forfeiture: for, as Sir Edward Coke juſtly obſerves, in all felonies which are puniſhable with death, the offender loſes all his lands in fee-ſimple, and alſo his goods and chattels; in ſuch as are not puniſhable, his goods and chattels only.

The idea of felony is indeed ſo generally connected with that of capital puniſhment, that we find it hard to ſeparate them; and to this uſage the interpretations of the law do now conform. And therefore, if a ſtatute makes any new offence felony, the law implies that it ſhall be puniſhed with death, viz. by hanging, as well as with forfeiture: unleſs the offender prays the benefit of clergy; which all felons are entitled once to have, unleſs the ſame is expreſsly taken away by ſtatute.

Felonies by ſtatute are very numerous; and as this work will not admit of a proper enumeration, we muſt refer to the table of the quarto edition of the Statutes, where they are ſet forth in alphabetical order.

FELT, in *Commerce*, a ſort of ſtuff deriving all its conſiſtence merely from being fulled, or wrought with lees and ſize, without either ſpinning or weaving. Felt is made either of wool alone or of wool and hair.

FELTING, the method of working up hair or wool into a ſpecies of cloth, independent of either ſpinning or weaving. Felting in Britain is not much practiſed, except in the manufacturing of hats; and as the generality even of thoſe who are employed in making them, are unacquainted with the principles on which they act, a few obſervations on the method of felting may, to ſuch, be both uſeful and agreeable.

If wool, the hair of a rabbit, hare, beaver, or human-hair, be examined with a microſcope of the greateſt magnifying power, the ſurface of each hair appears perfectly ſmooth, or if any inequalities are obſerved, they do not appear ſo much to ariſe from an irregular ſurface, as from ſome peculiar difference in the colour and tranſparency of the ſubſtances examined; for if their image be viewed by a ſolar microſcope, it terminates in even lines, without the ſmalleſt veſtige of any roughneſs. Yet nothing is more evident than that the ſurfaces of hairs are not perfectly ſmooth, but either compoſed of lamellæ covering each other from the root to the point, reſembling the ſcales of fiſhes; or what ſome have deemed

more

more probable, of zones placed over each other, similar to the ftructure of horns; and to this texture hair, wool, &c. owe their difpofition for what is denominated felting.

Let a perfon take hold of a hair by the root with one hand, and draw it between two fingers of the other, from the root towards the point, he will fcarcely perceive any friction, or hear any found; but fhould he hold the hair by the point, and draw it between his fingers from the point towards the root, he will feel a fenfible oppofition or refiftance which could not be felt before. A fort of tremulous motion is likewife produced, which can be diftinguifhed by the ear. From this fimple experiment it is obvious that the texture of the furface of a hair is not the fame from the point to the root, as it is from the root to the point. If a hair is taken hold of by the fore-finger and thumb, and rubbed in a longitudinal direction, a progreffive motion is the refult, which is invariably towards the root. This is wholly independent of the texture or nature of the fkin of the fingers; for if the hair be turned, and the point of it placed where the root formerly was, the movement becomes contrary, or, in other words, it is ftill directed towards the root.

It is found a very difficult tafk to untie a knot made in the middle of a hair, on account of its extreme thinnefs; but if the hair is placed in the bend of the hand, the knot being in a line with the little finger, and if the hair is grafped by clofing the hand, and the fift ftruck feveral times againft the knee, the knot is thereby opened, becaufe the afperities of one end of the hair are in a contrary direction to thofe of the other, by which means each end of it recedes a little. By the introduction of a pin into the eye thus formed at the knot, it is eafily untied. Although thefe obfervations have a direct reference to long hair; yet they are equally applicable to wool, furs, and almoft every fpecies of animal hair. The furfaces of all thefe confift of hard *lamellæ*, placed upon each other like tiles, in the direction from the root to the point.

By attending to thefe remarks, it is eafy to fee why the contact of woollen ftuffs is rough to the fkin. The afperities on the furface of the fibres of wool produce a difagreeable fenfation, by fixing themfelves in the fkin, which can only be endured by being accuftomed to feel it frequently. The injury done to wounds by the application of wool, is not the refult of any chemical property, but is entirely occafioned by the afperities of its furface.

A hatter feparates the hairs from each other, by ftriking the wool with the ftring of his bow, caufing them to fpring up in the air, which fall on the table in every poffible direction, forming a layer of a particular thicknefs, which is covered by the workmen with a cloth, preffing it with his hands, and moving the hairs backwards and forwards in different directions. In this manner the hairs are brought againft each other, and their points of contact confiderably multiplied, and the agitation gives each hair a progreffive motion towards the root, in confequence of which the hairs become twifted together. As the mafs becomes compact, the preffure ought to be increafed, in order to keep up the progreffive motion and twifting of the hairs, which is then performed with greater difficulty.

The hair defigned for the manufacturing of hats is always cut off with a fharp inftrument, and not pulled out by the roots, becaufe the bulb of the hair which would come out with it in the latter cafe, would render the end which was fixed in the fkin very obtufe, and nearly deftroy its difpofition to unite with the adjacent hairs. But in addition to the tendency of hairs to move progreffively towards the root, they fhould not be ftraight like needles, for in this cafe they could not produce any compactnefs in the ftuff. The fibres of wool having naturally a crooked form, that fubftance is well adapted to the operation of felting. The hair of beavers, rabbits, hares, &c. being ftraight, it cannot be employed in felting by itfelf, till it has been fubjected to a previous preparation, viz. rubbing and combing on the fkin, the brufh being dipped in a folution of mercury in nitric acid. This fubftance, by acting only on one fide of the hairs, gives them that difpofition to felting which is natural to wool.

When it is not intended that the hairs fhall enter into the body of the mafs, but ferve only as an external coating, which is fometimes given to the outer furface of hats, the operation with the nitric acid need not be performed. They muft be uniformly fpread upon the furface to which the coating is to be applied, and being covered with a cloth, it is preffed with the hands, and agitated for fome time. They receive a particular direction afterwards by means of a brufh, and are enabled to keep it by having a hot iron paffed over them. Woollen cloth is thickened by fulling, on the fame principles that wool and hair become capable of felting.

Felt-Spar or *Feld-Spar*, a mineral fubftance. See Mineralogy *Index*.

FELTRIA, in *Ancient Geography*, a town on the borders of Rhætia towards Italy. Now *Felitri*, in the territory of Venice, on the Piava. E. Long. 12. 16. N. Lat. 46. 0.

FELUCCA, in fea affairs, a little veffel rowed with fix oars, frequent in the Mediterranean; which has this peculiarity, that its helm may be applied either in the head or ftern, as occafion requires.

FEMALE, (foemina), a term peculiar to animals, fignifying that fex which conceives and generates its young within itfelf. See Sex and Generation.

Female is alfo applied, figuratively, to things without life, from the refemblance they bear to the females of animals. Thus we fay a

Female Screw. See Screw.

Female Flower. See *Fœmineus Flos*.

Female Plant. See *Fœminea Planta*.

FEMME covert, in *Law*, a married woman. See Coverture.

Femme Sole, an unmarried woman, whofe debts, contracted before marriage, become thofe of her hufband after it.

A femme fole merchant, is where a woman, in London, ufes a trade alone, without her hufband; on which account fhe fhall be charged without him.

FEMININE, in *Grammar*, one of the genders of nouns. See Gender.

The feminine gender is that which denotes the noun or name to belong to a female. In the Latin, the feminine gender is formed of the mafculine, by altering its termination; particularly by changing *us* into *a*. Thus,

Thus, of the maſculine *bonus equus*, "a good horſe," is formed the feminine *bona equa*, "a good mare;" ſo, of *parvus homo*, "a little man," is formed *parva fœmina*, "a little woman," &c.

In French, the feminine gender is expreſſed, not by a different termination, but by a different article: thus, *le* is joined to a male, and *la* to a female.

In Engliſh, we are generally more ſtrict, and expreſs the difference of ſex, not by different terminations, nor by different particles, but different words; as boar and ſow, boy and girl, brother and ſiſter, &c. —though ſometimes the feminine is formed by varying the termination of the male into *eſs*; as in abbot, abbeſs, &c.

FEMUR, OS FEMORIS, the thigh bone. See ANATOMY *Index*.

FEN, a place overflowed with water, or abounding with bogs. See BOG and DRAINING, in AGRICULTURE *Index*.

Fens are either made up of a congeries of bogs; or conſiſt of a multitude of pools or lakes, with dry ſpots of land intermixed, like ſo many little iſlands.

Several ſtatutes have been made for the draining of fens, chiefly in Kent, Cambridgeſhire, Bedfordſhire, and Lincolnſhire; and by a late act, 11 Geo. II. commiſſioners ſhall be appointed for the effectually draining and preſerving of the fens in the iſle of Ely, who are authorized to make drains, dams, and proper works thereon; and they may charge the landholders therein with a yearly acre-tax, and in default of payment, ſell the defender's lands.

The wet grounds called *fens*, in Lincolnſhire and elſewhere in England, bring many advantages to the inhabitants of thoſe counties. Fowl and fiſh are very plentiful in them. The pike and eels are large and eaſily caught, but they are uſually coarſe. The duck, mallard, and teal, are in ſuch plenty as is ſcarce to be conceived. They are taken by DECOYS in prodigious flocks at a time. They ſend theſe fowl from Lincolnſhire to London, twice a-week, on horſeback, from Michaelmas to Lady-day; and one decoy will furniſh 20 dozen, or more, twice a-week, for the whole ſeaſon in this manner. The decoy-men contract with the people, who bring them to London at a certain rate, and they are obliged to take off their hands the whole number that is catched. Two teal are uſually reckoned equal to one duck; and ſix ducks and twelve teal are accounted a dozen of wild fowl; and the uſual market price is about 9s. for ſuch a dozen. About midſummer, during the moulting ſeaſon, a great number alſo are deſtroyed by the people in the neighbourhoods. The poor birds at this ſeaſon are neither able to ſwim nor fly well; and the people going in with boats among the reeds where they lie, knock them down with long poles. A little before Michaelmas, vaſt flights of theſe birds arrive at the decoys from other places; they ſoon grow fat in them, and continue there a prey to the maſters or owners, as long as the decoys are unfrozen; but, when they are iced over, they fly away again, and go to the neighbouring ſeas for food.

The fens alſo abound in a ſort of herbage that is very nouriſhing to cattle. Sheep and horſes always grow fat upon it. The fens are common, and the owners of cattle mark them that they may be known. It is remarkable, that, though all is open, the cattle uſed to one particular ſpot of ground ſeldom leave it, but the owner may always find them in or near the ſame place. The fens have many large and deep drains. In theſe the pike and eel grow to a vaſt ſize: and they are full of geeſe which feed on the graſs; but theſe eat rank and muddy, and may even be ſmelt as ſoon as a perſon comes into the room where they are roaſting. But the people have another very great advantage from theſe birds beſides the eating of them, namely, their feathers and quills; and the produce of theſe is ſo great, that the cuſtomhouſe books in the town of Boſton ſhow, that there are frequently ſent away in one year 300 bags of feathers, each containing a hundred and a half weight. Each pound of feathers brings in the owner twopence; and it may be thought ſtrange by people unacquainted with theſe things, but it is a certain truth, that the owners pull them five or ſix times a year for the feathers, and three times for the quills. Each pulling comes to about a pound, and many people have 1000 geeſe at a time, or more. They are kept at no charge, except in deep ſnowy weather, when they are obliged to feed them with corn.

Oats alſo grow very well in many of the fen countries, and in good ſeaſons bring great increaſe and advantage to the owners. There is alſo another vegetable of great profit to them. This is the *rapum ſilveſtre*; the ſeed of which they call *cole ſeed*; and they make an oil from it of great uſe in trade. They grind the ſeed between two large ſtones, the one ſtanding perpendicularly on the other. The ſtones are made of a ſort of black marble, and are brought from Germany. They ſometimes turn them by ſails, and ſometimes by the drains which carry off the water from the fen lands.

The fens lying low, and being of a vaſt extent, are very ſubject to be overflowed by waters from the neighbouring high countries; and though great care and expence is uſed to keep them dry, they are often like a ſea; and the ſheep are obliged to be carried off in boats, and the people to live in their upper rooms, and to be ſupplied with proviſions alſo with boats.

FENCE, in *Gardening* and *Huſbandry*, a hedge, wall, ditch, bank, or other encloſure, made round gardens, fields, woods, &c.

In hot climates, where they have not occaſion for walls to ripen their fruit, their gardens lie open, where they can have a water fence, and proſpects; or elſe they bound their gardens with groves, in which are fountains, walks, &c. which are much more pleaſing to the ſight than a dead wall: but, in colder countries, we are obliged to have walls to ſhelter and ripen our fruit, although they take away much from the pleaſant proſpect of the garden. Brick walls are accounted the beſt and warmeſt for fruit: and theſe walls, being built pannelwiſe, with pillars at equal diſtances, will ſave a great deal of charge, in that the walls may be built thinner than if they were made plain without theſe pannels, for then it would be neceſſary to build them thicker everywhere; and, beſides, theſe pannels make the walls look the handſomer. Stone walls, however, on account of their durability, are to be preferred to thoſe of brick, eſpecially thoſe of ſquare hewn ſtones. Thoſe that are made of rough ſtones, though

Fence.

though they are very dry and warm, yet, by reaſon of their unevenneſs, are inconvenient to nail up trees to, except pieces of timber be laid in them here and there for that purpoſe.

But, in large gardens, it is better to have the proſpect open to the pleaſure garden; which ſhould be ſurrounded with a foſſe, that from the garden the adjacent country may be viewed. But this muſt depend on the ſituation of the place: for, if the proſpect from the garden is not good, it had better be ſhut out from the ſight than be open. As alſo, when a garden lies near a populous town, and the adjoining grounds are open to the inhabitants; if the garden is open, there will be no walking there in good weather, without being expoſed to the view of all paſſengers, which is very diſagreeable.

Miller's Gardener's Dictionary.

Where the foſſes are made round a garden which is ſituated in a park, they are extremely proper; becauſe hereby the proſpect of the park will be obtained in the garden, which renders thoſe gardens much more agreeable than thoſe that are confined.—In the making theſe foſſes there have been many inventions; but, upon the whole, none ſeem preferable to thoſe which have an upright wall next the garden, which (where the ſoil will admit of a deep trench) ſhould be five or ſix feet high; and, from the foot of this wall, the ground on the outſide ſhould riſe with a gradual eaſy ſlope, to the diſtance of 18 or 20 feet; and where it can be allowed, if it ſlopes much farther it will be eaſier, and leſs perceptible as a ditch, to the eye, when viewed at a diſtance; but, if the ground is naturally wet, ſo as not to admit a deep foſſe, then, in order to make a fence againſt cattle, if the wall be four feet high, and ſlight poſts of three feet high are placed juſt behind the wall, with a ſmall chain carried on from poſt to poſt, no cattle or deer will ever attempt to jump againſt it; therefore it will be a ſecure fence againſt them; and if theſe are painted green, they will not be diſcerned at a diſtance, and at the ſame time the chain will ſecure perſons walking in the garden from tumbling over.

In places where there are no good proſpects to be obtained from a garden, it is common to make the encloſure of park paling; which, if well performed, will laſt many years, and has a much better appearance than a wall; and this pale may be hid from the ſight within, by plantations of ſhrubs and evergreens; or there may be a quick hedge planted within the pale, which may be trained up, ſo as to be an excellent fence by the time the pales begin to decay.

Fences round parks are generally of paling; which, if well made of winter-fallen oak, will laſt many years. But a principal thing to be obſerved, in making theſe pales, is not to make them too heavy: for, when they are ſo, their own weight will cauſe them to decay: therefore the pales ſhould be cleft thin; and the rails ſhould be cut triangular, to prevent the wet lodging upon them; and the poſts ſhould be good, and not placed too far aſunder. If theſe things are obſerved, one of theſe pales will laſt, with a little care, upwards of 40 years very well. The common way of making theſe fences is, to have every other pale nine or ten inches above the intermediate ones; ſo that the fence may be ſix feet and a half high, which is enough for fallow deer; but, where there are red deer, the fence ſhould be one foot higher, otherwiſe they will leap over.

Fence-Month, Fencing.

Some encloſe their parks with brick walls; and in countries where ſtone is cheap, the walls are built with this material; ſome with, and others without, mortar.

A kitchen garden, if rightly contrived, will contain walling enough to afford a ſupply of ſuch fruits as require the aſſiſtance of walls, for any family; and this garden, being ſituated on one ſide, and quite out of ſight of the houſe, may be ſurrounded with walls which will ſcreen the kitchen garden from the ſight of perſons in the pleaſure garden; and, being locked up, the fruit will be much better preſerved than it can be in the public garden; and the having too great a quantity of walling is often the occaſion that ſo many ill managed trees are frequently to be ſeen in large gardens.

The height of garden walls ſhould be 12 feet, which is a moderate proportion; and, if the ſoil be good, it may in time be well furniſhed with bearing wood in every part, eſpecially that part planted with pears, notwithſtanding of the branches being trained horizontally from the bottom of the walls.

With regarded to the different kinds of fences, See Agriculture *Index*.

Fence-Month, the month wherein deer begin to fawn, during which it is unlawful to hunt in the foreſt.

It commences 15 days before Midſummer, and ends 15 days after it. This month, by ancient foreſters, is called *defence-month*.

FENCING, the art of making a proper uſe of the ſword, as well for attacking an enemy as for defending one's ſelf.

This art is acquired by practiſing with foils, called in Latin *rudes;* whence fencing is alſo denominated *gladiatura rudiaria*.—It is one of the exerciſes learnt in the academies (ſee Exercise and Academy); and is an accompliſhment both agreeable and uſeful:—Agreeable, as it affords gentlemen a noble and diſtinguiſhed amuſement:—Uſeful, as it forms their body; and furniſhes them with the faculty of defence, whether it be of their honour or their life, when the one or the other is attacked by thoſe turbulent and dangerous perſons whoſe correction is of ſervice to ſociety in general.

Pyrard aſſures us, that the art of fencing is ſo highly eſteemed in the Eaſt Indies, that none but princes and noblemen are allowed to teach it. They wear a badge or cognizance on their right arms, called in their language *eſaru;* which is put on with great ceremony, like the badges of our orders of knighthood, by the kings themſelves.

Fencing is divided into two parts, *ſimple* and *compound*.

Simple is that performed directly and nimbly, on the ſame line; and is either offenſive or defenſive.—The principal object of the firſt, is whatever may be attempted, in puſhing or making paſſes, from this or that point, to the moſt uncovered part of the enemy. The ſecond conſiſts in parrying and repelling the thruſts aimed by the enemy.

The *compound* includes all the poſſible arts and inventions to deceive the enemy, and make him leave that part we have a deſign on bare and unguarded, upon finding

Fenelon ‖ Fenton.

finding we cannot come at it by force, nor by the agility of the ſimple play. The principal means hereof are, on the offenſive ſide, feints, appeals, claſhings, and entanglings of ſwords, half thruſts, &c. and, on the defenſive, to puſh in parrying. Of all which a detail would be here uſeleſs, as they are only to be underſtood and acquired from perſonal inſtructions conjoined with practice.

FENELON, Francis de Salignac de la Motte, was of an ancient and illuſtrious family, and born at the caſtle of Fenelon in Perigord in 1651. In 1689, he was appointed tutor to the dukes of Burgundy and Anjou; and in 1655 was conſecrated archbiſhop of Cambray. After this preferment, a ſtorm aroſe againſt him, that obliged him to leave the court for ever, occaſioned by his performance entitled, An Explication of the Maxims of the Saints concerning the Interior Life; in which he was ſuppoſed to favour the extravagant notions of Madame Guyon, and the principles of Quietiſm. A controverſy on this occaſion was for ſome time carried on between him and M. Boſſuet, biſhop of Meaux: which terminated in an appeal to the pope; when his holineſs condemned the archbiſhop's book, by a brief dated March 12. 1699. Some friends indeed pretend, that there was more of court policy than religious zeal in this affair: but be this as it may, the archbiſhop ſubmitted patiently to this determination; and, retiring to his dioceſe of Cambray, acquitted himſelf punctually in all the duties of his ſtation, and led a moſt exemplary life. The work that gained him the greateſt reputation, and which will render his memory immortal, is his Adventures of Telemachus; the ſtyle of which is natural, the fictions well contrived, the moral ſublime, and the political maxims tending all to the happineſs of mankind. Hence it is thought, as the printing of this work was ſtopped at Paris, that the prelate's hereſy was in politics inſtead of religion; and though his diſgrace was prior to this work, he had, while he was tutor to the young princes, taught them the ſame principles aſſerted and exemplified in Telemachus. Fenelon died in 1715; and a collection of all his religious works was afterwards printed at Rotterdam, under the care of the marquis de Fenelon his grand-nephew, when ambaſſador to the States-General.

FENNEL. See Anethum, Botany *Index*.

FENTON, Sir Geoffroy, privy counſellor and ſecretary in Ireland during the reigns of Queen Elizabeth and King James I. is well known for his tranſlation of Guicciardini's Hiſtory of the Wars of Italy, dedicated to Queen Elizabeth in 1579. He died at Dublin in 1608; after having married his daughter to Mr Boyle, afterward the great earl of Corke.

Fenton, *Elijah*, deſcended from an ancient family, was born at Shelton near Newcaſtle, but in what year is uncertain. He was the youngeſt of 12 children, and was intended for the miniſtry; but embracing principles contrary to the government, while at Cambridge, he became diſqualified for entering into holy orders. After he quitted the univerſity, he was ſecretary to the earl of Orrery; but ſeems to have ſpent the moſt of his life amongſt his friends and relations, and uſed to pay an annual viſit to his elder brother who enjoyed an eſtate of 1000l. a-year. He was a man of great tenderneſs and humanity, enjoyed the faireſt reputation, and was much eſteemed by Mr Pope; who, when he died in 1730, paid him the tribute of a very elegant epitaph. He publiſhed a volume of poems in the year 1717; and in 1723 was acted his tragedy of Mariamne, built upon her ſtory collected from Joſephus in the third volume of the Spectator.

Fenugreek ‖ Feodal Syſtem.

FENUGREEK. See Trigonella, Botany *Index*.

FEOD, or Feud, is defined to be a right which a vaſſal hath in lands or ſome immoveable thing of his lord's, to uſe the ſame, and take the profits thereof hereditarily, rendering unto the lord ſuch feodal duties and ſervices as belong to military tenure, &c. and the property of the ſoil always remaining to the lord.

FEODAL, of or belonging to a Feud or Fee.

Feodal *Syſtem*, the conſtitution of Fiefs or Feuds. About 12 centuries ago, this ſyſtem was ſo univerſally received in Europe, that Sir Henry Spelman calls it *the law of nations in our weſtern world*. Hence it deſerves our attention in a particular manner; a knowledge of the different feuds being indiſpenſably requiſite for a proper underſtanding either of the civil government of our own country, or of the laws by which its landed property is regulated.

The military policy of the Celtic or northern nations, known by the names of *Goths*, *Vandals*, *Franks*, *Hunns*, and *Lombards*, furniſhed the original conſtitution or ſyſtem of feuds. Theſe people pouring out in vaſt multitudes from the ſame *officina gentium* or "ſtorehouſe of nations," overran all the European countries on the declenſion of the Roman empire. They brought the feudal ſyſtem along with them from the countries out of which they emigrated; and, ſuppoſing it to be the moſt proper method of ſecuring their new conqueſts, they introduced it into their more ſoutherly colonies. 1 Origin of feuds.

According to this ſyſtem, the victorious general alloted conſiderable tracts of land to his principal officers; while they, in like manner, divided their poſſeſſions among the inferior officers, and even thoſe common ſoldiers who were thought to be the moſt deſerving. Allotments of this kind were named *feoda*, *fiefs*, *fees*, or *feuds*, from a combination of words, in the language of theſe barbarians, ſignifying a reward or ſtipend beſtowed on certain conditions (A). The condition upon which theſe rewards were given was, that the poſſeſſors ſhould faithfully ſerve the perſon from whom they were received, both at home and abroad, in the military way. To this they engaged themſelves by a *juramentum fidelitatis*, or oath of fealty †; in the event of a breach of which, either by not performing the ſervice

† See the article Feodal *Tenure*.

(A) We were informed by Pontopiddan, that odh in theſe northern languages is the ſame with *proprietas*, and all with *totum* in the Latin. Hence among the northern nations, he tells us, that odhall ſignifies *right*; and hence we may conjecture that the udal right in Finland is derived ‡. By tranſpoſing theſe two northern ſyllables,

‡ See *Macdowall's Inſtit.* part 2.

Feodal System.

service agreed upon, by deserting their lord in time of battle, &c. the lands were to return to their original possessor.

2 General nature of the feodal association.

Thus the possessors of feodal allotments became interested in the defence of them; and not only the receivers but those who gave them, were equally and mutually bound to defend their possessions, none of them being able to pretend any right but that of conquest. For this purpose government and subordination were absolutely necessary; it being impossible to conduct any system of defence where every thing was tumultuous and irregular. Every person, therefore, who was a feudatory, i. e. who had received lands, was bound to do every thing in his power to defend the lord of his fee; while, on the other hand, the latter was no less subordinate to his immediate superior; and so on to the prince himself. In like manner a reciprocal bond of defence existed down from the prince to the lowest feodists.

Such were the foundations on which the feodal system was properly established; and the natural consequence was, a military subjection throughout the whole community. The prince could always collect an army of feudatories ready to defend not only the kingdom in general, but the particular possessions of each person; and the propriety of this constitution was soon apparent in the strength which these newly erected kingdoms acquired, and the valour with which their conquests were defended.

3 Of allodiality.

Besides these feodal grants, however, which were held only on the terms of military service above mentioned, there were others called *allodial*, which were given upon more enlarged principles. To these every free man had a title; and could not only claim his territory as well as the rest, but dispose of it at his pleasure (B); and this freedom was denominated *allodiality*. These allodials, however, were not exempted from military service. A part of their freedom consisted in liberty to go to the wars; for this, in the barbarous times we speak of, was the only way to acquire any degree of renown. Only the slaves were destined to follow the arts of peace; while every free person was not only at liberty to defend his country, but under an obligation to do it in case of any urgent necessity.

4 Feodal and national militia.

Thus there was a feodal and a national militia. The free people only were allowed to possess property; the *feudal vassals* constituted the army, properly so called; while the national militia was composed of the allodial proprietors. This allodiality, however, was not confined to landed property, but included likewise moveable estates or money; so that proprietors of the latter kind were obliged also in times of danger to bear arms and appear in the field. Between the feodal and allodial proprietors, however, there was this farther difference, that the latter had no concern with any private quarrels which might take place among the lords themselves; so that they were never obliged to appear in the field unless when called forth by the sovereign against the enemies of the nation at large. This circumstance we might suppose to be an advantage, but it ultimately operated otherwise; becoming the means of changing the allodial right into a feodal tenure. For some time the holders of fiefs had an eminent advantage over the allodial proprietors. This was owing to the imperfection of government in those days; so that the nobles had it in their power to revenge their own quarrels, while the weak were equally exposed to the insults of both parties. The lord and his vassals therefore were always formidable; but the allodial

5 Different situations of the feodal and of the allodial proprietor.

syllables, we form the word ALLODH; whence we have the etymology of the *allodium* or *absolute* property, claimed by the holders of fiefs or feuds; and by combining ODH, signifying "property," with the word *fee*, signifying "a conditional stipend or reward," we have the word FEODH, signifying "a property given by way of stipend or reward upon a certain condition."

(B) The author of A View of Society in Europe, has traced the remote sources of the feodal laws in an elegant and spirited manner (book i. chap. ii. sect. i.) Tacitus informs us, that the individuals of each of the German nations cultivated by turns a tract of land proportionable to their number, for the use of the whole; after which each individual received such an allotment of the cultivated tract as his dignity seemed to require. These nations had not altered their political principles at the time they overran the Roman empire; and hence the provinces of it were then divided after the same manner. The most considerable allotment was bestowed on the king, as being the most dignified person in the community, and this allotment was styled his *domain;* while the shares of citizens and warriors, which were likewise in proportion to the merit or dignity of each, constituted what was called *allodiality*. But as it often happened that all the land was not exhausted by these partitions, what remained was considered as the property of the community, and in the barbaric codes was called the *lands of the fisc*. In such German nations as had thus obtained a settlement, it was necessary that there should be a more close connexion betwixt the sovereign and the chiefs, as well as between the chiefs and people, than in others. This was effected by means of the lands of the *fisc;* for of these the sovereign took possession, dealing them out to the chiefs under the burden of appearing in arms whenever he should please to call; while the chiefs in like manner dealt out lands to those called their *retainers*, who were also obliged to supply them with military assistance in cases of necessity. Hence a political system was founded, which had a prodigious effect on society in all those countries where it prevailed. The intention and tendency of this system was to render the nation independent both at home and abroad; for, while the people were all armed in their common defence, individuals were also properly guarded against the attacks of despotism. The power of the chiefs, who formed a regular nobility, was a counterpoise to that of the sovereign; while the number of the retainers and vassals, constituting the greatness and power of the nobility, was a proper barrier against aristocratical oppression; for a chief who oppressed his vassals evidently acted against his own interest.

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allodial proprietors had scarce any means of defending themselves. The reason of this was, in the first place, that the law did not allow them to commit any hostilities; and in the next, they were too distant and unconnected to form any proper league for mutual defence; and hence proceeded the necessity already hinted at, of converting allodial property into feudal tenure. This was indeed owing in a great measure to the absurdity and violence of the times, by which gifts of property, burdened with service, and which might return to the person who granted them, were rendered superior in value to the absolute and unconditional possession of a subject. Other considerations, however, besides that just mentioned, contributed to produce the same effect. As in those dark ages no right existed but what had its origin in conquest, it thence followed, that the greatest conqueror or warrior was the most honourable person. The king, in whom the whole exploits of the community centered, as being their head, was the most honourable person: all others derived from him that portion of honour which they enjoyed, and which was most nicely adjusted in proportion as they approached him. Allodial proprietors, therefore, having no pretensions of this kind, were treated with contempt as a kind of poltroons. From this disagreeable situation they wished to free themselves, by converting their allodial property into feodal tenures; while the princes, supposing it their interest to extend those tenures as much as possible, discouraged the allodial possessions. As the feodists supported the importance of the nation and dignity of the monarch, it was not thought proper to allow the allodial proprietors any greater compensations than what were given to vassals in similar cases. Thus they were exposed to continual mortifications in the courts of justice: they were neglected by the king; denied sufficient protection from the laws; exposed not only to continual insults; but to have their property on all occasions destroyed by the great: so that they were without resource except from the feodal tenures, and were obliged even to solicit the privileges which were bestowed in other cases on vassals. In these unhappy circumstances, they were glad to yield up their lands to any superior whom they thought most agreeable, and to receive them back from him as a feudal gift. Thus the landed property was everywhere changed into feudal tenures, and fiefs became universal (c).

6 Conversion of allodium into tenure.

For some time the feodal system was not only useful in itself, but honourable in its principles; but this continued no longer than while the importers of it into Europe adhered to their original simple and noble maxims. During that period, the lord exercised his bounty

(c) It has been an object of inquiry to the learned, in what nation of barbarians fiefs had their origin? But it is probable, that they took place in all these nations nearly about the same time, on the same principles; and were continued by reason of a similarity of manners, conquests, &c. so that we cannot ascribe the prevalence of them to imitation.

In France, we find mention made of fiefs as early as the age of Childebert. They were introduced into Italy by the Lombards; amongst whom the customs and laws relating to fiefs seem very early to have made rapid advances *. They were introduced into Spain before the invasion of the Moors and Saracens in the year 710. Lands were granted for service and attachment among the Goths; among whom also the person who received the gift was the retainer of him who granted it. If he refused his service, the grant was forfeited, and he was said to receive it *in patrocinio;* he also swore fealty to his lord; and on this footing the national militia was regulated †. There can be very little doubt that the feodal law was known in England in the Saxon times, as is mentioned in the text ‡. In Scotland, however, the history of fiefs is still more uncertain than anywhere else; which has been ascribed partly to the mutilated state of the Scottish records, and partly to the want of able antiquaries in the nation. But, according to a late writer ||, allodiality and feudality have existed ever since the foundation of the Scottish monarchy, and have most probably arisen from a similarity of the manners and customs in Scotland to those of other nations. It has indeed been supposed, that these customs were introduced from some foreign model by Malcolm II. According to some, they were introduced directly from England; and the policy of Malcolm in establishing them has been highly extolled: but, according to our author, there is no foundation for any notion of that kind. Both the opinions just mentioned either directly assert or imply, that the feudal maxims were introduced into this country upon the principle of imitation; but it is very improbable that they could be imported from one people to another, on account of their excessive contrariety to the common usages and precepts of government among mankind. It must undoubtedly have been very absurd, if not altogether impracticable, to transplant the feudal tenures when the grants of land were precarious, or depending entirely on the will of the prince, to a country which had never known superiority or vassalage. This would have required an alteration of all the orders of society from the king to the peasant; while the whole chain of customs, as well as the jurisdiction of the kingdom, both high and low, must have sustained a correspondent alteration, in order to conform them to the new system. It is likewise obvious, that no conquest could be made on purpose to obtain a settlement by any nation who had already received the knowledge of fiefs. The establishment of them implied, that the people had already a fixed and settled residence; and accordingly history does not furnish us with any account of a nation among whom fiefs were known, who ever migrated from the country they already possessed, to seek for one in which they might settle. Feudal institutions must have originated wherever they have been observed to flourish.—Scotland was formerly a feudal kingdom, and we know pretty nearly the time when the fiefs were hereditary there; but in that form they could not be introduced by the sovereign; and there was not any nation among whom fiefs were already known who conquered, or made an establishment by conquest, in Scotland. Fiefs therefore must have *gradually* advanced to such a state of perfection. The progress they made may be likewise easily

* *Giannone Hist. of Naples,* book iv. sect. 3.

† *LL. Wisigoth,* lib. v. tit. 3. lib. iv. tit. 7. l. xx.

‡ See also *Whitaker's Hist. of Manchester.*

|| *Stuart's Observat. on the Law and Constitution of Scotland.*

Feodal System.

bounty to the vassal, which the latter repaid by acts of gratitude; so that the intercourse betwixt them was of the most tender and affectionate kind; and this gave rise to what are called the *feodal incidents*.

7 The feodal incidents.

The expectants of fiefs were educated in the hall of the superior, while the tenures were precarious or only for life: and even when they became hereditary, the lord took care of the son and estate of his deceased vassal; not only protecting his person, but taking charge of his education, and directing the management of his affairs. He took pleasure in observing his approach to maturity; and when he came of age, never failed to deliver to him the lands, with the care of which he had been intrusted, and which he had been careful to improve. This was called the *incident of wardship*.

The incident of *relief* was founded upon the gratitude of the vassal; who, upon entering on his fief, brought a present to his lord, as an acknowledgment of his care of him during the early part of his life; and in order to conciliate his future regard.

The incident of *marriage* proceeded also upon the principle of gratitude on the part of the vassal. The latter, conscious of the favours he had received, did not choose to ally himself with a family inimical to his chief; while the superior himself, ambitious to aggrandize and augment the importance of his family, sought how to find the most advantageous match for his vassal.

Sometimes the superior himself was reduced in his circumstances by war or other accident: but from whatever cause his distress proceeded, even though it had arisen from his own extravagance or prodigality, or when only destitute of means to support his ambition or grandeur, his vassals were bound to support and relieve him according to their circumstances; and this was called the *incident of aid*.

The incident of *escheat* took place on the part of the vassal, when, through cowardice, treachery, or any remarkable misbehaviour, he rendered himself unworthy of his fief. In that case, the taking it from him, and giving it to one more worthy, was called an *escheat*.

8 Happiness of the feodal association.

While the lords and vassals thus vied with one another in mutual acts of friendship and benevolence, universal happiness, liberty, and activity, were diffused through the society. The vassals behaved courteously towards the retainers, who were immediately below them; while they again were courted by the lords as constituting their importance and strength; the lords, lastly, giving a like importance and dignity to the sovereign himself. Thus a regular, powerful, and compact system of government took place; an unanimity and attention pervaded the various departments of state; so that, while the subjects were free, the nation at large was formidable.

During this happy state of affairs, the members of the national assembly in every country in Europe appeared there in arms, whether they came personally or by their representatives. Such particularly was the case under the Anglo-Saxon government; and the happiness they at that time enjoyed made the oppression and tyranny of the Normans appear the more intolerable.

9 Its declension.

In process of time, however, the state of society began to suffer a remarkable alteration. The high and disinterested notions, from which the happiness above mentioned took its origin, declined; the romantic ideas of chivalry † ceased; and much more interested notions of property came in their stead. The separation of the interests of the lords from their vassals was the first step towards the destruction of the feodal system. Thus the *incidents*, which, as has just now been mentioned, promoted their happiness, did the very reverse. Property being now looked upon as a distinction superior to personal merit, naturally introduced the most mercenary views. In consequence of these the infant *ward*, the care of whom was wont to be considered as a sacred and honorary trust, was now only looked upon as a mean of procuring emolument to the superior. The latter now regarded the profits of his vassals as so many diminutions of his own wealth. Instead of taking care to improve the estate of his ward as formerly, he impoverished it; not only neglecting the education of the heir, but offering insults to himself; insomuch that the relations of the unfortunate vassal were frequently obliged to ransom from the avaricious superior both his person and effects. By merchandise of this kind the coffers of princes were filled, and wardships let out to strangers, who might exercise their rapacity with greater freedom. When the vassal at last attained the years of maturity, he came to the possession of his land without any of that joy and festivity which usually took place on the occasion. He received an inheritance wasted and destroyed, while new grievances daily presented themselves to augment the horrors of his situation. All the *incidents*, which in former times were so many expressions of gratitude on the part of the vassal, were now changed into taxes which might be exacted at the pleasure of the lord. Before the vassal was invested in his land, the superior exacted from him a certain sum or other gift, to be measured only by his own rapacity; and in case of delay or inability to pay this demand, the superior continued in possession of the estate. Such scandalous oppression could not but produce the greatest discontent and clamour. Applications were made to the law without success; nor were even the laws regarded which were fabricated on purpose for their relief. The incident of *marriage* now proved a source of the most dreadful oppression. The lord assumed a right of marrying his vassal to whom he pleased; and he not only exerted this right himself, but would sell it to a stranger, or allow the vassal to buy it himself; while the penalty annexed to a marriage without

† See *Chivalry* and *Knights*.

10 The perversion of its incidents.

11 Oppressed situation of the vassal.

easily pointed out. At first they were precarious, or at the pleasure of the lord; afterwards they were granted for life; then for a course of years longer than the natural life of a man; and, lastly, they became hereditary, which was their most perfect stage. This progress has been observed in every country where feodal tenures exist; and the same must have been known in Scotland, though, in considering it, we are necessarily carried back to periods of remote antiquity; for as fiefs were hereditary as early as the time of Malcolm II. they must have been in their precarious state several centuries before.

out the conſent of the ſuperior involved no leſs puniſhment than the loſs of the eſtate itſelf, or ſome grievous infliction as for a crime of the firſt magnitude. The caſe was ſtill worſe with the female ward; whoſe beauty and accompliſhments became a ſource of gain to the ſuperior, or were ſacrificed to pleaſe his whim or caprice; ſo that her relations were frequently obliged to buy from him the privilege of marrying her to the perſon ſhe or they thought moſt proper. In like manner the *aid*, which was formerly a voluntary gift from the vaſſal in caſes of diſtreſs happening to his lord, now became an unavoidable tax. An aid formerly was demanded when the eldeſt daughter of the ſuperior was married, when his eldeſt ſon was knighted, or when the ſuperior himſelf was taken priſoner in battle. Theſe were the only legal cauſes of making a demand of this kind; but in the ſubſequent times of degeneracy, the moſt frivolous pretences were every day made uſe of by the prince to oppreſs the lords, and by the lords to oppreſs their vaſſals; demanding ſubſidies at pleaſure, which their inferiors were always obliged to comply with. Laſtly, The *eſcheat*, which in former times took place only in caſes of cowardice, treachery, or ſome other heinous crime, was now inflicted on the moſt trifling occaſions. If the vaſſal happened to be too long in attending the court of his ſuperior to take the oath of fealty; if he committed any action which could in the leaſt be conſtrued an infringement of the oath; if he neglected to give his lord warning of any misfortune which he might ſuppoſe was about to befal him; revealed any thing concerning him; made love to his ſiſter or daughter, &c.; or even if he ſhould grant a tenure of land to another perſon in form different from that in which he held his own; all theſe, nay others ſtill more ridiculous, were judged ſufficient reaſons for the ſuperior to ſeize on the eſtate of the vaſſal, and involve him and his family in ruin.

12
Conſequent degeneracy of the feodal militia.

Notwithſtanding theſe oppreſſions, however, the vaſſal was ſtill obliged to ſubmit to his lord; to own him as his ſuperior; and even, in appearance, to pay him the ſame reſpect as formerly when the greateſt unanimity and cordial affection ſubſiſted between them. Still he was obliged to perform the ſame military ſervice: becauſe a failure in that reſpect would have ſubjected him to a forfeiture of lands according to the original agreement. A vaſt difference, however, now took place in the valour and activity which inſpired the army. The vaſſals, forced into the field with deſponding hearts, were indifferent as to the ſucceſs of the cauſe in which they were engaged, and frequently obſtructed inſtead of forwarding the operations of the field. Hence the ſovereign found himſelf embarraſſed; and, though nominally at the head of a martial and powerful people, was frequently unable to effect any thing, by reaſon of the mutual hatred and diſſenſion which everywhere prevailed.

13
Expedient for its recovery.

Thus the feodal ſtates of Europe became unnaturally weak: a remedy was neceſſary; and it is remarkable that the ſame remedy was applied all over the continent. This was, in ſhort, the making fiefs hereditary, which till now had only been granted for a long term of years; and, in return, burdening the lands with a certain number of ſoldiers, which were not to be refuſed upon any pretence whatever. Hence was derived the tenure of *knight-ſervice*. A certain portion of land, burdened with the ſervice of one ſoldier or knight, was called a *knight's fee;* and thus an eſtate, furniſhing any number of ſoldiers, was ſaid to contain as many knight's fees; ſo that now the manors, baronies, &c. became powerful according to the number of ſoldiers they were bound to furniſh. In the grants from the crown, the nobility were obliged to furniſh a certain number of ſoldiers for the ſervice of the ſovereign; and in thoſe from the nobility to their vaſſals, the like ſervice was required. Even the commons who had grants from the crown furniſhed a certain proportion of knights. The force of the nation was called into action by grants *in capite*, or from the ſovereign and nobility. A numerous and powerful army was inſtantly aſſembled, and at once ready for action. Of this army the king was the general, the nobility the officers, and the vaſſals ſoldiers; the whole being exactly arranged, and capable of entering upon any expedition without the leaſt delay.

14
Invention of knight-ſervice.

Thus a remedy was found in ſome meaſure for the weakneſs of the feodal ſovereigns: but though the knights tenure could accompliſh this, it could not bring back the former affection and cordiality which ſubſiſted between the various ranks of people. On the contrary, by uniting them more firmly to one another by legal ties, it rendered matters rather worſe. The oppreſſion originating from the operation of the feodal *incidents*, ſtill continued with unremitting violence. The grants of knights tenure were attended with the ſame oaths of homage and fealty; the ſame incidents of relief, wardſhip, marriage, aid, and eſcheat, with the feodal tenures. The princes promiſed to abate ſomewhat of their rigour in demanding the feodal perquiſites, but did not keep their word. Laws were occaſionally promulgated, and for ſome time had an effect; but palliatives ſoon became ineffectual, and a new ſtate of weakneſs began to commence.

15
Two eras in the hiſtory of fiefs.

The two remarkable eras in the feodal hiſtory are, the time before the invention of knight-ſervice (D), and that during which it continued. Fiefs were in a ſtate of fluctuation from the deſtruction of the Roman empire till the ninth century; but they were rendered perpetual in France about the year 877, and were generally become ſo in every country of Europe about the beginning of the tenth. Du Cange, *voce Militia*, gives us an example of a knight fee in the year 880. By the year 987, when Hugh Capet was raiſed to the throne of France, knight ſervice was become general all over Europe, and was introduced into England after having made its appearance in other countries (E). In England, however, there have been ſeveral doubts and inquiries

16
Doubts concerning the introduction of the feodal laws into England.

(D) For the difference between the knights produced by this ſervice and the more ancient ones, or knights of honour, ſee the article Knight.

(E) Dr Stuart informs us, that it appears from the records of Malcolm IV. in 1153, that knights-ſervice was quiries among the learned concerning the introduction of the feodal laws. Many are of opinion, that they were firſt introduced by William the Conqueror; and, conſequently, that they were entirely unknown to the Anglo-Saxons: but others think, that they exiſted among the latter in the ſame form under which they were continued by the Normans. Dr Stuart is of opinion that the Saxons who ſettled in England could not be ſtrangers to fiefs. He ſuppoſes the conformity of manners, which undoubtedly prevailed between the Saxons and other barbarians, a ſufficient proof that the hereditary grant of land, as well as the fluctuating ſtate of feodal tenures which preceded it, were known to the former. Collateral proofs are derived from the ſpirit and tenure of the Anglo-Saxon laws, but eſpecially from the grants of hereditary eſtates on condition of military ſervice (F). The condition of fiefs under the Anglo-Saxons was very different from what it was afterwards. In their times we find no mention made of theſe oppreſſions of which ſo much notice has already been taken; and this may eaſily be accounted for from the alteration of the feodal ſpirit in different ages. During the time that a warm and generous affection ſubſiſted between the feodal ſuperiors and vaſſals, the incidents were marks of generoſity on the one part, and gratitude on the other; but as ſoon as a variance had taken place, by reaſon of the intereſted diſpoſition which the introduction of luxury produced, the ſame incidents became ſources of the moſt flagrant oppreſſion. This was remarkably the caſe in the time of William the Conqueror; and, during the reign of King John, matters were come to ſuch a criſis, that the people everywhere complained loudly, and demanded the reſtoration of the laws of Edward the Confeſſor (G). "What theſe laws of Edward the Confeſſor were (ſays Mr Hume), which the Engliſh every reign during a century and a half deſired ſo paſſionately to have reſtored, is much diſputed by antiquarians; and our ignorance of them ſeems one of the greateſt defects of the ancient Engliſh hiſtory." Dr Stuart has offered an explanation; but this is in fact no more than a conjecture, that "by the laws or cuſtoms of the Confeſſor, that condition of felicity was expreſſed which had been enjoyed during the fortunate ſtate of the feodal aſſociation. The cordiality, equality, and independence, which then prevailed among all ranks in ſociety, continued to be remembered in leſs proſperous times, and occaſioned an ardent deſire for the revival of thoſe laws and uſages which were the ſources of ſo much happineſs."

17 Inſufficient ſolution of them by Dr Stuart.

18 Diſtinction concerning fiefs in the Anglo-Saxon and the Anglo-Norman times.

Beſides the great diſtinction (of which an account has already been given) between the ſtate of fiefs under the Anglo-Saxons and under the Normans, they were no leſs diſtinguiſhed by the introduction of knight-ſervice. Hitherto the refinement of the Engliſh had been obſtructed by the invaſion of the Danes, and the inſular ſituation of the kingdom; but after the Norman conqueſt the fiefs were made perpetual. Still, however, the knight-fee and knight-ſervice were altogether unknown. William, the ſixth prince who enjoyed the duchy of Normandy, was well acquainted with every thing relating to fiefs; for that duchy had experienced all the variety incidental to them from the time of its being granted to Rollo by Charles the Simple in the year 912, to the year 1066, when William was put in poſſeſſion of England by the battle of Haſtings.

On his acceſſion to the throne, a number of forfeitures took place among thoſe who had followed the fortune of Harold. Their eſtates were to be diſpoſed of at the pleaſure of the conqueror; and it was natural to ſuppoſe that he would follow the method practiſed in

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was known in Scotland, and that it was not a novelty at that time. The ſame author thinks it even probable, that it was known in the time of David I.

(F) The uſe of entails was known to the Anglo-Saxons; and this practice, as well as the ſucceſſion to allodial eſtates, muſt have contributed very much to eſtabliſh hereditary fiefs. This opinion ſeems alſo to be confirmed by the accounts we have of the great power of many of the nobility among the Anglo-Saxons, and the natural tendency that fiefs muſt have, in the courſe of things, to become perpetual, though analogical arguments cannot entirely be depended upon in this caſe. There is indeed poſitive evidence that the territory which anciently conſtituted the kingdom of Mercland belonged to Ethelred as an hereditary fief and earldom. The grant was given him by Alfred when he married his daughter Ethelfleda: and it is likewiſe atteſted by Camden, that in the time of Ethelred the earldom of Leiceſter was an inheritance, and the regular ſucceſſion of its earls is ſtill known. We are informed alſo by creditable hiſtorians, that Bernicia and Deireland were feodal and inheritable earldoms among the Saxons. The ſame was true of the county of Cumberland when poſſeſſed by the Scottiſh monarchs, This laſt appears from the Saxon Chronicle: in which the grant was conveyed by Edmund king of England to Malcolm of Scotland in the following terms: "Edmundus rex totam Cumberland prædavit et contrivit, et *commendavit* eam Malcomo regi Scotiæ; hoc pacto, quod *in auxilio* ſibi foret terra et mari." From the uſe of the word *commendavit*, indeed, Spelman takes occaſion to ſay, that a feodal homage was not intended: but the contrary may be proved by the original Saxon from which the foregoing is a Latin tranſlation; and the word, according to ſeveral learned critics, ſignifies feodal homage with the moſt ſtrict propriety. Thus Du Cange informs us, that *commendare ſe alicui* was the general expreſſion for *faire l'hommage a un ſuſerain.*

(G) The laws which are now extant under the name of Edward, are generally allowed to be of doubtful authenticity; nor are they, even ſuppoſing them to be genuine, of any uſe in anſwering the preſent queſtion. They determine indeed the exiſtence of fiefs among the Anglo-Saxons: and Dr Stuart is of opinion, that the compilation which goes under the name of this prince, though poſterior to the date it bears, nevertheleſs merits greater attention than has uſually been beſtowed upon it. M. Honard, a foreign lawyer, is the lateſt writer who has made it his ſtudy; but he is better acquainted with the Norman than the Anglo-Saxon cuſtoms.

in his own country. Hence the origin of knight ſervice in England. A grant of land, to any perſon whatever, was eſtimated at a certain number of knights fees; and each of theſe required the ſervice of a knight. The grants of lands were even renewed to the old tenants under this tenure; ſo that by degrees the whole military people in the kingdom acquieſced in it. To accompliſh this, DOMESDAY *Book*, is ſuppoſed to have been compiled, which contained an exact account of all the landed property of the kingdom.—Hence it is to be concluded, not that William introduced fiefs into England, as ſome have imagined, but that he brought them to their ultimate ſtate of perfection by the introduction of knight-ſervice. This is evident from the laws enacted during his reign. In theſe it is not only mentioned that knight ſervice was enacted, but that it was done expreſsly with the conſent of the common council of the nation; which at that time was equivalent to an act of parliament (H).

19 Introduction of knight-ſervice into England.

The invention of knight-ſervice proved generally agreeable: for as only few of the Anglo-Saxon fiefs were hereditary, the advancement of the reſt to perpetuity, under the tenure of knight-ſervice, muſt have been accounted an acquiſition of ſome importance; as not only augmenting the grandeur and dignity of the ſovereign, but ſecuring the independence of the ſubject, and improving his property. In the happy ſtate of the feodal aſſociation, there was indeed no neceſſity for the knight's fee; but when the diſcordance and oppreſſion ſo often mentioned began to take place, it became then neceſſary to point out particularly every duty of the vaſſal, as well as of the lord; and this was fully done by the invention of knight-ſervice. The nobles poſſeſſed duchies, baronies, and earldoms; which extenſive poſſeſſions were divided into as many fees, each of them to furniſh a knight for the ſervice of the king, or of the ſuperior; ſo that every feudal ſtate could command a numerous army and militia to ſupport and defend it in caſe of any emergency. The knights were alſo bound to aſſemble in complete armour whenever the ſuperior thought proper to call, and to hold themſelves in readineſs for action whenever the king or ſuperior found it convenient to take the field: ſo that thus the militia might be marched at the ſhorteſt notice to defend or ſupport the honour of the nation.

20 Idea of the feodal militia.

The knights were uſually armed with a helmet, ſword, lance, and ſhield; and each was beſides obliged to keep a horſe. This laſt requiſite was owing to the contempt into which the infantry had fallen through the prevalence of tournaments and luxuries of various kinds, though it was by means of the infantry that the barbarians had originally diſtinguiſhed themſelves in their wars with the Romans, and became able to cope with theſe celebrated warriors. All proprietors of fees or tenants by knight-ſervice fought on foot: the cavalry were diſtinguiſhed by the name of *battle*; and the ſucceſs of every encounter was ſuppoſed to depend on them alone. They only were completely armed; the infantry, being furniſhed by the villages under the juriſdiction of the barons, had at firſt only bows and ſlings; though afterwards they were found worthy of much greater attention.

While the feodal aſſociation remained in perfection, the ſuperior could at any time command the military ſervice of his vaſſals; but in the ſubſequent degeneracy this ſervice could neither be depended upon when wanted, nor was it of the ſame advantage when obtained as formerly. The invention of knight-ſervice tended in a great degree to remedy this inconvenience. Thoſe who were poſſeſſed of knights fees were now obliged to remain 40 days in the field at their own expence; and this without exception, from the great crown vaſſals to the ſmalleſt feudatories; but if longer ſervice was required, the prince was obliged to pay his troops. In thoſe times, however, when the fate of nations was frequently decided by a ſingle battle, a continuance in the field for 40 days was ſufficient for ordinary occaſions.

21 Its inefficacy and corruption.

Thus matters ſeemed once more to be reſtored nearly to their former ſtate. It was now, as much as ever, the intereſt of the nation to act with unanimity in its defence, not only againſt foreign enemies, but againſt the tyranny of the prince over his ſubjects, or of one part of the ſubjects over the other. New inconveniencies, however, ſoon began to take place, owing to the gradual improvements in life and the refinement of manners. From the firſt inſtitution of military ſervice, a fine had been accepted inſtead of actual appearance in the field. In the times of barbarity, however, when men accounted rapine and bloodſhed their only glory, there were but few who made an offer of this compenſation; but as wealth and luxury increaſed, and the manners of people became ſofter, a general unwillingneſs of following the army into the field became alſo prevalent. A new tenure, called *eſcuage*, was therefore introduced, by which the vaſſal was only obliged to pay his ſuperior a ſum of money annually, inſtead of attending him into the field *. Hence originated taxes and their miſapplication; for as the king was lord paramount of the whole kingdom, it thence happened that the whole eſcuage money collected throughout the nation centred in him. The princes then, inſtead of recruiting their armies, frequently filled their coffers with the money, or diſſipated it otherwiſe, hiring mercenaries to defend their territories when threatened with any danger. Theſe being compoſed of the dregs of the people, and diſbanded at the end

* See the particular conſequences of this under the article *Knight-Service*.

22 Riſe of ſtanding armies, &c.

(H) The following law of William the Conqueror not only makes expreſs mention of the knight's fee and ſervice, but alludes to a former law of William and his parliament, by which this tenure was actually eſtabliſhed. "Statuimus etiam et firmiter præcipimus, ut omnes comites, et barones, et milites, et ſervientes, et univerſi liberi homines totius regni noſtri prædicti, habeant et teneant ſe ſemper bene in *armis* et in *equis*, ut decet et oportet, et quod ſint ſemper prompti et bene parati ad *ſervitium ſuum integrum* nobis explendum, et peragendum, cum ſemper opus adfuerit, ſecundum quod NOBIS debent de *feodis et tenementis ſuis* de jure facere, et ſicut illis ſtatuimus per *commune conſilium* totius regni noſtri prædicti, et dedimus et conceſſimus in feodo jure hæreditario." *LL. Guill.* c. 58.

end of every campaign, filled all Europe with a disorderly banditti, who frequently proved very dangerous to society. To avoid such inconveniencies, standing armies were introduced, and taxations began to be raised in every European kingdom. New inconveniencies arose. The sovereigns in most of these kingdoms, having acquired the right of taxation, as well as the command of the military power, became completely despotic: but in England the sovereign was deprived of this right by Magna Charta, which was extorted from him, as related under the article ENGLAND, N° [153]; so that, though allowed to command his armies, he could only pay them by the voluntary contributions of the people, or their submitting to such taxations as were virtually imposed by themselves.

FEOFFMENT, in *Law*, (from the verb *feoffare* or *infeudare*, "to give one a feud"); the gift or grant of any corporeal hereditament to another. He that so gives, or enfeoffs, is called the *feoffer*, and the person enfeoffed is denominated the *feoffee*.

This is plainly derived from, or is indeed itself the very mode of, the ancient feodal donation; for though it may be performed by the word "enfeoff," or "grant," yet the aptest word of feoffment is *do* or *dedi*. And it is still directed and governed by the same feodal rules; insomuch that the principal rule relating to the extent and effect of the feodal grant, *tenor est qui legem dat feudo*, is in other words become the maxim of our law with relation to feoffments, *modus legem dat donationi*. And therefore, as in pure feodal donations, the lord, from whom the feud moved, must expressly limit and declare the continuance or quantity of estate which he meant to confer, *ne quis plus donasse præsumatur, quam in donatione expresserit*; so, if one grants by feoffment lands or tenements to another, and limits or expresses no estate, the grantee (due ceremonies of law being performed) hath barely an estate for life. For, as the personal abilities of the feoffee were originally presumed to be the immediate or principal inducements to the feoffment, the feoffee's estate ought to be confined to his person, and subsist only for his life; unless the feoffe , by express provision in the creation and constitution of the estate, hath given it a longer continuance. These express provisions are indeed generally made; for this was for ages the only conveyance, whereby our ancestors were wont to create an estate in fee-simple, by giving the land to the feoffee, to hold to him and his heirs for ever; though it serves equally well to convey any other estate of freehold.

But by the mere words of the deed the feoffment is by no means perfected: there remains a very material ceremony to be performed, called *livery of seisin*, without which the feoffee has but a mere estate at will. See SEISIN.

FERÆ, an order of quadrupeds, belonging to the class *Mammalia*. See MAMMALIA *Index*.

FERALIA, in antiquity, a festival observed among the Romans on February 21st, or, according to Ovid, on the 17th of that month, in honour of the manes of their deceased friends and relations.

Varro derives the word from *inferi*, or from *fero*; on account of a repast carried to the sepulchres of such as the last offices were that day rendered to. Festus derives it from *ferio*, on account of the victims sacrificed. Vossius observes, that the Romans called death *fera*, "cruel," and that the word *feralia* might arise thence. —Macrobius, Saturn. lib. i. cap. 13. refers the origin of the ceremony to Numa Pompilius. Ovid, in his Fasti, goes back as far as Æneas for its institution. He adds, that on the same day a sacrifice was performed to the goddess Muta, or Dumb; and that the persons who officiated were an old woman attended with a number of young girls.

During the continuance of this festival, which lasted eleven days, presents were made at the graves of the deceased, marriages were forbidden, and the temples of the gods shut up. While the ceremonies continued, they imagined that the ghosts suffered no punishments in hell, but that their tormentors allowed them to wander round their tombs, and feast upon the meats which their surviving friends had prepared for them.—For a more particular account of the offerings and sacrifices and feasts for the dead, see INFERIÆ and SILICERNIUM.

Sometimes at the feralia public feasts were given to the people, at the tombs of the rich and great, by their heirs or particular friends.

FER DE FOURCHETTE, in *Heraldry*, a cross having at each end a forked iron, like that formerly used by soldiers to rest their muskets on. It differs from the cross-fourche, the ends of which turn forked; whereas this has that sort of fork fixed upon the square end. See HERALDRY.

Fer de Moulin, Milrinde, Inke de Moulin, in *Heraldry*, is a bearing supposed to represent the iron ink, or ink of a mill, which sustains the moving millstone.

FERDINAND V. king of Spain, called *the Catholic*, which title was continued to his successors. He married Isabella of Castile, by which that kingdom was united to the Spanish crown. This illustrious couple laid the foundation of the future glory and power of Spain. The conquest of Granada, and the discoveries of Christopher Columbus, make this reign a celebrated era in the history of Spain. He died in 1516, aged 63. See (*History of*) SPAIN.

FERENTARII, in Roman antiquity, were auxiliary troops, lightly armed; their weapons being a sword, bow, arrows, and a sling.

FERENTINUM, in *Ancient Geography*, a town of the Hernici in Latium, which the Romans, after subduing that nation, allowed to be governed by its own laws. Now *Feretino*, an episcopal city in the Campagna di Roma. E. Long. 14. 5. N. Lat. 41. 45.

FERENTUM, or FORENTUM, *in Ancient Geography*, a town of Apulia in Italy. Now *Forenza*, in the Basilicata of Naples.

FERETRIUS, a surname of Jupiter, *à ferendo*, because he had assisted the Romans: or *à feriendo*, because he had conquered their enemies under Romulus. He had a temple at Rome built by Romulus. It was there that the spoils called *opima* were always carried.

FERETRUM, among the Romans, the bier used in carrying out the bodies of the dead, which duty was performed by the nearest male relations of the deceased: thus, sons carried out their parents, brothers their sisters, &c.

FERG, or FERGUE, FRANCIS PAUL, a charming landscape-painter, was born at Vienna in 1689, and there learned the first principles of his art. He successively

ceſſively practiſed under Hans Graf, Orient, and Thiele. This laſt, who was painter to the court of Saxony, invited him to Dreſden to inſert ſmall figures in his landſcapes. Ferg thence went into Lower Saxony, and painted for the duke of Brunſwick and for the Gallery of Salzdahl. From Germany he went to London, where he might have lived in the higheſt eſteem and affluence, if, by an indiſcreet marriage, he had not been ſo effectually depreſſed, that he was ever after involved in difficulties. The neceſſities which aroſe from his domeſtic troubles compelled him to diminiſh the prices of his paintings in order to procure an immediate ſupport; and as thoſe neceſſities increaſed, his pictures were ſtill more ſunk in their price, though not in their intrinſic value. By a ſeries of misfortunes he was over-run with debts; and to avoid the purſuit of his creditors, he was conſtrained to ſecrete himſelf in different parts of London. He died ſuddenly in the ſtreet one night as he was returning from ſome friends, about the year 1738, before he had attained his 50th year; and left four children. This pleaſing artiſt, Mr Walpole obſerves, had formed a manner of his own from various Flemiſh painters, though reſembling Poelemburg moſt in the enamelled ſoftneſs and mellowneſs of his colouring; but his figures are greatly ſuperior; every part of them is ſufficiently finiſhed, every action expreſſive. He painted ſmall landſcapes, fairs, and rural meetings, with the moſt agreeable truth; his horſes and cattle are not inferior to Wouvermans; and his buildings and diſtances ſeem to owe their reſpective ſoftneſs to the intervening air, not to the pencil. More faithful to nature than Denner, he knew how to omit exactneſs, when the reſult of the whole demands a leſs preciſion in parts. The greateſt part of his works are in London and Germany; and the price they now bear is the beſt proof of their real merit. He alſo etched well with aquafortis; and his prints of that kind are greatly eſteemed by the curious.

FERGUS, the name of three kings of Scotland. See (*Hiſtory of*) SCOTLAND.

FERGUSON, JAMES, an eminent experimental philoſopher and mechanic, was born in Scotland, of very poor parents. At the earlieſt age his extraordinary genius began to exert itſelf. He firſt learned to read by overhearing his father teach his elder brother: and he had made this acquiſition before any one ſuſpected it. He ſoon diſcovered a peculiar taſte for mechanics, which firſt aroſe on ſeeing his father uſe a lever. He purſued this ſtudy a conſiderable length, even whilſt very young; and made a watch in woodwork, from having once ſeen one. As he had no inſtructor, nor any help from books, every thing he learned had all the merit of an original diſcovery; and ſuch, with infinite joy, he believed it to be. As ſoon as his age would permit, he went to ſervice; in which he met with hardſhips, which rendered his conſtitution feeble through life. Whilſt he was ſervant to a farmer (whoſe goodneſs he acknowledges in the modeſt and humble account of himſelf which he prefixed to his laſt publication), he frequently contemplated the ſtars; and began the ſtudy of aſtronomy, by laying down, from his own obſervations only, a celeſtial globe. His kind maſter, obſerving theſe marks of his ingenuity, procured him the countenance and aſſiſtance of his ſuperiors. By their help and inſtructions, he went on gaining farther knowledge, and was ſent to Edinburgh. There he began to take portraits; an employment by which he ſupported himſelf and family for ſeveral years, both in Scotland and England, whilſt he was purſuing more ſerious ſtudies. In London he firſt publiſhed ſome curious aſtronomical tables and calculations; and afterwards gave publio lectures in experimental philoſophy, which he repeated (by ſubſcription) in moſt of the principal towns in England, with the higheſt marks of general approbation. He was elected a fellow of the Royal Society, without paying for admiſſion (an honour ſcarcely ever conferred on a native); and had a penſion of 50l. per ann. given him, unſolicited, by our gracious king, at his acceſſion, who had heard lectures from him, and frequently ſent for and converſed with him on curious topics. He alſo received ſeveral preſents from his majeſty, the patron of real merit. To what a degree of conſideration Mr Ferguſon mounted by the ſtrength of his natural genius, almoſt every one knows. He was univerſally conſidered as at the head of aſtronomy and mechanics in this nation of philoſophers. And he might juſtly be ſtiled ſelf-taught, or rather heaven-taught; for in his whole life he had not above half a year's inſtruction at ſchool. He was a man of the cleareſt judgment, and the moſt unwearied application to ſtudy; benevolent, meek, and innocent in his manners as a child; humble, courteous, and communicative; inſtead of pedantry, philoſophy ſeemed to produce in him only diffidence and urbanity,—a love for mankind and for his Maker. His whole life was an example of reſignation and Chriſtian piety. He might be ſaid to be an enthuſiaſt in his love of God, if religion, founded on ſuch ſubſtantial and enlightened grounds as his was, could be ſtyled enthuſiaſm. He died in 1776.

FERGUSON, *Robert*, a Scottiſh poet, who acquired a conſiderable ſhare of celebrity at a very early period of life, was born at Edinburgh on the 5th of September 1750, of which we are aſſured from unqueſtionable authority, although ſome have placed it in 1751. His father's name was William, who, as well as the ſon, likewiſe paid court to the muſes; but he wiſely relinquiſhed the ſtudy of poetry for the more certain emoluments of trade and commerce, being employed in different mercantile houſes both in Edinburgh and Aberdeen. He was an accountant in the Linen Hall when he died, but never acquired any thing like an independent fortune.

The ſubject of the preſent ſketch was of a weak and delicate conſtitution during infancy,—indeed to ſuch a degree, that ſmall hopes were entertained of his ever reaching the years of manhood. Yet ſuch were the care and attention of his parents, that he was able to attend an Engliſh ſchool by the time he was ſix years of age, where his progreſs was conſidered as very extraordinary. It was no leſs rapid at the high ſchool of Edinburgh, which he attended for years, acquiring a competent knowledge of the Latin tongue with very little labour or exertion. From that he went to the grammar ſchool of Dundee, and in two years after to the univerſity of St Andrews, which place his father preferred to Edinburgh, becauſe a gentleman of the name of Ferguſon had left two burſaries for the education of two boys of the ſame name.

His

Ferguson.

His health was never impaired at any time by severe study; yet he kept alive at the university the opinion which had been entertained of him while at school, and he was decidedly the first mathematician of the same standing. He was patronized by Dr Wilkie, professor of natural philosophy, who was perhaps as much attached to him for his poetical as his mathematical talents, the doctor himself being a poet, and author of the Epigoniad. This kindness was repaid by Ferguson, on the death of Dr Wilkie, by a beautiful eclogue to his memory, written in the Scottish dialect. A little before he left the university, Ferguson had conceived the idea of writing a tragedy on the death of Sir William Wallace, for which he had collected materials; but as he afterwards met with a work on the same subject, he abandoned the design, after he had completed two acts. His own reason for doing so he thus expressed. "Whatever I publish shall be original, and this tragedy might be considered as a copy."

He returned to Edinburgh when he had finished his studies, without having fixed on any particular employment; for although he was destined for the church by his father, on his death he paid little attention to the expostulations of his mother. He declined also the study of physic, assigning this as a reason, that when he read the description of diseases, he believed that he felt the symptoms of them all in himself. He was then induced to attempt the study of the law, in which, as was natural to expect, he made no proficiency. He seems to have turned a wishful eye to some sinecure place, to obtain which he paid a visit to an uncle who resided at Aberdeen, a man of literature and opulence, hoping that through his influence he might be settled in some place suited to his merit. In this rational hope he was completely disappointed; for although his uncle shewed him every mark of attachment, his fondness decayed by degrees, and in six months he desired him in an abrupt manner to leave his house, without attempting to procure for him any kind of living. It would perhaps be rash and uncandid to reprobate this conduct of his uncle, whose penetration probably beheld, if not the actual commission, at least the germinating seeds of those too fashionable vices and follies into which he afterwards plunged. We only give this as a conjecture of our own; but it seems to derive considerable countenance from the contrast between the manner in which his uncle received him, and the nature of their separation. Be this as it may, the conduct of his uncle operated powerfully on the mind of Ferguson, which, with the fatigue of his journey back to Edinburgh, brought on him a severe illness, on his recovery from which he composed two elegies; one on the decay of friendship, and the other against repining at fortune; both which were suggested by this adventure at Aberdeen. The disappointment of his hopes, and the effect it produced on his mind, are very evident from the following stanzas.

But, ah! these youthful sportive hours are fled,
These scenes of jocund mirth are now no more;
No healing slumbers 'tend my humble bed,
No friends condole the sorrows of the poor.

And what avail the thoughts of former joys?
What comfort bring they in the adverse hour?
Can they the canker-worm of care destroy,
Or brighten fortune's discontented lour?

Ferguson, Feriæ.

So great were his necessities at this period, that he copied papers in the commissary clerk's office for so much per sheet, which employment he soon left in disgust.

So boundless was his wit, which was only equalled by his good nature, modesty, and goodness of heart, that all who knew him received him with affection; but his powers of song and talents for mimicry often led him into the company of the dissipated, whose example could not fail of doing him essential injury, but who had neither the power nor inclination to provide for him through life. The irregularities into which he was thus frequently led, often awakened upon him the dictates of conscience; and the conversation of a minister who understood his manner of life, made a deep impression on his mind. In short, his remorse soon after assumed the appearance of absolute despair. His sprightliness entirely forsook him; but he gradually recovered from his despondency, and his health was fully restored. Soon after he cut his head so dreadfully in consequence of a fall, that from the loss of blood he became delirious, in which condition he remained for some months, till the want of sleep and perpetual talking put a period to his existence on the 16th of October 1774. He was buried in the Canongate churchyard; over his grave his admirer Robert Burns has since erected a monument.

Had he joined prudence to his bright genius and good heart, he would have no doubt risen to distinguished eminence in the literary world. His poems in the Scottish dialect have been universally admired by his countrymen; and when we reflect that they were composed in a round of dissipation, they must be considered as unequivocal evidences of his genius and taste.

FERIÆ, in Roman antiquity, holidays, or days upon which they abstained from work. Proclamation was generally made by the herald, by command of the *Rex Sacrorum* or *Flamines*, that all should abstain from business; and whoever transgressed the order was severely fined.—The feriæ were of two kinds, public and private.

The *public* feriæ were fourfold. 1. *Stativæ*, which were kept as public feasts by the whole city upon certain immoveable days appointed by their kalendar;—such were the *Compitalia*, *Carmentalia*, *Lupercalia*, *&c.* 2. *Feriæ Conceptivæ*, which were moveable feasts, the days for the celebration of which were fixed by the magistrates or priests; of this sort were the *Feriæ Latinæ*, *Paganalia*, *Compitalia*, &c. which happened every year, but the days for keeping them were left to the discretion of the magistrates or priests. 3. *Feriæ Imperativæ*, which were fixed and instituted by the mere command of consuls, prætors, dictators, upon the gaining of some victory or other fortunate event. 4. *Nundinæ*. See the articles NUNDINÆ, AGONALIA, CARMENTALIA, &c.

The *private* feriæ were holidays observed by particular persons or families on several accounts, as birthdays, funerals, &c. The feriæ belonged to, and were one division of, the *dies festi*. See FESTI.

FERIÆ Latinæ, a festival at which a white bull was sacrificed, and the Latin and Roman towns provided each a set quantity of meat, wine, and fruits; and during the celebration, the Romans and Latins swore eternal

eternal friendship to each other, taking home a piece of the victim to every town. The festival was instituted by Tarquinius Superbus when he overcame the Tuscans and made a league with the Latins, proposing to build a common temple to Jupiter Latialis, at which both nations might meet and offer sacrifices for their common safety. At first the solemnity lasted but one day, but it was at different times extended to ten. It was held on the Alban mount, and celebrated with chariot races at the Capitol, where the victor was treated with a large draught of wormwood drink.

FERIA, in the Romish breviary, is applied to the several days of the week; thus Monday is the *feria secunda*, Tuesday the *feria tertia;* though these days are not working days, but holidays. The occasion of this was, that the first Christians were used to keep the Easter week holy, calling Sunday the *prima feria*, &c. whence the term *feria* was given to the days of every week. But besides these, they have extraordinary feriæ, viz. the three last days of Passion week, the two following Easter day, and the second feriæ of Rogation.

FERIANA, the ancient city of Thala in Africa, taken and destroyed by Metellus in the war with Jugurtha. It was visited by Mr Bruce in his late travels through Africa, who expected to have found many magnificent ruins in the place, but was disappointed. The only remarkable objects he met with were the baths, which are excessively warm. These are without the town, and flow from a fountain named *El Tarmid*. Notwithstanding the excessive heat of its water, the fountain is not destitute of fishes. They are of the shape of a gudgeon, above four inches in length; and he supposed that there might have been about five or six dozen of them in the pool. On trying the water with a thermometer, he found the heat so great, that he was surprised the fish were not boiled in it. That fish should exist in this degree of heat, is very surprising; but it seems no less wonderful that Mr Bruce, while standing naked in such water, should leisurely make observations on its heat, without suspecting that he himself would be boiled by continuing there. We have to regret that the accidental wetting of the leaf on which he wrote down his remarks has deprived the public of the knowledge of the precise degree to which the thermometer is raised by this water. The fish are said to go down the stream to some distance during the day, and to return to the spring or warmest part at night.

FERMANAGH, a county of Ireland, in the province of Ulster; bounded by Cavan on the south, Tir-Oen on the north and north-east, by Tyrconnel on the north-west, Leitrim on the south-west, and Monaghan on the west. It is 38 miles long and 24 broad. A great part of it is taken up with bogs; and the great lake called *Lough-Earne*, which is near 20 miles in length and in some places 14 in breadth, diversified with upwards of 300 islands, most of them well wooded, inhabited, and covered with cattle. It abounds also with great variety of fish, such as huge pike, large bream, roach, eels, trout, and salmon. The water of the lake in some places is said to have a particular softness and sliminess, that bleaches linen much sooner than could be done by other water. The lake is divided into the upper and lower, between which it contracts itself for five or six miles to the breadth of an ordinary river. In one part of the county are marble rocks 50 or 60 feet high. This county formerly sent four members to the Irish parliament, viz. two for the shire, and two for Inniskillen the capital. Fermanagh gives the title of viscount to Earl Verney.

FERMENT, any body which being applied to another, produces fermentation.

Ferments are either matters already in the act of fermentation, or that soon run into this act. Of the first kind are the flowers of wine, yeast, fermenting beer, or fermenting wine, &c. and of the second are the new expressed vegetable juices of summer fruit.

Among distillers, ferments are all those bodies which, when added to the liquor, only correct some fault therein, and, by removing some obstacle to fermentation, forward it by secondary means: as also such as, being added in time of fermentation, make the liquor yield a larger proportion of spirit, and give it a finer flavour.

FERMENTATION, may be defined a sensible internal motion of the constituent particles of a moist, fluid, mixed or compound body; by the continuance of which motion, these particles are gradually removed from their former situation or combination, and again, after some visible separation is made, joined together in a different order and arrangement, so that a new compound is formed, having qualities very sensibly different from those of the original fluid.

Fermentation, properly so called, is confined to the vegetable and animal kingdoms; for the effervescences between acids and alkalies, however much they may resemble the fermentation of vinous liquers, are nevertheless exceedingly different. It is divided into three kinds; or rather, there are three different stages of it, viz. the vinous, the acetous, and the putrefactive. To these has been added a fourth, the *panary*, or the fermentation of bread. Of the first, vegetables alone are susceptible; the flesh of young animals is in some slight degree susceptible of the second (A); but animal substances are particularly susceptible of the third, which vegetables do not so easily fall into without previously undergoing the first and second. The produce of the first stage is wine, or some other vinous liquor; of the second, vinegar; and of the third, ammonia or volatile alkali.

(A) Under the article CHINA, N° 115. a fact is mentioned which seems to show that animal substances are likewise capable of the vinous fermentation; viz. that the Chinese make use of a certain liquor called *lamb wine*, and likewise that they use a kind of spirit distilled from *sheeps flesh*. This is related on the credit of M. Grosier: but as he does not mention the particulars of the process, we are at liberty to suppose that the flesh of these animals has been mixed with rice, or some other ingredients naturally capable of producing a vinous liquor; so that, instead of contributing any thing to the fermentation in question, they may in reality be detrimental, and furnish only that strong and disagreeable smell complained of in the liquid.

kali. For the explanation of this procefs, according to the principles of modern chemiftry, fee CHEMISTRY *Index*; and for the more general details of the procefs, fee BREWING, MALTING and VINEGAR-*making*.

FERN, FILIX. See FILICES, BOTANY *Index*.

Fern is very common in dry and barren places. It is one of the worft weeds for lands, and very hard to deftroy where it has any thing of a deep foil to root in. In fome grounds, the roots of it are found to the depth of eight feet. One of the moft effectual ways to deftroy it is often mowing the grafs; and, if the field is ploughed up, plentiful dunging thereof is very good: but the moft certain remedy for it is urine. However, fern, cut while the fap is in it, and left to rot upon the ground, is a very great improver of land.

In fome places of the north, the inhabitants mow it green; and, burning it to afhes, make thofe afhes up into balls with a little water. They then dry them in the fun, and make ufe of them to clean their linen with; looking upon it to be near as good as foap for that purpofe.

Male FERN. See POLYPODIUM, BOTANY *Index*.

Female FERN. See PTERIS, BOTANY *Index*.

FERNANDO, or FERNANDES, an ifland in the Pacific ocean. See *JUAN Fernandes*.

FERNELIUS, JOHN, phyfician to Henry II. king of France, was born in Picardy, in the latter end of the 15th or the beginning of the 16th century. Being fent to Paris to ftudy rhetoric and philofophy, he applied himfelf in a moft intenfe manner. All other pleafure was infipid to him. He cared neither for play nor for walking, nor for entertainments, nor even for converfation. He read Cicero, Plato, and Ariftotle. The reading of Cicero procured him this advantage, that the lectures he read on philofophical fubjects were as eloquent as thofe of the other mafters were barbarous at that time. He alfo applied himfelf very earneftly to the mathematics. This continual ftudy drew upon him a long fit of ficknefs, which obliged him to leave Paris. On his recovery, he returned thither with a defign to ftudy phyfic; but before he applied himfelf entirely to it, he taught philofophy in the college of St Barbara. After this he fpent four years in the ftudy of phyfic; and taking a doctor's degree, confined himfelf to his clofet, in order to read the beft authors, and to improve himfelf in the mathematics; that is, as far as the bufinefs of his profeffion would fuffer him. Never was a man more diligent than Fernel. He ufed to rife at four o'clock in the morning, and ftudied till it was time either to read lectures or to vifit patients. He then examined the urine that was brought him; for this was the method of thofe times, with regard to the poor people, who did not fend for the phyfician. Coming home to dine, he fhut himfelf up among his books till they called him down to table. Rifing from table, he returned to his ftudy, which he did not leave without neceffary occafions. Coming home at night, he did juft as at noon: he ftaid among his books till they called him to fupper; returned to them the moment he had fupped; and did not leave them till eleven o'clock, when he went to bed. In the courfe of thefe ftudies, he contrived mathematical inftruments, and was at great charges in making them. But his wife murmuring at the expence, he difmiffed his inftrument-makers, and applied himfelf in good earneft to practife phyfic. But as vifiting patients did not employ his whole time, he read public lectures upon Hippocrates and Galen. This foon gained him a great reputation through France and in foreign countries. His bufinefs increafing, he left off reading lectures; but as nothing could make him ceafe to ftudy in private, he fpent all the hours he could fpare in compofing a work of phyfic, entitled *Phyfiologia*, which was foon after publifhed. He was prevailed with to read lectures upon this new work, which he did for three years: and undertaking another work, which he publifhed, *De venæ fectione*, he laid himfelf under the neceffity of reading lectures fome years longer, in order to explain this new book to the youth. While he was thus employed, he was fent for to court, in order to try whether he could cure a lady, whofe recovery was defpaired of. He was fo happy as to cure her; which was the firft caufe of that efteem which Henry II. who was then but dauphin, and was in love with that lady, conceived for him. This prince offered him, even then, the place of firft phyfician to him; but Fernel, who infinitely preferred his ftudies to the hurry of a court, would not accept the employment. When Henry came to the throne, he renewed his entreaties: but Fernel reprefented that the honour which was offered to him was due, for feveral reafons, and as an hereditary right, to the late king's phyfician; and that, as for himfelf, he wanted fome time to make experiments concerning feveral difcoveries he had made relating to phyfic. The king admitted this: but as foon as Francis I.'s phyfician died, Fernel was obliged to go and fill his place at Henry II.'s court. And here juft the contrary to what he dreaded came to pafs; for he enjoyed more reft and more leifure at court than he had done at Paris; and he might have confidered the court as an agreeable retirement, had it not been for the journeys which the new civil war obliged the king to take. He died in 1558, leaving behind him a great many works, befides what have been mentioned; as, *De abditis rerum caufis*, feven books of Pathology, a book on Remedies, &c. They have been printed feveral times; with his life prefixed, written by William Plantius his difciple.

FERONIA, the Pagan goddefs of woods and orchards. This deity took her name from the town Feronia, fituated at the foot of Mount Soracte in Italy, where was a wood and temple confecrated to her. That town and wood are mentioned by Virgil, in the catalogue of Turnus's forces. Strabo relates, that thofe who facrificed to this goddefs, walked barefoot upon burning coals, without being hurt. She was the guardian deity of freed men, who received their cap of liberty at her temple.

FERRARA, a city of Italy, in the territory of the pope, capital of a duchy of the fame name. It is feated in an agreeable and fertile plain; watered by the river Po, which is a defence on one fide; and on the other is encompaffed by a ftrong wall and deep broad ditches full of water, as well as by a good citadel, finifhed by Pope Paul. In the middle of the city is a magnificent caftle, which was formerly the palace of the dukes, and is not now the leaft ornament of Ferrara. It is quite furrounded with water; and the arfenal, which is near it, deferves the obfervation of travellers. Over againft the palace is the duke's garden; with a park, called

Belvidere on account of its beauty. Behind the garden there is a palace, built with white marble, called the *palace of diamonds*, because all the ſtones are cut diamond faſhion.

Ferrara had formerly a conſiderable trade; but it is now almoſt deſerted, being very poor, inſomuch that there is hardly a perſon to be ſeen in the ſtreets. This is owing to the exactions of the popes. The fortifications are now neglected, and the ancient univerſity is dwindled into a wretched college of the Jeſuits. However, in 1735, it was advanced to an archbiſhopric by Pope Clement XII. The country about it is ſo marſhy, that a ſhower or two of rain renders the roads almoſt impaſſable. It is 24 miles north-eaſt of Bologna, 38 north-weſt of Ravenna, 70 north-by-weſt of Florence, and 190 north of Rome. E. Long. 12. 14. N. Lat. 44. 36.

FERRARA, the duchy of; a province in the pope's territory, bounded on the north by the ſtate of Venice, on the weſt by the duchies of Mantua and Mirandola, on the ſouth by the Bologneſe and by Romagna, of which it was formerly a part, and on the eaſt by the gulf of Venice. It is 50 miles in length, and 43 in breadth along the coaſt; but grows narrower and narrower towards the Mantuan. This country is almoſt ſurrounded by the branches of the Po, which often overflow the country, and form the great moraſs of Comachio, which has a bad effect on the air. It is thin of people, and indifferently cultivated, though fit for corn, pulſe and hemp. The Po and the lake of Comachio yielded a large quantity of fiſh. Ferrara is the capital town; beſides which there are Arano, Comachio, Magnavacca, Belriguardo, Cento, Buendeno, and Ficherola. This duchy was formerly poſſeſſed by the houſe of Eſte. But the pope took poſſeſſion of it in 1598, after the death of Alphonſo II. duke of Ferrara, it being a fief of the church.

FERRARIA, a genus of plants, belonging to the gynandria claſs; and in the natural method ranking under the ſixth order, *Enſatæ*. See BOTANY *Index*.

FERRARS, GEORGE, a lawyer, poet, hiſtorian, and accompliſhed gentleman, was deſcended from an ancient family in Hertfordſhire, and born about the year 1510, in a village near St Alban's. He was educated at Oxford, and thence removed to Lincoln's Inn; where applying with uncommon diligence to the ſtudy of the law, he was ſoon diſtinguiſhed for his elocution at the bar. Cromwell earl of Eſſex, the great miniſter of Henry VIII. introduced him to the king, who employed him as his menial ſervant, and, in 1535, gave him a grant of the manor of Flamſtead in his native county. This is ſuppoſed to have been a profitable eſtate; nevertheleſs, Mr Ferrars being a gay courtier, and probably an expenſive man, about ſeven years after was taken to execution by a ſheriff's officer for a debt of 200 merks, and lodged in the compter. Being at this time member for Plymouth, the houſe of commons immediately interfered, and he ſoon obtained his liberty. He continued in favour with the king to the end of his reign, and in that of Edward VI. he attended the lord protector Somerſet as a commiſſioner of the army in his expedition to Scotland in 1548. In the ſame reign, the young king being then at Greenwich, Mr Ferrars was proclaimed *lord of miſrule*, that is, prince of ſports and paſtimes; which office he diſcharged during 12 days, in Chriſtmas holidays, to the entire ſatisfaction of the court. This is all we know of Mr Ferrars; except that he died in 1579, at Flamſtead in Hertfordſhire, and was buried in the pariſh church. He is not leſs celebrated for his valour in the field, than for his other accompliſhments as a gentleman and a ſcholar. He wrote, 1. Hiſtory of the Reign of Queen Mary; publiſhed in Grafton's chronicle, 1569, fol. 2. Six tragedies, or dramatic poems; publiſhed in a book called the *Mirror for Magiſtrates*, firſt printed in 1559, afterwards in 1587, and again in 1610.

FERRET, See MUSTELA, MAMMALIA *Index*.

FERRETS, among glaſsmakers, the iron with which the workmen try the melted metal, to ſee if it be fit to work.—It is alſo uſed for thoſe irons which make the rings at the mouth of the bottles.

FERRETTO, in glaſs-making, a ſubſtance which ſerves to colour glaſs.

This is made by a ſimple calcination of copper, but it ſerves for ſeveral colours: there are two ways of making it. The firſt is this. Take thin plates of copper, and lay them on a layer of powdered brimſtone, in the bottom of a crucible; over theſe lay more brimſtone, and over that another layer of the plates, and ſo on alternately till the pot is full. Cover the pot, lute it well, place it in a wind furnace, and make a ſtrong fire about it for two hours. When it is taken out and cooled, the copper will be found ſo calcined, that it may be crumbled to pieces between the fingers like a friable earth. It will be of a reddiſh, and, in ſome parts, of a blackiſh colour. This muſt be powdered and ſifted fine for uſe.

Another way of making ferretto is as follows. Make a number of ſtratifications of plates of copper and white vitriol alternately in a crucible; which place on the floor of the glaſs furnace near the eye; and let it ſtand there three days; then take it out, and make a new ſtratification with more freſh vitriol; calcine again as before. Repeat this operation ſix times, and a moſt valuable ferretto will be obtained.

FERRO, (W. Long. 19. N. Lat. 28.), the moſt weſterly of the Canary iſlands, near the African coaſt, where the firſt meridian was lately fixed in moſt maps; but now, the geographers of almoſt every kingdom make their reſpective capitals the firſt meridian, as we do London. It is a dry and barren ſpot, affording no water except what is ſupplied in a very ſurpriſing manner by a tree which grows in theſe iſlands, called the FOUNTAIN-*Tree*.

FERRO, *Faro*, or *Feroe Iſlands*; a cluſter of little iſlands lying in the Northern ocean, between 61°, 15′ and 62° 21′ N. Lat. and between 5° and 8° W. Long. They belong to Denmark. There are 17 which are habitable; each of which is a lofty mountain ariſing out of the waves, divided from the others by deep and rapid currents. Some of them are deeply indented with ſecure harbours; Providence ſeeming to have favoured mankind with the ſafeſt retreats in the moſt boiſterous ſeas. All are very ſteep, and moſt of them faced with moſt tremendous precipices. The ſurface of the mountains conſiſts of a ſhallow ſoil of remarkable fertility; for barley, the only corn ſown here, yields above 20 for one; and the graſs affords abundant paſturage for ſheep. The exports are, ſalted mutton and tallow, gooſe quills, feathers, and eider down; and, by by the induſtry of the inhabitants, knit woollen waiſtcoats, caps, and ſtockings. No trees beyond the ſize of juniper or ſtunted willows will grow here; nor are any wild quadrupeds to be met with except rats and mice, originally eſcaped from the ſhipping. Vaſt quantities of ſea fowl frequent the rocks; and the taking of them furniſhes a very perilous employment to the natives, as deſcribed under the article *Bird-Catching*.

The ſea which ſurrounds theſe iſlands is extremely turbulent. The tides vary greatly on the weſtern and eaſtern ſides. On the firſt, where is received the uninterrupted flood of the ocean from the remote Greenland, the tide riſes ſeven fathoms; on the eaſtern ſide it riſes only three. Dreadful whirlwinds, called by the Danes *oes*, agitate the ſea to a ſtrange degree; catch up a vaſt quantity of water, ſo as to leave a great temporary chaſm in the ſpot on which it falls, and carries away with it, to an amazing diſtance, any fiſhes which may happen to be within reach of its fury. Thus great ſhoals of herrings have been found on the higheſt mountains of Feroe. It is equally reſiſtleſs on land; tearing up trees, ſtones, and animals, and carrying them to very diſtant places.

Among the numerous whirlpools of theſe ſeas, that of Suderoe, near the iſland of the ſame name, is the moſt noted. It is occaſioned by a crater 61 fathoms in depth in the centre, and from 50 to 55 on the ſides. The water forms four fierce circumgirations. The point they begin at is on the ſide of a large baſon, where commences a range of rocks running ſpirally, and terminating at the verge of the crater. This range is extremely rugged, and covered with water from the depth of 12 to 8 fathoms only. It forms four equidiſtant wreaths with a channel from 35 to 20 fathoms in depth between each. On the outſide, beyond that depth, the ſea ſuddenly ſinks to 80 and 90. On the ſouth border of the baſon is a lofty rock, called *Sumboe Munk*, noted for the multitude of birds which frequent it. On one ſide, the water is only 3 or 4 fathoms deep; on the other 15. The danger at moſt times, eſpecially in ſtorms, is very great. Ships are irreſiſtibly drawn in; the rudder loſes its power; and the waves beat as high as the maſts; ſo that an eſcape is almoſt miraculous; yet at the reflux, and in very ſtill weather, the inhabitants will venture in boats for the ſake of fiſhing.

Innumerable flocks of aquatic birds are continually to be ſeen perched on the extremities of the rocks, which make their neſts in the clefts above the precipices; and vaſt numbers of them may be killed by the diſcharge of a ſingle muſket, and the reſt will not ſtir, ſo little are they accuſtomed to be diſturbed. One of the iſlands contains but a ſingle habitation, which can be viſited by the curate only in ſummer. In the ſouthern part of theſe iſlands coal-mines were diſcovered about the beginning of the eighteenth century, and trials of the coals were only made in 1777, when it was judged that working them would be of ſufficient intereſt and conſequence. The quarry was determined by a commiſſary to be about 12,000 feet long, 4000 broad on a medium, and five feet deep; but ſo great did the difficulty of working it appear, that the idea was abandoned. The coals were analyzed by the celebrated profeſſor Kratzenſtein of Copenhagen, who found that they were ſuperior to thoſe of England, as burning longer, and giving a more intenſe heat, but not ſo eaſily kindled. A trial of them has been made in Scotland, and they are allowed to be of a ſuperior quality. It is a favourable circumſtance to the exportation of the produce of thoſe iſlands, that their harbours are never frozen, and navigation of conſequence could meet with no interruption during the winter.

The meaſles and ſmall pox never attack the inhabitants but when they are brought there by ſtrangers, when the ravages they make are almoſt as terrible as thoſe of the peſtilence; but for 70 years back they have not been ſubjected to this dreadful viſitation. The air is temperate, and neither too hot in ſummer, nor extremely cold in winter. There are frequent miſts on theſe iſlands, but they do not ſeem to be injurious to the health of the inhabitants. The wind often blows with ſuch violence, that the people on horſeback are obliged to diſmount at its approach, which is announced by a whiſtling acroſs the rocks; and perſons on foot muſt throw themſelves flat on their face, to avoid the dreadful conſequences of the irreſiſtible hurricane. So ſudden is its approach at ſome times, that a burning candle might be carried in the open air but a few ſeconds before it. There is ſeldom any thunder on theſe iſlands; but when the phenomenon does happen, its awful and inceſſant roar among the rocks is truly alarming. Potatoes, the cultivation of which is rapidly advancing, thrive well, and the ſame is the caſe with radiſhes and turnips. Corn is not much cultivated, which would require exceſſive labour in a country ſo mountainous, and the ſpring fiſhery requires all the hands that can be ſpared. Trees cannot be made to grow upon them, and of conſequence there is no wood.

The number of inhabitants does not exceed 5000; and they are in general well made, with fair complexions, and their whiteneſs is very ſeldom impaired by the influence of the ſun. They are not deficient in underſtanding; and although phlegmatic, yet they are benevolent and hoſpitable, and are ſeldom known to quarrel. They are fond of brandy, and yet it is ſaid that they are very rarely ſeen in a ſtate of intoxication. They are frugal and upright, yet extremely credulous, and much addicted to ſuperſtitious practices. There are no ſchools among them, as parents educate their own children, and their knowledge of conſequence is very circumſcribed. They abound in ſkilful players at cheſs, but are wholly unacquainted with inſtruments of muſic, and dance to the ſound of the voice.

FERROL, a ſea port town of Spain, in the province of Gallicia, ſeated on a bay of the Atlantic ocean. It has a good harbour, and is frequented by the Spaniſh fleet in time of war. W. Long. 8. 46. N. Lat. 43. 26.

FERRUGINOUS, any thing partaking of iron, or which contains particles of that metal.

FERRUGO, rust, or oxide of iron. See Iron, *Oxide of*, Chemistry *Index*.

FERRUM, iron. See Iron, Chemistry *Index*.

FERRY, a liberty by preſcription, or by the king's grant, to have a boat for paſſage, on a frith or river, for carrying paſſengers, horſes, &c. over the ſame for a reaſonable toll.

FERTILITY, that quality which denominates a thing fruitful or prolific.

Nothing can produce fertility in either ſex, but what promotes

promotes perfect health: nothing but good blood, spirits, and perfect animal functions, that is, high health, can beget perfect fecundity; and therefore, all means and medicines, all nostrums and specifics, to procure fertility, different from those which procure good blood and spirits, are arrant quackery. Dr Cheyne says, that water-drinking males are very rarely infertile; and that if any thing in nature can prevent infertility, and bring fine children, it is a milk and seed diet persevered in by both parents.

To increase the fertility of *vegetables*, says Lord Bacon, we must not only increase the vigour of the earth and of the plant, but also preserve what would otherwise be lost: whence he infers, that there is much saved by setting, in comparison of sowing. It is reported, continues he, that if nitre be mixed with water to the thickness of honey, and after a vine is cut, the bud be anointed therewith, it will sprout within eight days. If the experiment be true, the cause may be in the opening of the bud, and contiguous parts, by the spirit of the nitre; for nitre is the life of vegetables.

How far this may be true, is not perhaps sufficiently shown, notwithstanding the experiments of Sir Kenelm Digby and M. Homberg. Consult Mr Evelyn's Sylva, the Philosophical Transactions, the French Memoirs, and Dr Stahl's Philosophical Principles of Chemistry; but a proper set of accurate experiments seems still wanting in this view.

FERULA, a little wooden pallet or slice, reputed the schoolmaster's sceptre, wherewith he chastises the boys, by striking them on the palm of the hand. The word is Latin, and has also been used to denote the prelate's crosier and staff. It is supposed to be formed of the Latin *ferire*, "to strike." Under the eastern empire, the ferula was the emperor's sceptre, as is seen on divers medals; it consists of a long stem or shank, and a flat square head. The use of the ferula is very ancient among the Greeks, who used to call their princes ναρθηκοφοροι, q. d. "ferula-bearers."

In the ancient eastern church, ferula or *narthex* signified a place separated from the church; wherein the penitents or the catechumens of the second order, called *auscultantes*, ακροαματικοι, were kept, as not being allowed to enter the church; whence the name of the place, the persons therein being under penance or discipline: *sub* ferula *erant ecclesiæ*.

Ferula, *Fennel-giant*, a genus of plants belonging to the pentandria class, and in the natural method ranking under the 45th order, *Umbellatæ*. See Botany *Index*. The drug assafetida is obtained from a species of ferula.

FESCENNIA, or Fescennium, in *Ancient Geography*, a town of Etruria, above Falerii; where the Fescennine verses were first invented. Now *Galese*, in the Ecclesiastical State, near the Tiber.

FESCENNINE verses, in antiquity, were a kind of satirical verses, full of wanton and obscene expressions, sung or rehearsed by the company, with many indecent gestures and dances, at the solemnization of a marriage among the Romans; (Hor. lib. v. ep. i. 145.) The word is borrowed, according to Macrobius, from *facinum*, "a charm;" the people taking such songs to be proper to drive away witches, or prevent their effect; but its more probable origin is from Fescennium, a city of Campania, where such verses were first used.

FESSE, in *Heraldry*, one of the nine honourable ordinaries. See Heraldry.

Fesse Point, is the exact centre of the escutcheon. See Point.

Fesse Ways, or *in Fesse*, denotes any thing borne after the manner of a fesse; that is, in a rank across the middle of the shield.

Party per Fesse, implies a parting across the middle of the shield, from side to side, through the fesse point.

FESTI dies, in Roman antiquity, certain days in the year devoted to the honour of the gods.

Numa, when he distributed the year into 12 months, divided the same into the *dies festi*, *dies profesti*, and *dies intercisi*.

The festi were again divided into days of sacrifices, banquets, games and feriæ. See Feriæ.

The *profesti* were those days allowed to men for the administration of their affairs, whether of a public or private nature: these are divided into fasti, comitiales, &c. See Fasti, Comitiales, &c.

The *intercisi* were days common both to gods and men, some parts of which were allotted to the service of the one, and some to that of the other.

FESTINO, in *Logic*, the third mood of the second figure of the syllogism, the first proposition whereof is an universal negative, the second a particular affirmative, and the third a particular negative; as in the following example:

FES No bad man can be happy.
TI Some rich men are bad men.
NO *Ergo*, Some rich men are not happy.

FESTIVAL, a time of feasting. See Feast.—The term is particularly applied to anniversary days of civil or religious joy.

FESTOON, in *Architecture* and *Sculpture*, &c. an ornament in form of a garland of flowers, fruits, and leaves, intermixed or twisted together.

It is in the form of a string or collar, somewhat biggest in the middle, where it falls down in an arch; being extended by the two ends, the extremities of which hang down perpendicularly.

Festoons are now chiefly used in friezes, and other vacant places which want to be filled up and adorned; being done in imitation of the long clusters of flowers, which the ancients placed on the doors of their temples and houses on festival occasions.

FESTUCA, fescue grass, a genus of plants belonging to the triandria class, and in the natural method ranking under the 34th order, *Gramina*. See Botany and Agriculture *Index*.

FESTUS Pompeius, a celebrated grammarian of antiquity, who abridged a work of Verrius Flaccus, *De Significatione Verborum*; but took such liberties in castration and criticising, as, Gerard Vossius observes, are not favourable to the reputation of his author. A complete edition of his fragments was published by M. Dacier in 1681, for the use of the Dauphin. Scaliger says, that Festus is an author of great use to those who would attain the Latin tongue with accuracy.

FETLOCK, in the *Manege*, a tuft of hair growing behind the pastern joint of many horses; for those of a low size have scarce any such tuft.

FETTI

Fetti || Feverfew.

FETTI, Domenico, an eminent painter in the style of Julio Romano, was born at Rome in 1589, and educated under Ludovico Civoli of Florence. He painted but little for churches, but excelled in history; his pictures are much sought after, and are scarce.—He abandoned himself to disorderly courses; and put an end to his life by excesses, in the 35th year of his age.

FETUS. See Foetus.

FEUD, in our ancient customs, is used for a capital quarrel or enmity, not to be satisfied but with the death of the enemy; and thence usually called *deadly feud*.—*Feud*, called also *feida*, and *faida*, in the original German, signifies *guerram*, i. e. *bellum*, "war." Lambert writes it *feeth*, and saith it signifies *capitales inimicitias*, or "implacable hatred."

In Scotland, and the north of England, feud is particularly used for a combination of kindred, to revenge the death of any of their blood, against the killer and all his race, or any other great enemy.

Feud (*Feoda*), the same with *Fief*, or *Fee*. See Feodal *System*.

FEUDAL, or Feodal, of or belonging to a feud or fee. See Feodal.

FEUDATORY, or Feodatory, a tenant who formerly held his estate by feodal service. See *Feodal Tenure*.

FEU-duty, in *Scots Law*, is the annual rent or duty which a vassal, by the tenor of his right, becomes bound to pay his superior.

Feu-Holding, in *Scots Law*, is that particular tenure by which a vassal is taken bound to pay an annual rent or feu-duty to his superior.

FEVER. See Medicine *Index*.

The ancients deified the diseases as well as the passions and affections of men. Virgil places them in the entrance into hell, Æn. vi. 273. Among these *Fever* had a temple on Mount Palatine, and two other parts of ancient Rome; and there is still extant an inscription to this goddess. FEBRI. DIVÆ. FEBRI. SANCTÆ. FEBRI. MAGNÆ. CAMILLA. AMATA. PRO. FILIO. MALE. AFFECTO.

Fever, in *Farriery*. See Farriery *Index*.

FEVERFEW. See Matricaria, Botany *Index*.

FEVERSHAM, a town of the county of Kent in England, situated on a branch of the river Thames, which is navigable for hoys. It was a royal demesne A. D. 811, and called in Kenulf's charter the *King's little Town*, though it is now a large one. It was inhabited by the Britons long before the invasion of Cæsar. In 903, King Athelstan held a great council here. King Stephen erected a stately abbey, 1147, whose abbots sat in parliament; and he was buried in it, together with Maud his queen, and Eustace his son; but of this building two mean gate-houses are all that now remain. The town was first incorporated by the name of the barons of Feversham, afterwards by Henry VIII. with the title of the mayor and commonalty, and lastly, by that of the mayor and jurats and commonalty. It is a populous flourishing place, consisting chiefly of two long broad streets, with a market-house in the centre, built 1574. Its ancient church was rebuilt in 1754, at the expence of 2300l. but was originally built in Edward II's reign. There is a free grammar school in the place, built and endowed by Queen Elizabeth in 1582; also two charity schools. It is a member of the cinque-port of Dover, and has a manufactory of gunpowder. The London markets are supplied from hence with abundance of apples and cherries, and the best oysters for stewing. These last were at one time carried away in such quantities by the Dutch, that many men and boats were employed in the winter to dredge for them; and it is said they carried home as many as amounted to above 2000l. a-year. The fishermen admit none to take up their freedom but married men.

Fevildea || Fez.

FEVILDEA, a genus of plants belonging to the diœcia class, and in the natural method ranking under the 34th order, *Cucurbitaceæ*. See Botany *Index*.

FEVRE, Tanegui le, of Caen in Normandy, born 1615, was an excellent scholar in the Greek and Roman learning. Cardinal de Richelieu gave him a pension of 2000 livres to inspect all the works published at the Louvre, and designed to have made him principal of a college he was about to erect at Richelieu. But the cardinal's death cut off his hopes; and Cardinal Mazarine having no great relish for learning, his pension was ill paid. Some time after, the marquis de Franciere, governor of Langres, took him along with him to his government, and there he embraced the Protestant religion; after which he was invited to Saumur, where he was chosen Greek professor. He there taught with extraordinary reputation. Young men were sent to him from all the provinces in the kingdom, and even from foreign countries, while divines and professors themselves gloried in attending his lectures. He was preparing to go to Heidelberg, whither he was invited by the prince Palatine, when he died, aged 57. He wrote, 1. Notes on Anacreon, Lucretius, Longinus, Phædrus, Justin, Terence, Virgil, Horace, &c. 2. A short account of the lives of the Greek poets. 3. Two volumes of letters: and many other works.

Fevre, Claud le, an eminent French painter, was born at Fountainbleau in 1633, and studied in the palace there, and then at Paris under Le Sueur and Le Brun; the latter of whom advised him to adhere to portraits, for which he had a particular talent, and in his style equalled the best masters of that country. He died in England in 1675, aged 42.

FEZ, the capital of a kingdom of the same name in Barbary, in Africa. It is described as a very large place, surrounded with high walls, within which there are hills and valleys, only the middle being level and flat. The river, which runs through the city, is divided into two streams, from which canals are cut into every part of the town; so that the mosques, colleges, palaces, and the houses of great men, are amply supplied with water. They have generally square marble basons in the middle of the court of their houses, which are supplied with water by marble pipes that pass through the walls. They constantly run over, and the stream returns back into the street, and so into the river. The houses are built with brick or stone; and are adorned on the outside with fine mosaic work, or tiles like those of Holland. The wood work and ceilings are carved, painted and gilt. The roofs are flat; for they sleep on the tops of the houses in summer. Most of the

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houſes are two ſtories high, and ſome three. There are piazzas and galleries running all round the court on the inſide, ſo that you may go under cover from one apartment to another. The pillars are of brick, covered with glazed tiles, or of marble, with arches between. The timber work is carved and painted with gay colours, and moſt of the rooms have marble ciſterns of water. Some of the great men build towers over their houſes ſeveral ſtories high, and ſpare no expence to render them beautiful; from hence they have a fine proſpect all over the city.

There are in this city 700 moſques, great and ſmall; 50 of which are magnificent, and ſupported with marble pillars, and other ornaments. The floors are covered with mats, as well as the walls to the height of a man. Every moſque has a tower or minaret, like thoſe in Turkey, with a gallery on the top, from whence they call the people to prayers. The principal moſque is near a mile and a half in circumference. The middle building is 150 yards in length, and 80 in breadth, with a tower proportionably high. Round this to the eaſt, weſt, and north, there are great colonnades 30 or 40 yards long. There are 900 lamps lighted every night; and in the middle of the moſque are large branches, which are capable of holding 500 lamps each. Along the walls are ſeven pulpits, from which the doctors of the law teach the people. The buſineſs of the prieſt is only to read prayers, and diſtribute alms to the people; to ſupport which, there are large revenues.

Beſides the moſques, there are two colleges built in the Mooriſh manner, and adorned with marble and paintings. In one of them there are 100 rooms, beſides a magnificent hall. In this there is a great marble vaſe full of water, adorned with marble pillars of various colours, and finely poliſhed. The capitals are gilt, and the roof ſhines with gold, azure, and purple. The walls are adorned with Arabic verſes in gold characters. The other colleges are not near ſo beautiful, or rather are all gone to ruin ſince the neglect of learning.

There are hoſpitals in the city, where formerly all ſtrangers were maintained three days *gratis*. But the eſtates belonging to them have been confiſcated for the emperor's uſe. There are above 100 public baths, many of which are ſtately buildings. People of the ſame trade or buſineſs live in ſtreets by themſelves.

Though the country about Fez is pleaſant and fertile, and in many places abounding with corn and cattle, yet a great part of it lies waſte and uncultivated, not ſo much for want of inhabitants as from the oppreſſion of the governors; which makes the people chooſe to live at ſome diſtance from the high roads, where they cultivate juſt as much land as is neceſſary for their own ſubſiſtence.

Round the city there are fine marble tombs, monuments, and gardens full of all manner of fruit trees.

Such are the common accounts of this city. The following are given by M. Chenier, in his *Recherches Hiſtoriques ſur les Maures*.

Fez was built in the end of the eighth century by Edris, a deſcendant of Mahomet and of Ali; whoſe father, in order to avoid the proſcriptions of the caliph Abdallah, retired to the extremity of Africa, and was proclaimed ſovereign by the Moors. Sidy Edris, having ſucceeded to the throne of his father, built the city of Fez in the year 793. He cauſed a moſque to be erected, in which his body was interred, and the city ever afterwards became an aſylum for the Moors, and a place of devotion. In the firſt moments of fervour which a new worſhip inſpires, another moſque was built called *carubin*, which is perhaps one of the largeſt and moſt beautiful edifices in Africa. Several others were ſucceſſively built, beſides colleges and hoſpitals; and the city was held in ſuch veneration, that when the pilgrimage to Mecca was interrupted in the fourth century of the Hegira, the weſtern Mahometans ſubſtituted that of Fez in its ſtead, while the eaſtern people went to Jeruſalem.

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When the Arabs had overſpread Aſia, Africa, and Europe, they brought to Fez the little knowledge they had acquired in the ſciences and arts; and that capital conjoined, with the ſchools of religion, academies where philoſophy was taught, together with medicine and aſtronomy. This laſt gradually degenerated; ignorance brought aſtrology into repute, and this quickly engendered the arts of magic and divination.

Fez ſoon became the common reſort of all Africa. The Mahometans went thither for the purpoſes of devotion; the affluence of ſtrangers introduced a taſte for pleaſure; libertiniſm quickly followed; and, as its progreſs is moſt rapid in warm countries, Fez, which had been the nurſe of ſciences and arts, became a harbour for every kind of vice. The public baths, which health, cleanlineſs, and cuſtom, had rendered neceſſary, and which were everywhere reſpected as ſacred places, became ſcenes of debauchery; where men introduced themſelves in the habits of women: youths in the ſame diſguiſe, with a diſtaff in their hands, walked the ſtreets at ſunſet in order to entice ſtrangers to their inns, which were leſs a place of repoſe than a convenience for proſtitution.

The uſurpers who diſputed the kingdom of Fez after the 16th century overlooked theſe abuſes, and contented themſelves with ſubjecting the maſters of the inns to furniſh a certain number of cooks for the army. It is to this laxity of diſcipline that Fez owed its firſt ſplendour. As the inhabitants are beautiful, the Africans flocked thither in crowds; the laws were overturned, morals deſpiſed, and vice itſelf turned into an engine of political reſource. The ſame ſpirit, the ſame inclinations, the ſame depravity, ſtill exiſt in the hearts of all the Moors. But libertiniſm is not now encouraged; it wears there, as in other places, the maſk of hypocriſy; and dares not venture to ſhow itſelf in the face of day.

The Mahometans of Andaluſia, thoſe of Granada and Cordova, migrated to Fez during the different revolutions that agitated Spain: they carried with them new cuſtoms and new arts, and perhaps ſome ſlight degree of civilization. The Spaniſh Moors carried from Cordova to Fez the art of ſtaining goat and ſheep ſkins with a red colour, which were then called Cordova leather, and now Morocco leather, from that city where the art is leſs perfect. They manufacture gauzes at Fez, ſilk ſtuffs, and girdles elegantly embroidered with gold and ſilk, which ſhow how far their ingenuity might be carried if induſtry were more encouraged.

There is ſtill ſome taſte for ſtudy preſerved at Fez, and the Arabic language is ſpoken there in greater purity

purity than in any other part of the empire. The rich Moors send their children to the schools at Fez, where they are better instructed than they could be elsewhere.

Leo Africanus, in the 16th century, gave a magnificent description of this city, from which most of those that have been afterwards made are copied: but its situation, its schools, and the industry and great urbanity of its inhabitants, are the only circumstances that give it any preference to the other cities of the empire. There are some pretty convenient inns here, consisting of two or three stories. The houses have no elegance externally: the streets are ill paved, and so strait that two persons riding abreast can hardly pass. The shops are like stalls; and have no more room in them than is sufficient to serve for the owner, who is always seated with his wares around him, which he shows to the passengers. But though the Moors of Fez are more civilized than the rest, they are vain, superstitious, and intolerant; and an order must be obtained from the emperor before a Christian or a Jew can be allowed to enter the city.

The situation of Fez is exceedingly singular. It lies in the bottom of a valley surrounded by little hills in the shape of a funnel; the declivities are divided into gardens planted with tall trees, orange shrubs, and all sorts of fruit trees; a river meanders along the declivity, and turns a number of mills, which disperse the water abundantly to all the gardens, and almost to every house. The descent to the city, which stands in the centre, is long; and the road lies through these gardens, which it traverses, in a serpentine direction.

The gardens, seen from the city, form a most delightful amphitheatre. Formerly each garden had a house in which the inhabitants spent the summer. These houses were destroyed in the times of the civil wars, and in the revolutions to which Fez has been subject, and few individuals have restored them. The situation of Fez, however, cannot be healthful; moist vapours fill the air in summer, and fevers are exceedingly common.

On the height above Fez, in a plain susceptible of rich cultivation, stands New Fez, finely situated, and enjoying excellent air, containing some old palaces, in which the children of the emperor live, and where he sometimes resides himself. New Fez is inhabited by some Moorish families, but by a greater number of Jews.

Fez is seated on the river Cebu, W. Long. 4. 25. N. Lat. 33. 58.

FEZZAN, a kingdom of Africa, about 300 miles long from north to south, and 200 broad from east to west. It is bounded on the east by the Harutsch and line of the deserts; by the country of the Tibboes on the south and south-east; by that of the Nomadic Tuaricks on the south-west; and the country which forms the western boundary, is inhabited by Arabs. It contains 101 towns and villages, of which Mourzouk is the metropolis. The climate of this kingdom is neither temperate nor agreeable at any season whatever; for the heat of summer is almost intolerable, even to the inhabitants, especially when the wind blows from the south; and the prevalence of the north wind during winter makes the cold so intense, as not only to chill the natives, but those also who visit it from northern regions.

Rain falls but seldom in this country, and in very small quantities. Thunder is also a rare phenomenon: Mr Horneman assures us that there was not a single storm from November 1798 to June 1799; and that on the last day of January 1799 there were some faint flashes of lightning unaccompanied by any claps of thunder. Winds, however, blow very frequently, both from the north and south, whirling up the dust and sand in such a manner as to give the atmosphere a yellowish appearance. There is neither river nor rivulet of any consequence in the whole country, according to Mr Horneman, who informs us that the soil is a deep sand, beneath which is found calcareous rock or earth, and sometimes a stratum of an argillaceous substance.

Date trees may be considered as the natural production of Fezzan, in the western parts of which some senna grows, of a superior quality to that which is imported from the country of the Tibboes. Culinary plants, and almost every vegetable peculiar to the garden, are met with in abundance. Wheat and barley seem well adapted to the nature of the soil, as well as to the climate; yet corn is not raised in sufficient quantity for home consumpt, which is brought from those parts of Africa bordering on the northern parts of the kingdom. This is most probably owing to the native indolence of the people, the despotism of their government, and the difficulties inseparable from their peculiar mode of tillage.

They bestow little attention on the rearing of cattle, which are only found in the most fertile parts of the country, and even in these their numbers are but small. They are made use of to draw water from the wells, and are never killed but in cases of absolute necessity. The common domestic animal is the goat; and although sheep are reared in the southern parts of the country, the most abundant supply is furnished by the Arabs on the borders. They make coarse cloths of the wool, which constitute the apparel of the inhabitants in general. Their horses are not numerous, as they make most use of asses, either for carriage, draught, or burthen. Camels bear a most extravagant price, being only made use of by the higher ranks, or by opulent merchants; and the common food of all those animals is the fruit of the date tree.

Although the trade of Fezzan consists entirely of foreign articles, it is nevertheless considerable. Mourzouk is the great market and place of general resort for different caravans from Cairo, Bengasi, Tripoli, and other places, between the months of October and February. The caravans which come to Mourzouk from the west or south, deal in ostrich feathers, tiger skins, gold dust, and also in slaves of both sexes as articles of commerce. Tobacco and snuff, with other articles manufactured in Turkey, are brought to the capital by the merchants from Bengasi; and paper, fire-arms, sabres, knives, and woollen cloth, are conveyed to it from Tripoli.

Fezzan is governed by a sultan, a descendant of the family of the Shereefs; and according to the tradition of the country, his ancestors came from the western parts of Africa, invaded and made a conquest of it about 500 years ago. He reigns over his dominions with abſolute power, but is at the ſame time tributary to the baſhaw of Tripoli, who annually receives from him the ſum of 4000 dollars by the hands of an officer appointed for that purpoſe. The ſultan who was upon the throne when Mr Horneman in 1798 viſited the country, aſſumed the title of "Sultan Muhammed ben Sultan Manſur," engraved on a ſeal which is applied to all public acts, and alſo to correſpondence within his dominions; but he makes uſe of a ſmaller ſeal when he writes to the baſhaw of Tripoli. The crown is hereditary; yet it deſcends not in all caſes from father to ſon, for when the heir apparent dies, a nephew may ſucceed in preference to a ſecond ſon, which is frequently the occaſion of much bloodſhed, when the right of ſucceſſion comes to be warmly conteſted. The palace of the ſultan is within the walls of the fortreſs of the capital, where he leads a life of retirement attended by his eunuchs. The harem is near the palace, into which he never enters, as the female whom he inclines to ſee is conducted to his apartment. The harem conſiſts of the ſultana and about 40 female ſlaves, which laſt he frequently diſpoſes of, and replaces them by others, unleſs they bear him children, or become the objects of his ardent attachment, either by their perſonal beauty or other accompliſhments.

Thoſe who wiſh for an audience with the ſultan, approach the throne, which is an old elbow chair raiſed a few ſteps from the ground, kiſs his hand, and raiſe it ſo as to touch their forehead, and then kneel before him to give a ſtatement of their buſineſs in common language, taking care, however, to intermix it with ſuch exclamations as theſe: "God prolong thy life, God protect thy country," and to offer him ſome ſmall preſent. The court of the ſultan conſiſts of a firſt and ſecond miniſter, the general of his forces, a number of black, and a few white ſlaves. Some of the black ſlaves who are purchaſed while boys, and educated according to their diſtinctions and talents, often acquire conſiderable influence with the ſultan.

The dreſs of the ſultan, when he appears in ſtate, conſiſts of a white frock of ſtuff, ornamented with gold and ſilver, and ſometimes of ſatin interwoven with ſilver. The appearance of his turban is remarkable, which meaſures not leſs than three feet from the fore to the hinder part, and two feet in breadth. His revenue ariſes from certain taxes on all gardens and cultivated lands, and from fines and requiſitions impoſed in an arbitrary manner. The ſlaves who are employed in collecting theſe are often rigorous in the extreme, but it is often poſſible to procure their lenity by means of a bribe. The expenditure of this revenue is chiefly confined to the ſupport of the ſultan, his court and palace, for the cadi and department of juſtice; the religious order, and principal officers of government, are ſupported by the produce of date-tree woods and gardens.

The adminiſtration of juſtice is veſted in the hands of a cadi, whoſe deciſions are guided by the Mohammedan law, by antiquated cuſtoms, and eſtabliſhed practice; but judgment in all criminal caſes is purely arbitrary, or is referred to the ſultan. The office of cadi has been hereditary in one family, ever ſince the conqueſt of the country by the anceſtors of the preſent ſultan; and when he dies, his place is filled up by one who is moſt eminent for learning, or who can beſt read and write, which is all the learning that he is ever poſſeſſed of.

It is difficult to aſcertain any thing like an accurate ſtatement of the population of Fezzan, but Mr Horneman conjectures that they may amount to about 75,000, all of them profeſſing the religion of Mahomet. The complexion of the people varies conſiderably; thoſe in the northern parts bearing in this reſpect a ſtriking reſemblance to the Arabians, while thoſe in the ſouthern diſtricts are very much like the Tibboes and Tuaricks. Thoſe who are ſtrictly indigenous are of ordinary ſtature, and their limbs far from being muſcular; of a deep brown colour, ſhort black hair, with their face formed like the people of Europe, and their noſe not ſo flat as that of the negro. Their walk, mein and geſture, indicate a total want of energy, either of body or mind.

The women of this country are in general fond of dancing, and the wanton manners and public freedoms in which they are permitted to indulge, are frequently aſtoniſhing, even to Mahometans from other countries; and the men are very much addicted to the vice of drunkenneſs, uſing the juice of the date-tree, or a drink that is called *buſa*, which is of an intoxicating nature.

Different ſpecies of the venereal diſeaſe prevail in this country, but that which is brought from Soudan is reckoned the moſt inveterate. The common lues venerea is called *franzi*, for the cure of which they make uſe of ſalts and colocynth as powerful cathartics, healing the ſores with natron water or diſſolved ſoda. They are ſometimes afflicted with hæmorrhoids, the cure of which is no doubt rendered more difficult by the too liberal uſe of red pepper; and a fever and ague which are very pernicious to foreigners. They are entirely unacquainted with phlebotomy, yet they ſometimes draw blood by means of cupping; and ſome are as much acquainted with ſurgery as to be able to cure a ſimple fracture.

Their houſes are miſerable ſtructures, compoſed of ſtones or bricks mixed with clay, and dried in the ſun, and the hands of the labourer are all the tools which are employed in building. When the walls are finiſhed, they are covered over with mortar made of calcareous earth, which is alſo done with the hand. Their houſes are extremely low, and there is no other entrance for the light but by the door. They are uncommonly abſtemious in reſpect of diet. Indeed they can never abſtain from butcher meat when it is placed before them; but this is not an article of food with the generality, and their expreſſion for a rich man is, "*that he eats* bread and meat every day."

FEWEL. See Fuel.

FIASCONE, a town of Italy, in the territories of the pope, remarkable for its good wine. E. Long. 13. 12. N. Lat. 42. 20.

FIAT, in *Law*, a ſhort order or warrant ſigned by a judge, for making out and allowing certain proceſſes.

FIBRARIÆ, an old term applied to minerals of a fibrous ſtructure.

FIBRE, in *Anatomy*, a perfectly ſimple body, or at leaſt as ſimple as any thing in the human ſtructure; being fine and ſlender like a thread, and ſerving to form other parts. Hence ſome fibres are hard, as the bony ones; and others ſoft, as thoſe deſtined for the formation of all the other parts.

The fibres are divided alſo, according to their poſition and

and direction, into such as are straight, oblique, transverse, annular, and spiral; as they are arranged in these directions in different parts of the body.

Fibre is also used to denote the slender Filaments which compose other bodies, whether animal, vegetable, or mineral; but more especially the capillary roots of plants.

FIBROSE, or Fibrous, something consisting of fibres, as the roots of plants. See Root.

FIBULA, in *Anatomy*, the outer and smaller of the bones of the leg. See Anatomy *Index*.

Fibula, in *Surgery*, an instrument in use among the ancients for the closing of gaping wounds.—Celsus speaks of the fibula as to be used when the wound was so patent as not easily to admit of being sewed. (*Op.* lib. vii. cap. 25. *apud fin.*)

Fibula, in *Antiquity*, was a sort of button, buckle, or clasp, made use of by the Greeks and Romans for keeping close or tying up some part of their clothes. They were of various forms, and often adorned with precious stones. Men and women wore them in their hair and at their shoes. Players and musicians, by way of preserving the voices of children put under their care to learn their arts, used to keep close the prepuce with a fibula, lest they should have commerce with women.

FICINUS, Marsilius, a celebrated Italian, was born at Florence in 1433, and educated at the expence of Laurence de Medicis. He attained a perfect knowledge of the Greek and Latin tongues, and became a great philosopher, a great physician, and a great divine. He was in the highest favour with Laurence and Cosmo de Medicis, who made him a canon of the cathedral church of Florence. He applied himself intensely to the study of philosophy; and while others were striving who should be the deepest read in Aristotle, who was then the philosopher in fashion, he devoted himself wholly to Plato. He was indeed the first who restored the Platonic philosophy in the west; for the better effecting of which he translated into Latin the whole works of Plato. There goes a story, but we know not how true it is, that when he had finished his translation, he communicated it to his friend Marcus Musurus, to have his approbation of it; but that, Musurus disliking it, he did it all over again. He next translated Plotinus; and afterwards the works, or part of them at least, of Proclus, Jamblicus, Porphyrius, and other celebrated Platonists.—In his younger years, Ficinus lived like a philosopher; and too much so, as is said, to the neglect of piety. However, Savonarola coming to Florence, Ficinus went with every body else to hear his sermons; and while he attended them for the sake of the preacher's eloquence, he imbibed a strong sense of religion, and devoted himself henceforward more especially to the duties of it. He died at Correggio in 1499; and as Baronius assures us upon the testimony of what he calls credible authors, appeared immediately after his death to his friend Michael Mercatus: to whom, it seems, he had promised to appear, in order to confirm what he had taught concerning the immortality of the soul. His writings, sacred and profane, which are very numerous, were collected and printed at Venice in 1516, at Basil in 1561 and 1576, and at Paris 1641, in two vols. folio. Twelve books of his Epistles, among which are many treatises, were printed separately in folio at Venice 1495, and at Nuremberg 1497, in 4to.

FICOIDES, the specific name given to several plants, as the mesembryanthemum, musa, and opuntia. See Mesembryanthemum, &c. Botany *Index*.

FICTION. See Fable and Poetry.

FICUS, the fig-tree: A genus of plants, belonging to the polygamia class; and in the natural method ranking under the 53d order, *Scabridæ*. See Botany *Index*.

The ficus religiosa, or Banian tree, is a native of several parts of the East Indies. It has a woody stem, branching to a great height and vast extent, with heart-shaped entire leaves ending in acute points. Of this tree the following lines of Milton contain a description equally beautiful and just:

———There soon they chose
The fig tree; not that tree for fruit renown'd,
But such as, at this day to Indians known
In Malabar or Decan, spreads her arms,
Branching so broad and long, that in the ground
The bended twigs take root, and daughters grow
About the mother tree, a pillar'd shade,
High overarch'd, and echoing walks between:
There oft' the Indian herdsman, shunning heat,
Shelters in cool, and tends his pasturing herds
At loop-holes cut through thickest shade.
Par. Lost, Book ix. l. 1100.

The Banian tree, or Indian fig, is perhaps the most beautiful of Nature's productions in that genial climate, where she sports with the greatest profusion and variety. Some of these trees are of amazing size and great extent, as they are continually increasing, and, contrary to most other things in animal and vegetable life, they seem to be exempted from decay. Every branch from the main body throws out its own roots; at first, in small tender fibres, several yards from the ground: these continually grow thicker until they reach the surface; and there striking in, they increase to large trunks, and become parent trees, shooting out new branches from the top: these in time suspend their roots, which, swelling into trunks, produce other branches; thus continuing in a state of progression as long as the earth, the first parent of them all, contributes her sustenance. The Hindoos are particularly fond of the Banian tree; they look upon it as an emblem of the Deity, from its long duration, its outstretching arms, and overshadowing beneficence; they almost pay it divine honours, and

Find a fane in every sacred grove.

Near these trees the most esteemed pagodas are generally erected; under their shade the Brahmins spend their lives in religious solitude; and the natives of all casts and tribes are fond of recreating in the cool recesses, beautiful walks, and lovely vistas of this umbrageous canopy, impervious to the hottest beams of a tropical sun.

A remarkable large tree of this kind grows on an island in the river Nerbudda, ten miles from the city of Baroche in the province of Guzerat; a flourishing settlement lately in possession of the East India Company, but ceded by the government of Bengal, at the treaty of peace concluded with the Mahrattas in 1783, to to Mahdajee Scindia a Mahratta chief. It is diſtinguiſhed by the name of Cubbeer Burr, which was given it in honour of a famous ſaint. It was once much larger than at preſent; but high floods have carried away the banks of the iſland where it grows, and with them ſuch parts of the tree as had thus far extended their roots: yet what remains is about 2000 feet in circumference, meaſured round the principal ſtems; the overhanging branches, not yet ſtruck down, cover a much larger ſpace. The chief trunks of this ſingle tree (which in ſize greatly exceed our Engliſh elms and oaks), amount to 350; the ſmaller ſtems, forming into ſtronger ſupporters, are more than 3000; and every one of theſe is caſting out new branches, and hanging roots, in time to form trunks, and become the parents of a future progeny. Cubbeer Burr is famed throughout Hindoſtan for its great extent and ſurpaſſing beauty: the Indian armies generally encamp around it; and, at ſtated ſeaſons, ſolemn jatarras, or Hindoo feſtivals, are held there, to which thouſands of votaries repair from various parts of the Mogul empire.—It is ſaid that 7000 perſons find ample room to repoſe under its ſhade. The Engliſh gentlemen, on their hunting and ſhooting parties, uſed to form extenſive encampments, and ſpend weeks together under this delightful pavilion, which is generally filled with green wood pigeons, doves, peacocks, and a variety of feathered ſongſters; crowded with families of monkeys performing their antic tricks; and ſhaded by bats of a large ſize, many of them meaſuring upwards of ſix feet from the extremity of one wing to the other. This tree not only affords ſhelter, but ſuſtenance, to all its inhabitants, being covered amid its bright foliage with ſmall figs of a rich ſcarlet, on which they all regale with as much delight, as the lords of creation on their more coſtly fare in their parties.

FIDD, an iron pin uſed at ſea to ſplice or faſten ropes together; it is made tapering and ſharp at one end.

There are alſo fidds of wood, which are much larger than the iron ones.

The pin alſo in the heel of the topmaſt, which bears it upon the cheſs-tree, is called a *fidd*.

Fidd-Hammer, is uſed for a hammer, the handle of which is a fidd, or made tapering into that form.

FIDDLE. See Violin.

Fiddle-Wood. See Citharexylon, Botany *Index*.

FIDDES, Richard, a learned divine and polite writer, was born in 1671, and educated at Oxford. He was preſented to the living of Halſham in Yorkſhire, where he was ſo admired for the ſweetneſs of his voice and the gracefulneſs of his delivery, that the people for ſeveral miles round flocked to his ſermons. Coming to London in 1712, he was by the favour of Dean Swift, introduced to the earl of Oxford, who made him one of his chaplains, and the queen ſoon after appointed him chaplain to the garriſon at Hull: but loſing his patrons upon the change of the miniſtry, he loſt his chaplainſhip; and being obliged to apply himſelf to writing, compoſed, 1. A body of Divinity; 2. The Life of Cardinal Wolſey; 3. A Treatiſe of Morality, &c. He died in 1725.

FIDE-jussores *Aſſidui*. See Assiduus.

Fide-Juſſor, in the *Civil Law*, is a ſurety, or one that obliges himſelf in the ſame contract with a principal, for the greater ſecurity of the creditor or ſtipulator.

FIDEI-commissum, in Roman antiquity, an eſtate left in truſt with any perſon, for the uſe of another. See Trustee.

FIDENA, or Fidénæ, in *Ancient Geography*, a town of the Sabines, five miles to the north of Rome, where traces of it are ſtill to be ſeen. Fidenates, the people (Livy.)

FIDES, Faith or Fidelity, one of the virtues deified by the Pagans. She had a temple near the Capitol, founded by Numa Pompilius; but no animals were offered, or blood ſpilt, in her ſacrifices. During the performance of her rites, her prieſts appeared in white veſtments, with their heads and hands covered with linen, to ſhow that fidelity ought to be ſacred.

FIDIUS, in Pagan worſhip, a god who preſided over alliances and promiſes. This deity, which the Romans borrowed from the Sabines, was alſo called *Sanctus*, *Semon*, and *Semi-Pater*.

FIELD, in *Agriculture*, a piece of ground encloſed, whether for tillage or paſture.

Field, in *Heraldry*, is the whole ſurface of the ſhield or the continent, ſo called becauſe it containeth thoſe achievements anciently acquired in the field of battle. It is the ground on which the colours, bearing, metals, furs, charges, &c. are repreſented. Among the modern heralds, field is leſs frequently uſed in blazoning than ſhield or eſcutcheon. See Shield, &c.

Field-Book, in *Surveying*, a book in which the angles, ſtations, diſtances, &c. are ſet down.

Field-Colours, or *Camp-Colours*, in *War*, are ſmall flags of about a foot and a half ſquare, which are carried along with the quartermaſter general, for marking out the ground for the ſquadrons and battalions.

Field-Fare, in *Ornithology*. See Turdus, Ornithology *Index*.

Field-Officers, in the art of war. See Officer.

Field-Pieces, ſmall cannons, from three to twelve pounders, carried along with an army in the field.

Field-Staff, a weapon carried by the gunners, about the length of a halbert, with a ſpear at the end; having on each ſide ears ſcrewed on, like the cock of a matchlock, where the gunners ſcrew in lighted matches when they are upon command; and then the field-ſtaffs are ſaid to be armed.

Field-Works, in *Fortification*, are thoſe thrown up by an army in beſieging a fortreſs, or by the beſieged to defend the place. Such are the fortifications of camps, highways, &c.

Elyſian-Fields. See Elysian.

FIELDING, Henry, a well-known writer of the preſent age, ſon of lieutenant-general Fielding who ſerved under the duke of Marlborough, was born in 1707. He had four ſiſters; of whom Sarah is well known, as writer of The Adventures of David Simple. On the death of his mother, his father married again; and Sir John Fielding, who ſucceeded him in the commiſſion of the peace for Middleſex, is his brother by this marriage. Henry was ſent to ſtudy at Leyden; but a failure in his remittances obliged him to return in two years, when his own propenſity to gaiety and profuſion drove him to write for the ſtage at 20 years of age. His firſt dramatic piece, Love in ſeveral Maſques, which was well received, appeared in 1727; and all his plays and farces, to the amount of 18, were written before the year 1737, and many of them are ſtill acted with applauſe. While he was thus employed, he married a young lady with 1500l. fortune, and inherited an eſtate of 200l. a-year from his mother; all which, though on the plan of retiring into the country, he contrived to diſſipate in three years; and then applied himſelf to the ſtudy of the law for a maintenance. In loſing his fortune, he acquired the gout; which, rendering it impoſſible for him to attend the bar, he with a ſhattered conſtitution had recourſe to many extempore applications of his pen for immediate ſupplies; until, ſoon after the rebellion in 1745, he accepted the office of acting juſtice for Middleſex, an employment much more profitable than honourable in the public eſteem. Reduced at length by the fatigues of this office, and by a complication of diſorders, he, by the advice of his phyſicians, went to Liſbon, where he died in 1754. He wrote a great number of fugitive pamphlets and periodical eſſays; but is chiefly diſtinguiſhed by his Adventures of Joſeph Andrews, and Hiſtory of Tom Jones. His works have been collected and publiſhed, with his life prefixed, by Mr Murphy.

FIENUS, Thomas, an ingenious and learned phyſician, born at Antwerp in 1566. He went into Italy to ſtudy phyſic under Mercurialis and Aldrovandus; and on his return diſtinguiſhed himſelf ſo much in the univerſity of Louvain, that he was there choſen profeſſor of phyſic, and was afterwards made phyſician to the duke of Bavaria. He wrote ſeveral works, among which were, *De viribus imaginationis*; and *De formatione fœtus*. He died at Louvain in 1631.

FIERI facias, in *Law*, a writ that lies where a perſon has recovered judgment for debt or damages in the king's courts againſt one, by which the ſheriff is commanded to levy the debt and damages on the defendant's goods and chattels.

FIFE, in *Muſic*, is a ſort of wind inſtrument, being a ſmall pipe. See Pipe.

FIFESHIRE, a county of Scotland, lying between the friths of Tay and Forth; bounded on the north and north-eaſt by the frith of Tay, which divides it from Perth and Angus; on the ſouth by the frith of Forth, which ſeparates it from the Lothians; the German ocean bounds it on the eaſt; and on the weſt it borders with the counties of Perth and Kinroſs, and a ſmall corner of Clackmannan. It extends about 60 miles in length from Culroſs to Fifeneſs, and is about 18 in breadth; comprehending a ſuperficies of nearly 480 ſquare miles. The face of the country is agreeably diverſified; towards the weſt it is mountainous, and a ridge of hills extends eaſtward almoſt its whole length, occupying the central diſtrict; towards the north and ſouth the ſurface gradually deſcends to the friths, exhibiting the moſt beautiful and enlivening proſpect of fertile and well cultivated fields. It is watered by ſeveral ſtreams, none of which deſerve the name of rivers, except the Eden and Leven; the former empties itſelf into the ocean at St. Andrews, and the latter at the village of Leven: both theſe rivers abound with trout and ſalmon; and on no coaſt of Scotland is the white fiſhing more productive than on the Fife coaſt. From its ſituation, it appears to have been very early inhabited; the fiſhings, coal mines, harbours, and other advantages for navigation, attracted ſettlers, and the coaſt was firſt peopled and beſt cultivated: this appears to have been the caſe, when King James VI. compared the county to a gray mantle with a gold fringe. The whole coaſt is covered with ſmall burghs, which that monarch regarded with particular attention, and very early in his reign endeavoured to render them ſubſervient to his wiſhes, of raiſing Scotland high in the world as a commercial nation; he granted them many privileges and immunities, and encouraged the inhabitants by every means in his power, to proſecute the advantages which, by their local ſituation, they poſſeſſed; indeed, the municipal privileges which they received from that monarch, though rendered unimportant by the union with England, will long remain a monument of his political ſagacity and diſcernment, The county can boaſt of poſſeſſing ſeveral ancient ſeats of royalty: at Dunfermline, at Falkland, at Kinghorn, and at St Andrews, veſtiges of royal ſplendour are ſtill to be ſeen. It contains 13 royal boroughs, which poſſeſs parliamentary repreſentation, and ſeveral which have loſt that privilege from their being unable to defray the expence which attended the ſending a commiſſioner to the Scottiſh parliament. To the county alſo belongs the ſmall iſland of May, on which there is a lighthouſe, and Inchgarvie. Fifeſhire is divided into 60 pariſhes, and contains, by the enumeration in 1801, 93,743 inhabitants, being nearly 196 to the ſquare mile; a much greater proportion than is to be found in any other county in Scotland. It was anciently an earldom in the Macduff family, created by Malcolm III. for the ſervices performed by the thane of Fife, in reſtoring him to the throne of Scotland, when uſurped by Macbeth. That title having expired, it was lately revived in the Duffs of Braco, lateral deſcendents of the ancient family: the ruins of the reſidences of that powerful nobleman are ſtill evident in many parts of the county. The whole of the ſouth ſide lies upon coal, and many pits are wrought on every part of the coaſt: in many places is excellent limeſtone; and ſome marl is found in the county. Ironſtone, of excellent quality, is found in the weſtern and middle quarters, and much is forged in the county, or exported to the Carron works. Lead ore is found in the Eaſtern Lomond, one of the two conical hills which riſe nearly in the middle of the county, and are ſeen at a great diſtance: in Kemback pariſh alſo lead ore has been wrought. The county of Fife ſends one member to parliament. Cupar is the county town.

The following account of the population of Fifeſhire at two different periods, is taken from the *Statiſt. Hiſt. of Scotland.*

	Pariſhes.	*Population in 1755.*	*Population in 1790-98.*
1	Abbotſhall -	1348	2136
	Abdie - -	822	494
	Aberdour -	1198	1280
	Anſtruther, - -	1100	1000
5	Anſtruther, Weſter -	385	370
	Auchterderran -	1143	1200
	Auchtermuchty -	1308	1439
	Auchtertool -	389	334
	Ballingry - -	464	220
10	Balmerino - -	565	703
	Beath - -	1099	450
	Burntiſland - -	1390	1210

Cameron

	Pariſhes.	Population in 1755.	Population in 1790-98.
	Cameron	1295	1165
	Carnbee	1293	1041
15	Carnock	583	970
	Ceres	2540	2320
	Coleſſie	989	949
	Crail	2173	1710
	Creich	375	306
20	Cult	449	534
	Cupar	2192	3702
	Dairſie	469	540
	Dalgety	761	869
	Denbog	255	235
25	Denino	598	383
	Dunfermline	8552	9550
	Dyſart	2369	4862
	Elie	642	620
	Falkland	1795	2198
30	Ferrie	621	875
	Fliſk	318	331
	Forgan	751	875
	Inverkeithing	1694	2210
	Kemback	420	588
35	Kennoway	1240	1500
	Kettle	1621	1759
	Kilconquhar	2131	2013
	Kilmaney	781	869
	Kilrenny	1348	1086
40	Kinghorn	2389	1768
	Kinglaſſie	998	1200
	Kingſbarns	871	807
	Kirkaldy	2296	2673
	Largo	1396	1913
45	Leſly	1130	1212
	Leuchars	1691	1620
	Logie	413	425
	Markinch	2188	2790
	Monimail	884	1101
50	Moonſie	249	171
	Newburgh	1347	1664
	Newburn	438	456
	Pittenweem	939	1157
	St Andrew's and St Leonard's	4913	4335
55	St Monance	780	832
	Saline	1285	950
	Scoonie	1528	1675
	Strathmiglo	1695	980
	Torryburn	1635	1600
60	Wemyſs	3041	3025
	Total,	81,570	87,250
			81,570
	Increaſe,		5680

Fife-Rails, in a ſhip, are thoſe that are placed on baniſters, on each ſide of the top of the poop, and ſo along with haunces or falls. They reach down to the quarter deck, and to the ſtair of the gangway.

FIFTH, in *Muſic*. See INTERVAL.

FIG, or FIG-TREE. See FICUS, BOTANY *Index*.

FIGWORT. See SCROPHULARIA, BOTANY *Index*.

FIGURAL, FIGURATE, or *Figurative*, a term applied to whatever is expreſſed by obſcure reſemblances. The word is chiefly applied to the types and myſteries of the Moſaic law; as alſo to any expreſſion which is not taken in its primary and literal ſenſe.

FIGURATE Numbers. See *NUMBERS, Figurate*.

FIGURE, in *Phyſics*, expreſſes the ſurface or terminating extremities of any body.

FIGURES, in *Arithmetic*, are certain characters whereby we denote any number which may be expreſſed by any combination of the nine digits, &c. See ARITHMETIC.

FIGURE, among divines, is uſed for the myſteries repreſented under certain types.

FIGURE, in *Dancing*, denotes the ſeveral ſteps which the dancer makes in order and cadence, conſidered as they mark certain figures on the floor. See DANCING.

FIGURE, in *Painting* and *Deſigning*, denotes the lines and colours which form the repreſentation of any animal, but more particularly of a human perſonage. See PAINTING.

FIGURE, in the manufactures, is applied to the various deſigns repreſented or wrought on velvets, damaſks, taffeties, ſatins, and other ſtuffs and cloths.

The moſt uſual figures for ſuch deſigns are flowers imitated from the life; or groteſques, and compartiments of pure fancy. Repreſentations of men, beaſts, birds, and landſcapes, have only been introduced ſince the taſte for the Chineſe ſtuffs, particularly thoſe called *furees*, began to prevail among us. It is the woof of the ſtuff that forms the figures; the warp only ſerves for the ground. In working figured ſtuffs there is required a perſon to ſhow the workman how far he muſt raiſe the threads of the warp, to repreſent the figure of the deſign with the woof, which is to be paſſed acroſs between the threads thus raiſed. This ſome call *reading the deſign*.

For the figures on tapeſtry, brocade, &c. ſee TAPESTRY, &c.

For thoſe given by the calenders, printers, &c. ſee CALENDAR, &c.

FIGURE, in *Logic*, denotes a certain order and diſpoſition of the middle term in any ſyllogiſm.

Figures are fourfold. 1. When the middle term is the ſubject of the major propoſition, and the predicate of the minor, we have what is called the firſt figure. 2. When the middle term is the predicate of both the premiſes, the ſyllogiſm is ſaid to be in the ſecond figure. 3. If the middle term is the ſubject of the two premiſes, the ſyllogiſm is in the third figure: and laſtly, by making it the predicate of the major, and ſubject of the minor, we obtain ſyllogiſms in the fourth figure. Each of theſe figures has a determinate number of moods, including all the poſſible ways in which propoſitions differing in quantity or quality can be combined, according to any diſpoſition of the middle term, in order to arrive at a juſt concluſion. See LOGIC.

FIGURE, in compoſition. See ORATORY; alſo ALLEGORY, APOSTROPHE, HYPERBOLE, METAPHOR, PERSONIFICATION, &c.

A FIGURE, the means or inſtrument conceived to be the agent. When we ſurvey a number of connected objects, that which makes the greateſt figure employs chiefly our attention; and the emotion it raiſes, if lively, prompts us even to exceed nature in the conceptions we form of it. Take the following examples,

Figure.

For Neleus' ſon Alcides' *rage* had ſlain.

A broken rock the *force* of Pirus threw.

In theſe inſtances, the rage of Hercules and the force of Pirus, being the capital circumſtances, are ſo far exalted as to be conceived the agents that produce the effects.

In the firſt of the following inſtances, hunger being the chief circumſtance in the deſcription, is itſelf imagined to be the patient.

Whoſe hunger has not taſted food theſe three days.
Jane Shore.

———————As when the *force*
Of ſubterranean wind tranſports a hill.
Paradiſe Loſt.

———————As when the *potent rod*
Of Amram's ſon, in Egypt's evil day,
Wav'd round the coaſt, upcall'd a pitchy cloud
Of locuſts. *Paradiſe Loſt.*

A FIGURE, *which, among related objects, extends the properties of one to another.* This figure is not dignified with a proper name, becauſe it has been overlooked by writers. *Giddy brink, jovial wine, daring wound,* are examples of this figure. Here are adjectives that cannot be made to ſignify any quality of the ſubſtantives to which they are joined: a *brink*, for example, cannot be termed *giddy* in a ſenſe, either proper or figurative, that can ſignify any of its qualities or attributes. When we examine attentively the expreſſion, we diſcover, that a *brink* is termed *giddy* from producing that effect in thoſe who ſtand on it: in the ſame manner, a wound is ſaid to be *daring*, not with reſpect to itſelf, but with reſpect to the boldneſs of the perſon who inflicts it: and wine is ſaid to be *jovial*, as inſpiring mirth and jollity. Thus the attributes of one ſubject are extended to another with which it is connected; and the expreſſion of ſuch a thought muſt be conſidered as a figure, becauſe the attribute is not applicable to the ſubject in any proper ſenſe.

How are we to account for this figure, which we ſee lies in the thought, and to what principle ſhall we refer it? Have poets a privilege to alter the nature of things, and at pleaſure to beſtow attributes upon a ſubject to which they do not belong? It is obſerved †, that the mind paſſeth eaſily and ſweetly along a train of connected objects; and, where the objects are intimately connected, that it is diſpoſed to carry along the good or bad properties of one to another; eſpecially when it is in any degree inflamed with theſe properties. From this principle is derived the figure under conſideration. Language, invented for the communication of thought, would be imperfect, if it were not expreſſive even of the ſlighter propenſities and more delicate feelings: but language cannot remain ſo imperfect among a people who have received any poliſh; becauſe language is regulated by internal feeling, and is gradually improved to expreſs whatever paſſes in the mind. Thus for example, when a ſword in the hand of a coward is termed *a coward ſword*, the expreſſion is ſignificative of an internal operation; for the mind, in paſſing from the agent to its inſtrument, is diſpoſed to extend to the latter the properties of the former. Governed by the ſame principle, we ſay *liſtening* fear, by extending the attribute *liſtening* of the man who liſtens, to the paſſion with which he is moved. In the expreſſion *bold deed*, or *audax facinus*, we extend to the effect what properly belongs to the cauſe. But not to waſte time by making a commentary upon every expreſſion of this kind, the beſt way to give a complete view of the ſubject, is to exhibit a table of the different relations that may give occaſion to this figure. And in viewing the table, it will be obſerved, that the figure can never have any grace but where the relations are of the moſt intimate kind.

† Vid. *Elem. of Criticiſm*, ch. ii. part I. ſect. 6.

1. An attribute of the cauſe expreſſed as an attribute of the effect.

Audax facinus.
Of yonder fleet a *bold* diſcovery make.
An impious mortal gave the *daring* wound.

———————To my *advent'rous* ſong,
That with no middle flight intends to ſoar.
Paradiſe Loſt.

2. An attribute of the effect expreſſed as an attribute of the cauſe.

Quos periiſſe ambos *miſero* cenſebam in mari.
PLAUTUS.

No wonder, fallen ſuch a *pernicious* height.
Paradiſe Loſt.

3. An effect expreſſed as an attribute of the cauſe.

Jovial wine, Giddy brink, Drowſy night, Muſing midnight, Panting height, Aſtoniſh'd thought, Mournful gloom.

Caſting a dim *religious* light. MILTON, *Comus.*
And the *merry* bells ring round,
And the *jocund* rebecks ſound. MILTON, *Allegro.*

4. An attribute of a ſubject beſtowed upon one of its parts or members.

Longing arms.
It was the nightingale, and not the lark,
That pierc'd the *fearful* hollow of thine ear.
Romeo and Juliet, act iii. ſc. 7.

———————Oh, lay by
Thoſe moſt ungentle looks and angry weapons:
Unleſs you mean my griefs and killing fears
Should ſtretch me out at your *relentleſs* feet.
Fair Penitent, act. iii.

———————And ready now
To ſtoop with *wearied* wing, and *willing* feet,
On the bare outſide of this world.
Paradiſe Loſt, book iii.

5. A quality of the agent given to the inſtrument with which it operates.

Why peep your *coward* ſwords half out their ſhells?

6. An attribute of the agent given to the ſubject upon which it operates.

High-climbing hill. MILTON.

7. A quality of one ſubject given to another.

Icci, *beatis* nunc Arabum invides
Gazis. HORAT. *Carm.* lib. i. ode 29.

When ſapleſs age, and weak unable limbs,
Should bring thy father to his *drooping* chair.
SHAKESPEARE.

Figure.

By art, the pilot through the boiling deep,
And howling tempest, steers the *fearless* ship.
Iliad, book xxiii. l. 385.

Then, nothing loth, th' enamour'd fair he led,
And sunk transported on the *conscious* bed.
Odyssey, book viii. l. 337.

A *stupid* moment motionless she stood.
Summer, l. 1336.

8. A circumstance connected with a subject, expressed as a quality of the subject.

Breezy summit.

'Tis ours the chance of *fighting* fields to try,
Iliad, book i. l. 301.

Oh! had I dy'd before that *well-fought* wall.
Odyssey, book v. l. 395.

From this table it appears, that the adorning a cause with an attribute of the effect, is not so agreeable as the opposite expression. The progress from cause to effect is natural and easy: the opposite progress resembles retrograde motion *; and therefore *panting height*, *astonish'd thought*, are strain'd and uncouth expressions, which a writer of taste will avoid.

† See PERCEPTION *and Ideas in a Train.*

It is not less strained, to apply to a subject in its present state, an epithet that may belong to it in some future state:

Submersasque obrue puppes. *Eneid*, book i. l. 73.

And mighty *ruins* fall. *Iliad*, book v. l. 411.

Impious sons their *mangled* fathers wound.

Another rule regards this figure, That the property of one subject ought not to be bestowed upon another with which the property is incongruous.

K. Rich. ———How dare thy joints forget
To pay their *awful* duty to our presence?
Richard II. act. iii. sc. 6.

The connexion between an awful superior and his submissive dependent is so intimate, that an attribute may readily be transferred from the one to the other: but awfulness cannot be so transferred, because it is inconsistent with submission.

FIGURE *of Speech*, as peculiarly distinguished from the above and from those first referred to.] Under the article *METAPHOR and Allegory*, a figure of speech is defined, "The using a word in a sense different from what is proper to it;" and the new or uncommon sense of the word is termed *the figurative sense*. The figurative sense must have a relation to that which is proper; and the more intimate the relation is, the figure is the more happy. How ornamental this figure is to language, will not be readily imagined by any one who hath not given peculiar attention; and therefore we shall endeavour to unfold its capital beauties and advantages. In the first place, a word used figuratively, or in a new sense, suggests at the same time the sense it commonly bears: and thus it has the effect to present two objects; one signified by the figurative sense, which may be termed *the principal object*; and one signified by the proper sense, which may be termed *accessory*: the principal makes a part of the thought; the accessory is merely ornamental. In this respect, a figure of speech is precisely similar to concordant sounds in music, which, without contributing to the melody, make it harmonious.

Elem. of Criticism.

Figure.

To explain the matter by examples. *Youth*, by a figure of speech, is termed *the morning of life*: This expression signifies *youth*, the principal object which enters into the thought; it suggests, at the same time, the proper sense of *morning*; and this accessory object, being in itself beautiful, and connected by resemblance to the principal object, is not a little ornamental. *Imperious ocean* is an example of a different kind, where an attribute is expressed figuratively: Together with *stormy*, the figurative meaning of the epithet *imperious*, where is suggested its proper meaning, viz. the stern authority of a despotic prince; and these two are strongly connected by resemblance. Upon this figurative power of words, Vida descants with elegance, *Poet.* lib. iii. l. 44.

In the next place, this figure possesses a signal power of aggrandizing an object, by the following means.—Words, which have no original beauty but what arises from their sound, acquire an adventitious beauty from their meaning: a word signifying any thing that is agreeable, becomes by that means agreeable; for the agreeableness of the object is communicated to its name. This acquired beauty, by the force of custom, adheres to the word even when used figuratively; and the beauty received from the thing it properly signifies, is communicated to the thing which it is made to signify figuratively. Consider the foregoing expression *Imperious ocean*, how much more elevated it is than *Stormy ocean*.

Thirdly, This figure hath a happy effect by preventing the familiarity of proper names. The familiarity of a proper name is communicated to the thing it signifies by means of their intimate connexion; and the thing is thereby brought down in our feeling. This bad effect is prevented by using a figurative word instead of one that is proper: as for example, when we express the sky by terming it *the blue vault of heaven*; for though no work of art can compare with the sky in grandeur, the expression however is relished, because it prevents the object from being brought down by the familiarity of its proper name. With respect to the degrading the familiarity of proper names, Vida has the following passage:

Hinc si dura mihi passus dicendus Ulysses,
Non illum vero memorabo nomine, sed qui
Et mores hominum multorum vidit, et urbes,
Naufragus eversæ post sæva incendia Trojæ.
Poet. lib. ii. l. 460.

Lastly, By this figure, language is enriched, and rendered more copious; in which respect, were there no other, a figure of speech is a happy invention. This property is finely touched by Vida; *Poet.* lib. iii. l. 90.

The beauties we have mentioned belong to every figure of speech. Several other beauties, peculiar to one or other sort, we shall have occasion to remark afterward.

Not only subjects, but qualities, actions, effects, may be expressed figuratively. Thus, as to subjects, *gates of breath* for the lips, *the watery kingdom* for the ocean. As to qualities, *fierce* for stormy, in the expression *Fierce winter*; *altus* for profundus, *Altus puteus*, *Altum mare*;

Figure. *mare; breathing* for perspiring, *Breathing plants*. Again, as to actions, The sea *rages*, Time will *melt* her frozen thoughts, Time *kills* grief. An effect is put for the cause, as *lux* for the sun; and a cause for the effect, as *boum labores* for corn. The relation of resemblance is one plentiful source of figures of speech; and nothing is more common than to apply to one object the name of another that resembles it in any respect: Height, size, and worldly greatness, resemble not each other; but the emotions they produce resemble each other, and, prompted by this resemblance, we naturally express worldly greatness by height or size: One feels a certain uneasiness in seeing a great depth; and, hence depth is made to express any thing disagreeable by excess, as *depth* of grief, *depth* of despair: Again, Height of place, and time long past, produce similar feelings; and hence the expression, *Ut altius repetam!* Distance in past time, producing a strong feeling, is put for any strong feeling; *Nihil mihi antiquius nostra amicitia:* Shortness with relation to space, for shortness with relation to time; *Brevis esse laboro, obscurus fio:* Suffering a punishment resembles paying a debt; hence *pendere pœnas*. In the same manner, light may be put for glory, sunshine for prosperity, and weight for importance.

Many words, originally figurative, having, by long and constant use, lost their figurative power, are degraded to the inferior rank of proper terms. Thus the words that express the operation of the mind, have in all languages been originally figurative: the reason holds in all, that when these operations came first under consideration, there was no other way of describing them but by what they resembled: it was not practicable to give them proper names, as may be done to objects that can be ascertained by sight and touch. A *soft* nature, *jarring* tempers, *weight* of woe, *pompous* phrase, *beget* compassion, *assuage* grief, *break* a vow, *bend* the eye downward, *shower* down curses, *drowning* in tears, *wrapt* in joy, *warm'd* with eloquence, *loaded* with spoils, and a thousand other expressions of the like nature, have lost their figurative sense. Some terms there are that cannot be said to be altogether figurative or altogether proper: originally figurative, they are tending to simplicity, without having lost altogether their figurative power. Virgil's *Regina saucia cura*, is perhaps one of these expressions: with ordinary readers, *saucia* will be considered as expressing simply the effect of grief; but one of a lively imagination will exalt the phrase into a figure.

For epitomizing this subject, and at the same time for giving a clear view of it, Lord Kames † gives a list of the several relations upon which figures of speech are commonly founded. This list he divides into two tables; one of subjects expressed figuratively, and one of attributes.

† *Elem. of Criticism.* ii. 305.

TAB. I. *Subjects expressed figuratively.*

1. A word proper to one subject employed figuratively to express a resembling subject.

There is no figure of speech so frequent, as what is derived from the relation of resembling. Youth, for example, is signified figuratively by the *morning* of life. The life of a man resembles a natural day in several particulars: the morning is the beginning of a day, youth the beginning of life; the morning is cheerful, so is youth, &c. By another resemblance, a bold warrior is termed the *thunderbolt* of war; a multitude of troubles, a *sea* of troubles.

This figure, above all others, affords pleasure to the mind by variety of beauties. Besides the beauties above mentioned, common to all sorts, it possesses in particular the beauty of a metaphor or a simile: a figure of speech built upon resemblance, suggests always a comparison between the principal subject and the accessory; whereby every good effect of a metaphor or simile may, in a short and lively manner, be produced by this figure of speech.

2. A word proper to the effect employed figuratively to express the cause.

Lux for the sun; *Shadow* for cloud. A helmet is signified by the expression *glittering terror;* a tree by *shadow* or *umbrage*. Hence the expression,

> Nec habet Pelion umbras. OVID.

> Where the dun umbrage hangs. *Spring*, l. 1023.

A wound is made to signify an arrow:

> Vulnere non pedibus te consequar. OVID.

There is a peculiar force and beauty in this figure: the word which signifies figuratively the principal subject, denotes it to be a cause by suggesting the effect.

3. A word proper to the cause employed figuratively to express the effect.

Boumque labores for corn. *Sorrow* or *grief* for tears.

> Again Ulysses veil'd his pensive head;
> Again unmann'd, a show'r of *sorrow* shed.

> Streaming *grief* his faded cheek bedew'd.

Blindness for darkness:

> Cæcis erramus in undis. *Æneid.* iii. 200.

There is a peculiar energy in this figure, similar to that in the former: the figurative name denotes the subject to be an effect by suggesting its cause.

4. Two things being intimately connected, the proper name of the one employed figuratively to signify the other.

Day for light. *Night* for darkness; and hence, A sudden night. *Winter* for a storm at sea:

> Interea magno misceri murmure pontum,
> Emissamque Hyemem sensit Neptunus.
> *Æneid.* i. 128.

This last figure would be too bold for a British writer, as a storm at sea is not inseparably connected with winter in this climate.

5. A word proper to an attribute, employed figuratively to denote the subject.

Youth and *beauty* for those who are young and beautiful:

> Youth and beauty shall be laid in dust.

Majesty for the king:

> What art thou, that usurp'st this time of night,
> Together with that fair and warlike form
> In which the *Majesty* of buried Denmark
> Did sometime march? *Hamlet*, act. i. sc. 1.

—Or

Figure.

———Or have ye chosen this place,
After the toils of battle to repose
Your weary'd *virtue?* *Paradise Lost.*

Verdure for a green field. *Summer*, l. 301.

Speaking of cranes,

The pigmy nations, wounds and death they bring,
And all the *war* descends upon the wing.
Iliad, book iii. l. 10.

Cool *age* advances venerably wise.
Iliad, book iii. l. 149.

The peculiar beauty of this figure arises from suggesting an attribute that embellishes the subject, or puts it in a stronger light.

6. A complex term employed figuratively to denote one of the component parts.

Funus for a dead body. *Burial* for a grave.

7. The name of one of the component parts instead of the complex term.

Tæda for a marriage. The *East* for a country situated east from us. *Jovis vestigia servat*, for imitating Jupiter in general.

8. A word signifying time or place, employed figuratively to denote what is connected with it.

Clime for a nation, or for a constitution of government: hence the expression, *Merciful clime*, *Fleecy winter*, for snow, *Seculum felix*.

9. A part for the whole.

The *pole* for the earth. The *head* for the person:

Triginta minas pro *capite* tuo dedi. PLAUTUS.

Tergum for the man:

Fugiens tergum. OVID.

Vultus for the man:

Jam fulgor armorum fugaces
Terret equos, equitumque vultus. HORAT.

Quis desiderio sit pudor aut modus
Tam chari *capitis?* HORAT.

Dumque virent *genua?* HORAT.

Thy growing virtues justify'd my cares,
And promis'd comfort to my *silver hairs*.
Iliad, book ix. l. 616.

———Forthwith from the pool he rears
His mighty *stature*. *Paradise Lost.*

The silent *heart* which grief assails. PARNEL.

The peculiar beauty of this figure consists in marking that part which makes the greatest figure.

10. The name of the container, employed figuratively to signify what is contained.

Grove for the birds in it; Vocal *grove*. *Ships* for the seamen; Agonizing *Ships*. *Mountains* for the sheep pasturing upon them; Bleating *mountains*. *Zacynthus*, *Ithaca*, &c. for the inhabitants; *Ex mœstis domibus*. Livy.

11. The name of the sustainer, employed figuratively to signify what is sustained.

Altar for the sacrifice. *Field* for the battle fought upon it; Well-fought *field*.

12. The name of the materials, employed figuratively to signify the things made of them.

Ferrum for *gladius*.

13. The names of the Heathen deities, employed figuratively to signify what they patronize.

Jove for the air, *Mars* for war, *Venus* for beauty, *Cupid* for love, *Ceres* for corn, *Neptune* for the sea, *Vulcan* for fire.

This figure bestows great elevation upon the subject; and therefore ought to be confined to the higher strains of poetry.

TAB. II. *Attributes expressed figuratively.*

1. When two attributes are connected, the name of the one may be employed figuratively to express the other.

Purity and virginity are attributes of the same person: hence the expression, *Virgin* snow, for pure snow.

2. A word signifying properly an attribute of one subject, employed figuratively to express a resembling attribute of another subject.

Tottering state. *Imperious* ocean. *Angry* flood. *Raging* tempest. *Shallow* fears.

My sure divinity shall bear the shield,
And edge thy sword to *reap* the glorious field.
Odyssey, book xx. l. 61.

Black omen, for an omen that portends bad fortune.

Ater omen. VIRGIL.

The peculiar beauty of this figure arises from suggesting a comparison.

3. A word proper to the subject, employed to express one of its ottributes.

Mens for *intellectus*. *Mens* for a resolution:

Istam, oro, exue mentem.

4. When two subjects have a resemblance by a common quality, the name of the one subject may be employed figuratively to denote that quality in the other:

Summer life for agreeable life.

5. The name of the instrument made to signify the power of employing it:

———Melpomene, cui liquidam pater
Vocem cum *cithara* dedit.

The ample field of figurative expression displayed in these tables, affords great scope for reasoning. Several of the observations relating to metaphor†, are applicable to figures of speech: these shall be slightly retouched, with some additions peculiarly adapted to the present subject.

† See Metaphor.

1. As the figure under consideration is built upon relation, we find from experience, and it must be obvious from reason, that the beauty of it depends on the intimacy of the relation between the figurative and proper sense of the word. A slight resemblance, in particular, will never make this figure agreeable: the expression, for example, *Drink down a secret*, for listening to a secret with attention, is harsh and uncouth, because there is scarce any resemblance between *listening* and *drinking*. The expression *weighty crack*, used by Ben Johnson for *loud crack*, is worse if possible; a loud sound has not the slightest resemblance to a piece of matter that is weighty.

Phemius! let acts of gods, and heroes old,
What ancient bards in hall and bow'r have told,
Attemper'd

Figure.

Attemper'd to the lyre, your voice employ,
Such the pleas'd *ear will drink* with silent joy.
Odyssey, book i. l. 433.

Strepitumque exterritus *hausit.*
Æneid, book vi. l. 559.

——————————Write, my queen,
And with mine eyes I'll *drink* the words you send.
Cymbeline, act i. sc. 2.

As thus th' effulgence tremulous I *drink.*
Summer, l. 1684.

Neque *audit* currus habenas.
Georg. book i. l. 514.

O prince! (Lycaon's valiant son reply'd),
As thine the steeds, be thine the task to guide.
The horses practis'd to their lord's command,
Shall *hear* the rein, and answer to thy hand.
Iliad, book v. l. 288.

The following figures of speech seem altogether wild and extravagant, the figurative and proper meaning having no connexion whatever. *Moving* softness, Freshness *breathes*, *Breathing* prospect, *Flowing* spring, *Dewy* light, *Lucid* coolness, and many others of this false coin, may be found in Thomson's *Seasons.*

2. The proper sense of the word ought to bear some proportion to the figurative sense, and not soar much above it, nor sink much below it. This rule, as well as the foregoing, is finely illustrated by Vida, *Poet.* book iii. l. 148.

3. In a figure of speech, every circumstance ought to be avoided that agrees with the proper sense only, not with the figurative sense: for it is the latter that expresses the thought, and the former serves for no other purpose but to make harmony:

Zacynthus green with ever-shady groves,
And Ithaca, presumptuous boast their loves;
Obtruding on my choice a second lord,
They press the Hymenean rite abhorr'd.
Odyssey, book xix. l. 152.

Zacynthus here standing figuratively for the inhabitants, the description of the island is quite out of place: it puzzles the reader, by making him doubt whether the word ought to be taken in its proper or figurative sense.

——————————Write, my queen,
And with mine eyes I'll drink the words you send,
Though ink be made of gall.
Cymbeline, act. i. sc. 2.

The disgust one has to drink ink in reality, is not to the purpose where the subject is drinking ink figuratively.

4. To draw consequences from a figure of speech, as if the word were to be understood literally, is a gross absurdity; for it is confounding truth with fiction:

Be Moubray's sins so heavy in his bosom,
That they may break his foaming courser's back,
And throw the rider headlong in the lists,
A caitiff recreant to my cousin Hereford.
Richard II. act. i. sc. 3.

Sin may be imagined heavy in a figurative sense: but weight in a proper sense belongs to the accessory only; and therefore to describe the effects of weight, is to desert the principal subject, and to convert the accessory into a principal:

Figure.

Cromwell. How does your Grace?
Wolsey. Why, well;
Never so truly happy, my good Cromwell.
I know myself now, and I feel within me
A peace above all earthly dignities,
A still and quiet conscience. The king has cur'd me,
I humbly thank his Grace: and, from these shoulders,
These ruin'd pillars, out of pity, taken
A load would sink a navy, too much honour.
Henry VIII. act. iii. sc. 6.

Ulysses speaking of Hector—

I wonder now how yonder city stands,
When we have here the base and pillar by us.
Troilus and Cressida, Act. iv. Sc. 9.

Othello. No; my heart is turned to stone: I strike it, and it hurts my hand. *Othello*, act. iv. sc. 5.

Not less, even in this despicable now,
Than when my name fill'd Afric with affrights,
And froze your hearts beneath your torrid zone.
Don Sebastian King of Portugal, act. i.

How long a space, since first I lov'd, it is!
To look into a glass I fear,
And am surpris'd with wonder, when I miss
Gray hairs and wrinkles there.
COWLEY, vol. i. p. 86.

I chose the flourishing'st tree in all the park,
With freshest boughs and fairest head;
I cut my love into its gentle bark,
And in three days behold 'tis dead;
My very written flames so violent be,
They've burnt and wither'd up the tree.
COWLEY, vol. i. p. 136.

Ah, mighty Love, that it were inward heat
Which made this precious limbeck sweat!
But what, alas! ah, what does it avail,
That she weeps tears so wond'rous cold,
As scarce the ass's hoof can hold,
So cold, that I admire they fall not hail!
COWLEY, vol. i. p. 132.

Such a play of words is pleasant in a ludicrous poem.

Almeria. O Alphonso, Alphonso!
Devouring seas have wash'd thee from my sight,
No time shall raze thee from my memory:
No, I will live to be thy monument:
The cruel ocean is no more thy tomb;
But in my heart thou art interr'd.
Mourning Bride, act i. sc. 1.

This would be very right, if there were any inconsistence in being interred in one place really, and in another place figuratively.

From considering, that a word used in a figurative sense suggests at the same time its proper meaning, we discover a fifth rule, That we ought not to employ a word in a figurative sense, the proper sense of which is inconsistent or incongruous with the subject: for every inconsistency, and even incongruity, though in the expression only and not real, is unpleasant:

Interea

Figure.

Interea genitor Tyberini ad fluminis undam,
Vulnera *ficcabat* lymphis———

Æneid, book x. l. 833.

Tres adeo incertos cæca caligine *foles*
Erramus pelago, totidem fine fidere noctes.

Æneid, book iii. l. 203.

The foregoing rule may be extended to form a fixth, That no epithet ought to be given to the figurative fenfe of a word that agrees not alfo with its proper fenfe:

———————Dicat Opuntiæ
Frater Megillæ, quo *beatus*
Vulnere. HORAT. *Carm.* lib. i. ode 27.

Parcus deorum cultor, et infrequens,
Infanientis dum fapientiæ
Confultus erro. HORAT. *Carm.* lib. i. ode 54.

Seventhly, The crowding into one period or thought different figures of fpeech, is not lefs faulty than crowding metaphors in that manner: the mind is diftracted in the quick tranfition from one image to another, and is puzzled inftead of being pleafed:

I am of ladies moft deject and wretched,
That fuck'd the honey of his mufic vows. *Hamlet.*

My bleeding bofom fickens at the found.

Odyffey, book i. l. 439.

———————Ah mifer,
Quanta laboras in *Charybdi!*
Digne puer meliore *flamma*.
Quæ faga, quis te folvere Theffalis
Magus *venenis*, qua poterit Deus:
Vix illigatum tetriformi
Pegafus expediet *Chimera*.

HORAT. *Carm.* lib. i. ode 27.

Eighthly, If crowding figures be bad, it is ftill worfe to graft one figure upon another: For inftance,

While his keen falchion drinks the warriors lives.

Iliad, book xi. l. 211.

A falchion drinking the warriors blood, is a figure built upon refemblance, which is paffable. But then in the expreffion, *lives* is again put for *blood;* and by thus grafting one figure upon another, the expreffion is rendered obfcure and unpleafant.

Ninthly, Intricate and involved figures, that can fcarce be analyzed, or reduced to plain language, are leaft of all tolerable:

Votis incendimus aras. *Æneid*, book iii. l. 279.

———Onerentque caniftris
Dona laboratæ Cereris *Æneid*, book viii. l. 180.

Vulcan to the Cyclops:

Arma acri facienda viro: nunc viribus ufus,
Nunc manibus rapidis, omni nunc arte magiftra:
Præcipitate moras. *Æneid*, book viii. l. 441.

———Huic gladio, perque ærea fcuta,
Per tunicam fqualentem auro, latus *haurit* apertum.

Æneid, book x. l. 313.

Scriberis Vario fortis, et hoftium
Victor, Mæonii carminis *alite*.

HORAT. *Carm.* lib. i. ode 6.

3

Else fhall our fates be number'd with the dead.

Iliad, book v. l. 294.

Figure.

Commutual death the fate of war confounds.

Iliad, book viii. l. 85, and book xi. l. 117.

Speaking of Proteus.

Inftant he wears, elufive of the rape,
The mimic force of every favage fhape.

Odyffey, book iv. l. 563.

Rolling convulfive on the floor, is feen
The piteous object of a proftrate queen.

Ibid. book iv. l. 652.

The mingling tempeft weaves its gloom.

Autumn, l. 337.

A various fweetnefs fwells the gentle race.

Ibid. l. 640.

The diftant waterfall fwells in the breeze.

Winter, l. 738.

In the tenth place, When a fubject is introduced by its proper name, it is abfurd to attribute to it the properties of a different fubject to which the word is fometimes applied in a figurative fenfe:

Hear me, Oh Neptune! thou whofe arms are hurl'd
From fhore to fhore, and gird the folid world.

Odyffey, book ix. l. 617.

Neptune is here introduced perfonally, and not figuratively, for the ocean: the defcription therefore, which is only applicable to the latter, is altogether improper.

It is not fufficient that a figure of fpeech be regularly conftructed, and be free from blemifh: it requires tafte to difcern when it is proper, when improper; and tafte perhaps is our only guide. One, however, may gather from reflections and experience, that ornaments and graces fuit not any of the difpiriting paffions, nor are proper for expreffing any thing grave and important. In familiar converfation, they are in fome meafure ridiculous: Profpero, in the *Tempeft*, fpeaking to his daughter Miranda, fays,

The fringed curtains of thine eyes advance,
And fay what thou feeft yond.

No exception can be taken to the juftnefs of the figure; and circumftances may be imagined to make it proper: but it is certainly not proper in familiar converfation.

In the laft place, Though figures of fpeech have a charming effect when accurately conftructed and properly introduced, they ought, however, to be fcattered with a fparing hand; nothing is more lufcious, and nothing confequently more fatiating, than redundant ornaments of any kind.

FIGURE is ufed, in *Theology*, for the myfteries reprefented or delivered obfcurely to us under certain types, or actions in the Old Teftament. Thus manna is held a figure or type of the eucharift; and the death of Abel a figure of the fuffering of Chrift.

Many divines and critics contend, that all the actions, hiftories, ceremonies, &c. of the Old Teftament, are only figures, types, and prophecies, of what was to happen under the New. The Jews are fuppofed to to have had the figures or ſhadows, and we the ſubſtance.

Figure is alſo applied in a like ſenſe to profane matters; as the emblems, enigmas, fables, ſymbols, and hieroglyphics, of the ancients.

FIGURED, in general, ſomething marked with figures.

The term *figured* is chiefly applied to ſtuffs, whereon the figures of flowers, and the like, are either wrought or ſtamped.

Figured, in *Muſic*, is applied either to ſimple notes or to harmony: to ſimple notes, as in theſe words *figured baſs*, to expreſs a baſs whoſe notes carrying chords are ſubdivided into many other notes of leſſer value: to harmony, when, by ſuppoſition and in a diatonic procedure, other notes than thoſe which form the chord are employed. See Supposition.

To *figure* is to paſs ſeveral notes for one; to form runnings or variations; to add ſome notes to the air, in whatever manner it be done; in ſhort, it is to give to harmonious ſounds a figure of melody, by connecting them with other intermediate ſounds.

FILAGO, a genus of plants, belonging to the ſyngeneſia claſs; and in the natural method ranking under the 49th order, *Compoſitæ*. See Botany *Index*.

FILAMENT, in *Anatomy*, *Natural Hiſtory*, &c. a term uſed in the ſame ſenſe with fibre, for thoſe fine threads whereof the fleſh, nerves, ſkin, plants, roots, &c. are compoſed. See Fibre.

Vegetable Filaments form a ſubſtance of great uſe in the arts and manufactures; furniſhing thread, cloth, cordage, &c.

For theſe purpoſes the filamentous parts of the *Cannabis* and *Linum*, or hemp and flax, are employed among us †. But different vegetables have been employed in different countries for the ſame uſes. Putrefaction deſtroys the pulpy or fleſhy matter, and leaves the tough filaments entire: By putrefying the leaf of a plant in water, we obtain the fine flexile fibres, which conſtituted the baſis of the ribs and minute veins, and which now form as it were a ſkeleton of the leaf. Alkaline lixivia, in ſome degree, produce ſimilar effects to putrefaction.

† See *Hemp* and *Flax*.

The Sieur de Flacourt, in his hiſtory of Madagaſcar, relates, that different kinds of cloth are prepared in that iſland from the filaments of the bark of certain trees boiled in ſtrong lye; that ſome of theſe cloths are very fine, and approach to the ſoftneſs of ſilk, but in durability come ſhort of cotton; that others are coarſer and ſtronger, and laſt thrice as long as cotton; and that of theſe the ſails and cordage of his veſſel were made. See alſo the article Bark.

The ſame author informs us, that the ſtalks of nettles are uſed for the like purpoſes in his own country, France. And Sir Hans Sloane relates, in one of his letters to Mr Ray, that he has been informed by ſeveral, that muſlin and callico, and moſt of the Indian linens, are made of nettles.

In ſome of the Swediſh provinces, a ſtrong kind of cloth is ſaid to be prepared from hop ſtalks: and in the tranſactions of the Swediſh Academy for the year 1750, there is an account of an experiment made in conſequence of that report. Of the ſtalks, gathered in autumn, about as many were taken as equalled in bulk a quantity of flax that would have produced a pound after preparation. The ſtalks were put into water, and kept covered therewith during the winter. In March they were taken out, dried in a ſtove, and dreſſed as flax. The prepared filaments weighed nearly a pound, and proved fine, ſoft, and white: They were ſpun and woven into ſix ells of fine ſtrong cloth. The author, Mr Shiſler, obſerves, that hop ſtalks take much longer time to rot than flax; and that, if not fully rotted, the woody part will not ſeparate, and the cloth will neither prove white nor fine.

Hemp, flax, and all other vegetable filaments, and thread or cloth prepared from them, differ remarkably from wool, hair, ſilk, and other animal productions, not only in the principles into which they are reſoluble by fire, but likewiſe in ſome of their more intereſting properties, particularly in their diſpoſition to imbibe colouring matters; ſundry liquors, which give a beautiful and durable dye to thoſe of the animal, giving no ſtain at all to thoſe of the vegetable kingdom.

A ſolution of copper in aquafortis, which had been changed blue by an addition of volatile ſpirit, on being mixed with a little ſolution of tin, became turbid and greeniſh. Pieces of white ſilk and flannel boiled, without any previous preparation, in this mixture, received a bright deep yellow dye; whilſt pieces of linen, prepared and unprepared, came out as colourleſs as they were put in.

Fiſhing nets are uſually boiled with oak bark or other like aſtringents, which render them more laſting. Thoſe made of flax receive from this decoction a browniſh colour, which, by the repeated alternations of water and air, is in a little time diſcharged, whilſt the fine gloſſy brown, communicated by the ſame means to ſilken nets, permanently reſiſts both the air and water, and ſtands as long as the animal filaments themſelves. In like manner the ſtain of ink, or the black dye from ſolutions of iron, mixed with vegetable aſtringents, proves durable in ſilk and woollen; but from linen, the aſtringent matter is extracted by waſhing, and only the yellow iron mould remains.

The red decoction of cochineal, which, heightened with a little ſolution of tin, gives the fiery ſcarlet dye to wool or ſilk that have been previouſly impregnated with ſolution of tartar, makes no impreſſion upon linen or cotton prepared in the ſame manner. M. du Fay informs us, in the Memoirs of the French Academy for the year 1737, that having prepared a mixed cloth whoſe warp was of wool and the woof of cotton, and thoroughly blended the two together by fulling, he ſtill found the cotton to reſiſt the action of the ſcarlet liquor, and the wool to receive the ſame colour from it as wool by itſelf, the ſtuff coming out all over marbled fiery and white.

Many other inſtances of this kind are known too well to the callico printer; whoſe grand deſideratum it is, to find means of making linen receive the ſame colours that wool does. The phyſical cauſe of the difference is wholly unknown; and indeed, of the theory of dyes in general, we know as yet extremely little. (See Dyeing.) Are animal filaments tubular, and the colouring atoms received within them? Are vegetable filaments ſolid, and the colour depoſited on the ſurface? Or, does not their different ſuſceptibility of colour depend rather on the different intrinſic properties of the two? There are many inſtances of a like diverſity, even

Filaments || File.

in the metallic kingdom, where a mechanical difference in texture can ſcarcely be preſumed to be the cauſe: Thus ſilver receives a deep ſtain from ſulphureous or putrid vapours, or the yolk of a boiled egg, which have no effect upon tin.

FILAMENTS, among botaniſts. See BOTANY *Index*.

FILANDERS, in falconry, a diſeaſe in hawks, &c. conſiſting of filaments or ſtrings of blood coagulated; and occaſioned by a violent rupture of ſome vein, by which the blood, extravaſating, hardens into theſe figures, and incommodes the reins, hips, &c.

FILANDERS, are alſo worms as ſmall as thread, and about an inch long, that lie wrapt up in a thin ſkin or net, near the reins of a hawk, apart from either gut or gorge.

This malady is known by the hawk's poverty; by ruffling her tail; by her ſtraining the fiſt, or perch, with her pounces; and laſtly, by croaking in the night, when the filanders prick her. The diſeaſe proceeds from bad food; and muſt be remedied in time, to prevent its ſpreading over the whole body, and deſtroying the bird. Theſe muſt not be killed as other worms are, for fear of impoſthumes from their corruption, being incapable of paſſing away with the hawk's meat. They muſt only be ſtupified, to prevent their being offenſive; and this is done by giving the hawk a clove of garlic, after which ſhe will feel nothing of the filanders for 40 days. It will be prudent in the falconer, when he obſerves the hawk poor and low, to give her a clove of garlic once a month by way of prevention.

FILBERT, or FILBERD, the fruit of the corylus, or hazel. See CORYLUS, BOTANY *Index*.

FILE, among mechanics, a tool uſed in metal, &c. in order to ſmooth, poliſh, or cut.

This inſtrument is of iron or forged ſteel, cut in little furrows, with chiſſels and a mallet, this and that way, and of this or that depth, according to the grain or touch required. After cutting the file, it muſt be tempered with a compoſition of chimney ſoot, very hard and dry, diluted and wrought up with urine, vinegar, and ſalt, the whole being reduced to the conſiſtence of muſtard. Tempering the files conſiſts in rubbing them over with this compoſition, and covering them in loam; after which they are put in a charcoal fire, and taken out by that time they have acquired a cherry colour, which is known by a ſmall rod of the ſame ſteel put in along with them. Being taken out of the fire, they are thrown into cold ſpring water; and, when cold, they are cleaned with charcoal and a rag; and being clean and dry, are kept from ruſt by laying them up in wheat bran. Iron files require more heating than ſteel ones. Files are of different forms, ſizes, cuts, and degrees of fineneſs, according to the different uſes and occaſions for which they are made. See FILING.

FILE, in the art of war, a row of ſoldiers, ſtanding one behind another, which is the depth of the battalion or ſquadron. The files of a battalion of foot are generally three deep; as are ſometimes thoſe of a ſquadron of horſe. The files muſt be ſtraight and parallel one to another.

FILE, in *Law*, a thread, ſtring, or wire, upon which writs and other exhibits in courts and offices are faſtened or filed, for the more ſafe keeping, and ready turning to the ſame. A file is a record of the court; and the filing of a proceſs of a court makes it a record of it. An original writ may be filed after judgement given in the cauſe, iſſued forth before; declarations, &c. are to be filed, and affidavits muſt be filed, ſome before they are read in court, and ſome preſently when read in court. Before filing a record removed by *certiorari*, the juſtices of B. R. may refuſe to receive it, if it appears to be for delay, &c.; and remand it back for the expedition of juſtice: but if the *certiorari* be once filed, the proceedings below cannot be revived. An indictment, &c. cannot be amended after it is filed.

Filial.

FILIAL, ſomething belonging to the relation of ſon. See SON.

The divines uſually diſtinguiſh between a *ſervile* and a *filial* fear. The moſt abandoned may have a ſervile fear of God, ſuch as that of a ſlave to his maſter; but not a filial fear, i. e. a fear reſulting from love and reſpect. See FEAR.

FILIAL Piety, the affectionate attachment of children to their parents; including in it love, reverence, obedience, and relief. Theſe are duties prompted equally by nature and by gratitude, independent of the injunctions of religion. For where ſhall we find the perſon who hath received from any one benefits ſo great or ſo many, as children from their parents? And it may be truly ſaid, that if perſons are undutiful to their parents, they ſeldom prove good to any other relation. Profane hiſtory furniſhes many fine examples of this amiable virtue; a few of which we ſhall ſelect, according to the plan obſerved in other ſimilar articles.

1. The Roman dictator T. Manlius having exerciſed great cruelty over the citizens, was cited at the expiration of his office to anſwer for his conduct. Among other things that were laid to his charge, he was accuſed of treating with barbarity one of his own ſons. Manlius, according to Livy, had no other cauſe of complaint againſt this ſon than his having an impediment in his ſpeech. For this reaſon he was baniſhed far from the city, from his home, and the company of thoſe of his own age and fortune, and condemned to ſervile works. All were highly exaſperated againſt ſuch inhuman conduct, except the ſon himſelf, who, under the greateſt concern that he ſhould furniſh matter of accuſation againſt his father, reſolved upon a moſt extraordinary method to relieve him. One morning, without appriſing any body, he came to the city armed with a dagger, and went directly to the houſe of the tribune Pomponius, who had accuſed his father. Pomponius was yet in bed. Young Manlius ſent up his name, and was immediately admitted by the tribune, who did not doubt but he was come to diſcover to him ſome new inſtances of his father's ſeverity. But Manlius, as ſoon as he was left alone with the tribune, drew out his dagger, and preſented it to his breaſt; declaring he would ſtab him that moment if he did not ſwear in the form he ſhould dictate, "Never to hold the aſſembly of the people for accuſing his father." Pomponius, who ſaw the dagger glittering at his breaſt, himſelf alone without arms, Liv. l. 7. c. 4. 5. and attacked by a robuſt young man, full of a bold confidence in his own ſtrength, took the oath demanded of him; and afterwards confeſſed with a kind of complacency in the thing, and a ſincerity which ſufficiently

Filial.

ciently argued he was not sorry for what he had done, that it was that violence which obliged him to desist from his design.

2. Among the multitude of persons who were proscribed under the second triumvirate of Rome, were the celebrated orator Cicero and his brother Quintus. The fate of the former, in endeavouring to make his escape, is related under the article CICERO. The latter found means to conceal himself so effectually at home, that the soldiers could not find him. Enraged at their disappointment, they put his son to the torture, in order to make him discover the place of his father's concealment; but filial affection was proof against the most exquisite torments. An involuntary sigh, and sometimes a deep groan, was all that could be extorted from the youth. His agonies were increased; but with amazing fortitude he still persisted in his resolution of not betraying his father. Quintus was not far off; and it may be imagined better than can be expressed, how his heart must have been affected with the sighs and groans of a son expiring in tortures to save his life. He could bear it no longer; but quitting the place of his concealment, he presented himself to the assassins, begging of them to put him to death, and dismiss the innocent youth, whose generous behaviour the triumvirs themselves, if informed of the fact, would judge worthy of the highest approbation. But the inhuman monsters, without being the least affected with the tears either of the father or the son, answered, that they both must die; the father because he was proscribed, and the son because he had concealed his father. Then a new contest of tenderness arose who should die first; but this the assassins soon decided, by beheading them both at the same time.—This anecdote is related by Appian, Dio, Plutarch, Valerius Maximus, and other historians.

Plut. in vita Pomp.

3. Cinna, who scrupled no attempt, how atrocious soever, which could serve his purpose, undertook to get Pomponius Strabo murdered in his tent; but his son saved his life, which was the first remarkable action of Pompey the Great. The treacherous Cinna, by many alluring promises, had gained over one Terentius, a confidant of Pompey's, and prevailed on him to assassinate the general, and seduce his troops. Young Pompey being informed of this design a few hours before it was to be put in execution, placed a faithful guard round the prætorium; so that none of the conspirators could come near it. He then watched all the motions of the camp, and endeavoured to appease the fury of the soldiers, who hated the general his father, by such acts of prudence as were worthy of the oldest commanders. However, some of the mutineers having forced open one of the gates of the camp, in order to desert to Cinna, the general's son threw himself flat on his back in their way, crying out, that they should not break their oath and desert their commander, without treading his body to death. By this means he put a stop to their desertion, and afterwards wrought so effectually upon them by his affecting speeches and engaging carriage, that he reconciled them to his father.

Q. Curtius.

4. Olympias, Alexander's own mother, was of such an unhappy disposition, that he would never allow her to have any concern in the affairs of the government. She used frequently to make very severe complaints on that account; but he always submitted to her ill humour with great mildness and patience. Antipater, one of his friends, having one day written a long letter against her to the king then absent, the latter, after reading it, replied, "Antipater does not know that one single tear shed by a mother will obliterate ten thousand such letters as this." A behaviour like this, and such an answer, show at one and the same time, that Alexander was both an affectionate son and an able politician.

5. Epaminondas is universally acknowledged to have been one of the greatest generals and one of the best men which Greece ever produced. Before him the city of Thebes was not distinguished by any memorable action, and after him it was not famous for its virtues, but its misfortunes, till it sunk into its original obscurity; so that it saw its glory take birth and expire with this great man. The victory he obtained at Leuctra had drawn the eyes and admiration of all the neighbouring people upon Epaminondas, who looked upon him as the support of Thebes, as the triumphant conqueror of Sparta, as the deliverer of Greece: in a word, as the greatest man, and the most excellent captain, that ever was in the world. In the midst of this universal applause, so capable of making the general of an army forget the man for the victor, Epaminondas, little sensible to so affecting and so deserved a glory, "My joy (said he) arises from my sense of that which the news of my victory will give my father and my mother."

6. Among an incredible number of illustrious persons who were falsely accused and put to death by Nero, was one Bareas Soranus; a man, as Tacitus informs us, of singular vigilance and justice in the discharge of his duty. During his confinement, his daughter Servilia was apprehended and brought into the senate, and there arraigned. The crime laid to her charge was, that she had turned into money all her ornaments and jewels, and the most valuable part of her dress, to defray the expence of consulting magicians. To this the young Servilia, with tears, replied, That she had indeed consulted magicians, but the whole of her inquiry was to know whether the emperor and senate would afford protection and safety to her dear and indulgent parent against his accusers. "With this view (said she) I presented the diviners, men till now utterly unknown to me, with my jewels, apparel, and the other ornaments peculiar to my quality, as I would have presented my blood and life, could my blood and life have procured my father's liberty. But whatever this my proceeding was, my unfortunate father was an utter stranger to it; and if it is a crime, I alone am the delinquent." She was, however, together with her father, condemned to die; but in what manner, history is silent. [Vid. *Taciti Annales*, lib. vi. cap. 20.]

7. Valerius Maximus † likewise relates a very singular fact upon this subject. A woman of illustrious birth had been condemned to be strangled. The Roman prætor delivered her up to the triumvir, who caused her to be carried to prison, in order to her being put to death. The gaoler, who was ordered to execute her, was struck with compassion, and could not resolve to kill her. He chose therefore to let her die of hunger. Besides which, he suffered her daughter to

† Lib. v. 4. *Plinii Hist.* lib. vii. 36.

to fee her in prifon; taking care, however, that fhe brought her nothing to eat. As this continued many days, he was furprifed that the prifoner lived fo long without eating; and fufpecting the daughter, upon watching her, he difcovered that fhe nourifhed her mother with her own milk. Amazed at fo pious, and at the fame time fo ingenious an invention, he told the fact to the triumvir, and the triumvir to the prætor, who believed the thing merited relating in the affembly of the people. The criminal was pardoned, and a decree was paffed that the mother and daughter fhould be fubfifted for the reft of their lives at the expence of the public.

The fame author gives a fimilar inftance of filial piety in a young woman named Xantippe to her aged father Cimonus, who was likewife confined in prifon, and which is univerfally known by the name of the *Roman Charity*. Both thefe inftances appeared fo very extraordinary and uncommon to that people, that they could only account for them, by fuppofing that the love of children to their parents was the firft law of nature. *Putaret aliquis* (fays our author) *hoc contra naturam factum effe, nifi prima naturæ lex effet diligere parentes.*

In addition to the foregoing examples, we may refer to the article ÆTNA, where a very noble inftance of filial piety is taken notice of. See alfo the article PIETAS.

FILIBEG, or PHILIBEG. See PHILIBEG.

FILICACIA, VINCENT, a celebrated Italian poet, was born at Florence in 1642. He was a member of the Academy della Crufca and of that of the Arcadi, and became fecretary to the duke of Tufcany. He died in 1707. His poems are much efteemed for the delicacy and noblenefs of their fentiments. Scipio de Filicacia, his fon, had them all printed together, under the title of *Poefie Fofiano di Vicenzo da Filicacia*, in 1707, 4to.

FILICES, (from *filum* "a thread," *quafi filatim incifa*), FERNS; one of the feven tribes or families of the vegetable kingdom, according to Linnæus, by whom it is thus characterized: "having their fructification on the back fide of the frondes." They conftitute the firft order in the clafs cryptogamia; and confift of 16 genera, which are divided into *fructificationes, fpicatæ, frondofæ, et radicales.* This order comprehends the entire 16th clafs of Tournefort, in whofe fyftem the filices make only a fingle genus, in the firft fection of the above-mentioned clafs.

FILICES, is alfo an order of plants in the *fragmenta methodi naturalis* of Linnæus. See BOTANY *Index*.

FILIGRANE, FILIGREE, or FILLAGREE, *Work*. See FILLAGREE.

FILING, one of the principal operations in fmithery, &c. fucceeding to forging. See FILE.

The coarfer cut files are always to be fucceeded by finer; and in all the kinds the rule is, to lean heavy on the file in thrufting it forward, becaufe the teeth of the file are made to cut forwards. But in drawing the file back again for a fecond ftroke, it is to be lightly lifted juft above the work, by reafon it cuts not coming back.

The rough or coarfe-toothed file (which, when large, is called a *rubber*) ferves to take off the unevenneffes of the work, left by the hammer in forging.

The baftard-toothed file is to take out too deep cuts, and file ftrokes made by the rough file. The fine-toothed file takes out the cuts or file-ftrokes the baftard file made; and the fmooth file thofe left by the fine file.

In this order, the files of feveral cuts are to fucceed each other till the work is as fmooth as it can be filed. After which it may be made yet fmoother with emery, tripoli, &c. See POLISHING.

FILIPENDULA, DROPWORT, a fpecies of fpiræa. See SPIRÆA, BOTANY *Index*.

FILIX, FERN. See FILICES, BOTANY *Index*.

FILLAGREE, FILIGREE, or FILIGRANE, *Work*, a kind of enrichment on gold or filver, wrought delicately, in manner of little threads or grains, or both intermixed. The word is compounded of *fil* or *filum*, "thread," and *granum*, "grain." In Latin it is called *filatim elaboratum opus, argentum, aurum.*

There is no manufacture in any part of the world, that has been more admired and celebrated, than the fine gold and filver fillagree of Sumatra. And what renders it a matter of greater curiofity is the coarfenefs of the tools employed in the workmanfhip, and which, in the hands of an European, would not be thought fufficiently perfect for the moft ordinary purpofes.—They are rudely and inartificially formed, by the goldfmith (*pandi*) from any old iron he can pick up. When you engage one of them to execute a piece of work, his firft requeft is ufually for a piece of iron hoop, to make his wire-drawing inftrument; an old hammer head, ftuck in a block, ferves for an anvil; and a pair of compaffes is often compofed of two old nails tied together at one end. The gold is melted in a piece of a *preeoo* or earthen rice-pot, or fometimes in a crucible of their own make, of ordinary clay. In general they ufe no bellows, but blow the fire with their mouths, through a joint of bamboo; and if the quantity of metal to be melted is confiderable, three or four perfons fit round their furnace, which is an old broken quallee or iron pot, and blow together. At Padang alone, where the manufacture is more confiderable, they have adopted the Chinefe bellows. Their method of drawing the wire differs but little from that ufed by European workmen. When drawn to a fufficient finenefs, they flatten it by beating it on their anvil; and when flattened, they give it a twift like that in the whalebone handle of a punch ladle, by rubbing it on a block of wood with a flat ftick. After twifting they again beat it on the anvil, and by thefe means it becomes flat wire with indented edges. With a pair of nippers they fold down the end of the wire, and thus form a leaf, or element of a flower in their work, which is cut off. The end is again folded and cut off, till they have got a fufficient number of leaves, which are all laid on fingly. Patterns of the flowers or foliage, in which there is not very much variety, are prepared on paper, of the fize of the gold plate on which the fillagree is to be laid. According to this, they begin to difpofe on the plate the larger compartments of the foliage, for which they ufe plain flat wire of a larger fize, and fill them up with the leaves before mentioned. To fix the work, they employ a gelatinous fubftance, made of the red-hot berry called *boca fago*, ground to a pulp on a rough ftone. This pulp they place on a young

Marfden's Account of Sumatra, p. 141.

young cocoa nut about the ſize of a walnut, the top and bottom being cut off. After the leaves have been all placed in order, and ſtuck on, bit by bit, a ſolder is prepared of gold filings and borax, moiſtened with water, which they ſtrew over the plate; and then putting it in the fire for a ſhort time, the whole becomes united. This kind of work on a gold plate, they call *carrang papan*: when the work is open, they call it *carrang trouſe*. In executing the latter, the foliage is laid out on a card, or ſoft kind of wood, and ſtuck on, as before deſcribed, with the ſago berry; and the work, when finiſhed, being ſtrewed over with their ſolder, is put into the fire, when the card or ſoft wood burning away, the gold remains connected. If the piece be large, they ſolder it at ſeveral times. In the manufacture of badjoo buttons, they firſt make the lower part flat, and having a mould formed of a piece of buffalo's horn, indented to ſeveral ſizes, each like one half of a bullet mould, they lay their work over one of theſe holes, and with a horn punch they preſs it into the form of the button. After this they complete the upper part. When the fillagree is finiſhed, they cleanſe it, by boiling it in water with common ſalt and alum, or ſometimes lime juice; and in order to give it that fine purple colour which they call *ſapo*, they boil it in water with brimſtone. The manner of making the little balls with which their works are ſometimes ornamented, is as follows: They take a piece of charcoal, and having cut it flat and ſmooth, they make in it a ſmall hole, which they fill with gold duſt, and this melted in the fire becomes a little ball. They are very inexpert at finiſhing and poliſhing the plain parts, hinges, ſcrews, and the like, being in this as much excelled by the European artiſts, as theſe fall ſhort of them in the fineneſs and minuteneſs of the foliage. The Chineſe alſo make fillagree moſtly of ſilver, which looks elegant, but wants likewiſe the extraordinary delicacy of the Malay work. The price of the workmanſhip depends upon the difficulty or uncommonneſs of the pattern. In ſome articles of uſual demand, it does not exceed one-third of the value of the gold; but in matters of fancy, it is generally equal to it.

FILLET, or FILET, in *Architecture*, denotes a little ſquare member or ornament uſed in divers places, and on divers occaſions, but generally as a ſort of corona over a greater moulding.

The fillet is the ſame with what the French call *reglet*, *bande*, and *bandelette;* the Italians *liſta* or *liſtella*.

FILLET, in *Heraldry*, a kind of orle or bordure, containing only a third or fourth part of the breadth of the common bordure. It is ſuppoſed to be withdrawn inwards, and is of a different colour from the field. It runs quite round, near the edge, as a lace over a cloak.

FILLET is alſo uſed for an ordinary drawn like the bar from the ſiniſter point of the chief acroſs the ſhield, in manner of a ſcarf; though it is ſometimes alſo ſeen in the ſituation of a bend, feſſe, croſs, &c.

According to Guillim, the fillet is a fourth part of the chief, and is placed in the chief point of the eſcutcheon.

FILLET is alſo uſed among painters, gilders, &c. for a little rule or reglet of leaf gold, drawn over certain mouldings; or on the edges of frames, pannels, &c. eſpecially when painted white, by way of enrichment.

FILLETS, in the *Manege*, are the loins of a horſe, which begin at the place where the hinder part of the ſaddle reſts.

FILLY, a term among horſe-dealers, to denote the female or male colt.

FILM, a thin ſkin or pellicle. In plants, it is uſed for that thin, woody ſkin, which ſeparates the ſeeds in the pods, and keeps them apart.

FILTER, or FILTRE, in *Chemiſtry*, &c. a piece of woollen cloth, linen, paper, or other matter, ſome of which are in the form of hollow inverted cones, uſed to filtrate or ſtrain liquors through. The filtre has the ſame uſe and effect with regard to liquids that the ſieve or ſearce has in dry matters.

Filters are of two ſorts. The firſt are ſimple pieces of paper or cloth, through which the liquor is paſſed without farther trouble. The ſecond are twiſted up like a ſkain or wick, and firſt wetted, then ſqueezed, and one end put in the veſſel that contains the liquor to be filtrated: the other end is to be out, and hang down below the ſurface of the liquor; by means hereof the pureſt part of the liquor diſtills drop by drop out of the veſſel, leaving the coarſer part behind. This filter acts as a ſyphon.

Water is freed from various impurities by means of baſins made of porous ſtones, which veſſels muſt be peculiarly beneficial in long voyages, and even upon land they are of conſiderable benefit, when none but ſtagnant waters are to be found, or ſprings iſſuing through clay.

A patent was granted in 1790 to a female potter, for inventing a compoſition to make filtering baſins, as a ſuccedaneum for that porous ſtone which is not every where to be found. She took four out of nine equal parts of tobacco-pipe clay, and five out of nine equal parts of ſea, river, or pit ſand, which ſhe uſed for making ſmall baſins ſufficient to contain one gallon of water. Her next proportions were equal parts of ſea, river, or pit ſand, and tobacco-pipe clay; her third proportions were three out of nine equal parts of tobacco-pipe clay; one out of nine equal parts of Stourbridge clay, or one out of nine equal parts of Windſor or other loam: and her fourth proportions were four out of eight equal parts of the burnt ground clay of which crucibles are made.

A patent was alſo granted to Mr Joſhua Collier of Southwark, for a moſt ingenious method of filtering and ſweetening water, oil, and every other liquid. The following is the contrivance, which combines the application of machinery with the antiſeptic properties of charcoal.

Fiſh oil is one of the liquids which he had particularly in view, to free it from every thing diſagreeable, either in taſte, ſmell, or colour, to accompliſh which he poured a quantity of oil into a convenient veſſel, heated to the temperature of 120° of Fahrenheit's thermometer, adding cauſtic mineral alkali of the ſpecific gravity of 1.25. He then agitated the mixture, afterwards allowing it to ſtand till the ſediment ſubſided; and then drew it off into another veſſel, with a ſufficient quantity of burnt charcoal finely powdered, and a ſmall quantity of diluted ſulphuric acid, to decompoſe the ſaponaceous matter ſtill ſuſpended in the oil, when the oil became

Filter.

came clear at the surface. He then agitated the contents of this vessel, and left the coaly, saline, and aqueous particles to subside; afterwards passing it through proper strainers, when it became quite transparent and fit for use.

The principle of the improved filtering machines consists in combining hydrostatic pressure with the mode of filtering *per ascensum*, which procures the peculiar advantage of causing the fluid and its sediment take opposite directions. The filtering surface remains the same, while the dimensions of the chamber in which the sediment is received may be varied. To adapt the machines to every purpose for which they are intended, chambers must be provided of various capacities, for the precipitated matter. The space required is very great with respect to the oil trade, and as all dimensions will be required occasionally, no particular limits can be fixed. For distilleries and breweries they may be smaller in proportion, and a very small chamber will be sufficient for domestic economy. If water is to be freed from noxious particles, it must be made to pass through an iron box in its way to the filtering chamber, and the box must contain charcoal finely powdered. The water is received into this box and delivered by two apertures, which are opened and closed by cocks.

Another part of the invention consists in filtering machines in the form of stills, in which charcoal may be repeatedly burnt after any fluid substances have passed through it, for the purpose of freeing them from noxious particles, or discharging their colouring matter.

To the filtering apparatus of Mr Collier, instruments are attached for discovering the comparative qualities of oils, which depend in some measure on their specific gravities; spermaceti oil, when compared with fish oils being as 875 to 920. To do this, a glass vessel of any shape most convenient is employed, with a glass bubble, and a thermometer. If the oil is pure, the bubble sinks, when the mercury rises to a particular standard. When spermaceti oil is impure, the bubble floats, though of the temperature required.

To determine the tendency of oils used for burning to congeal in cold weather, a freezing mixture may be put into a phial of thin glass, into which let a thermometer be immersed, and a single drop of the oil permitted to fall on the outside of the vessel, where it will instantly congeal. As the cold produced by the mixture decreases, let the temperature be observed by the thermometer at which the oil becomes fluid, and runs down the side of the glass.

The following is a short description of the apparatus contrived for this purpose. A (fig. 1. Plate CCXVII.) is the cistern, into which the water or other liquor to be filtered is put. B B, is a tube opening into the bottom of the cistern A, and bent along the bottom of the machine conveying the fluid into C C C the filtering chamber, which is covered with leather bound down round its circular rim, and through which leather the water is percolated. D D, The bason rising above the level of the chamber and receiving the filtered liquor. E, The spout by which it runs off into a pitcher or other vessel. F, Another spout furnished with a cock to draw off the foul water from the chamber when necessary. G G G, The air tube, which begins above the level of the chamber, is covered with a button, which saves the leather from being cut, and has a small lateral aperture for the air to be carried off. This pipe passes along the bottom and up the side, and rising above the level of the water in the cistern, is there closed, except a small lateral aperture through which the air escapes. H, A guard or rim with cross bars put over the leather to keep it from being forced up by the water. It is fastened down by means of two notches on opposite sides of the ground, by which it locks into two staples rivetted into the bottom of the bason. I, The lid sliding down to cover the water from dust, and suspended at pleasure by means of K K, two springs on each tube for that purpose. L M N O, A cylindrical box containing charcoal, which is connected with the above by means of the tube P, and a continuation of the tube B. L M, The water tube B continued below the charcoal apparatus, so that the fluid may pass through the same into the cylinder, from whence it enters the chambers at P, so as to be filtered through the leather as before described. R R, Collars which may be unscrewed at pleasure, so as to detach the charcoal apparatus whenever the charcoal requires to be purified by heat. SS, Two cocks to direct the fluid through the charcoal cylinder or immediately into the filtering chamber.

Fig. 2. A, A tub or cistern containing the oil to be filtered, and supplying a tube of sufficient height for the hydrostatic pressure to operate. B B, A main tube of wood, tin, leather, or cloth, to which any number of bags, C C, of the size and shape of corn sacks, or any convenient size or shape, may be connected. These are bound to D D D, straight double iron bars, furnished with a hinge at one end and a screw at the other, by opening which the bags may be emptied. F, A trough underneath, made to receive the filtered oil from the receivers E E E.

Fig. 3. A, A funnel, cask or cistern, into which the fluid is put which passes down. B, A tube fitted into the same, through which it enters. C, An iron still, or still of any other substance capable of sustaining heat, full of finely powdered and sifted charcoal, through the head of which the fluid passes into any receiver. D, A fire-place of any construction to drive over the fluid remaining interspersed among the charcoal, and also to purify the charcoal by an increase of temperature when required. E, A cock to let water into the flues to cool the apparatus for a subsequent operation.

Fig. 4. The trial glass with its thermometer.

Filter is also a charm, supposed to have a virtue of inspiring love. The word is derived from φιλτρον, which signifies the same thing, of φιλεω, *amo*, "I love."

The Greeks, when their love was without success, had several arts to procure the affections of their beloved. The Thessalian women were famous for their skill in this as well as other magical practices. The means whereby it was effected were of divers sorts; it was sometimes done by potions called φιλτρα, which are frequently mentioned in authors of both languages. Juvenal speak thus:

> *Hic magicus affert cantus, hic Thessala vendit*
> Philtra, *quibus valeant mentem vexare mariti.*

Their operations were violent and dangerous, and commonly deprived such as drank them of their reason. Plutarch

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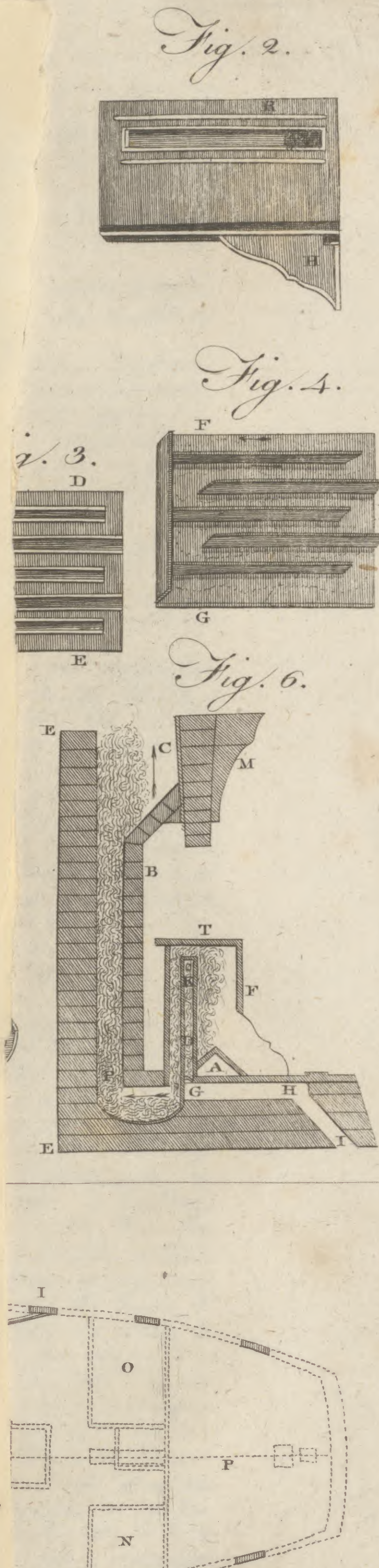

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Filter.

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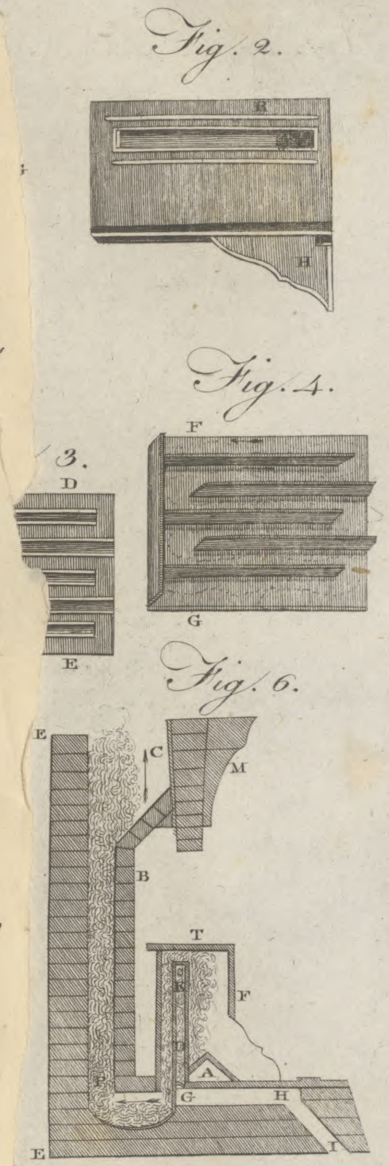

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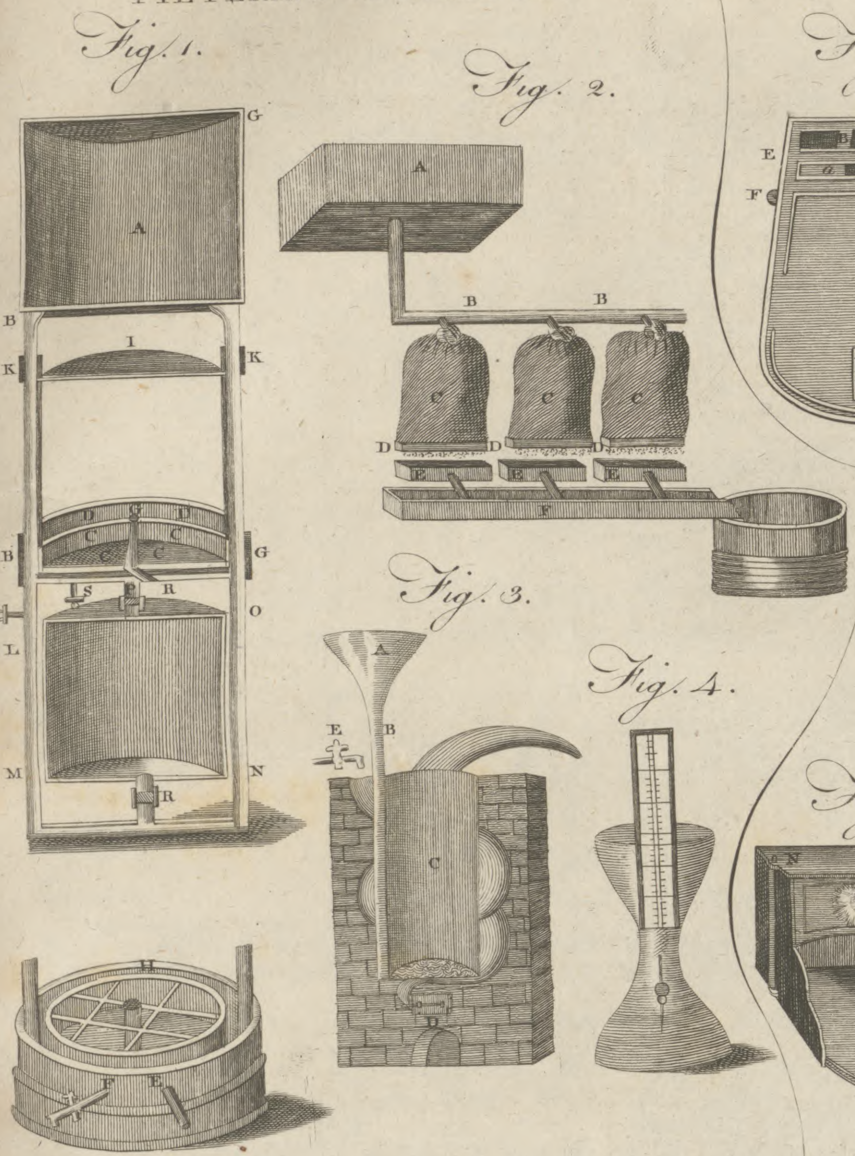

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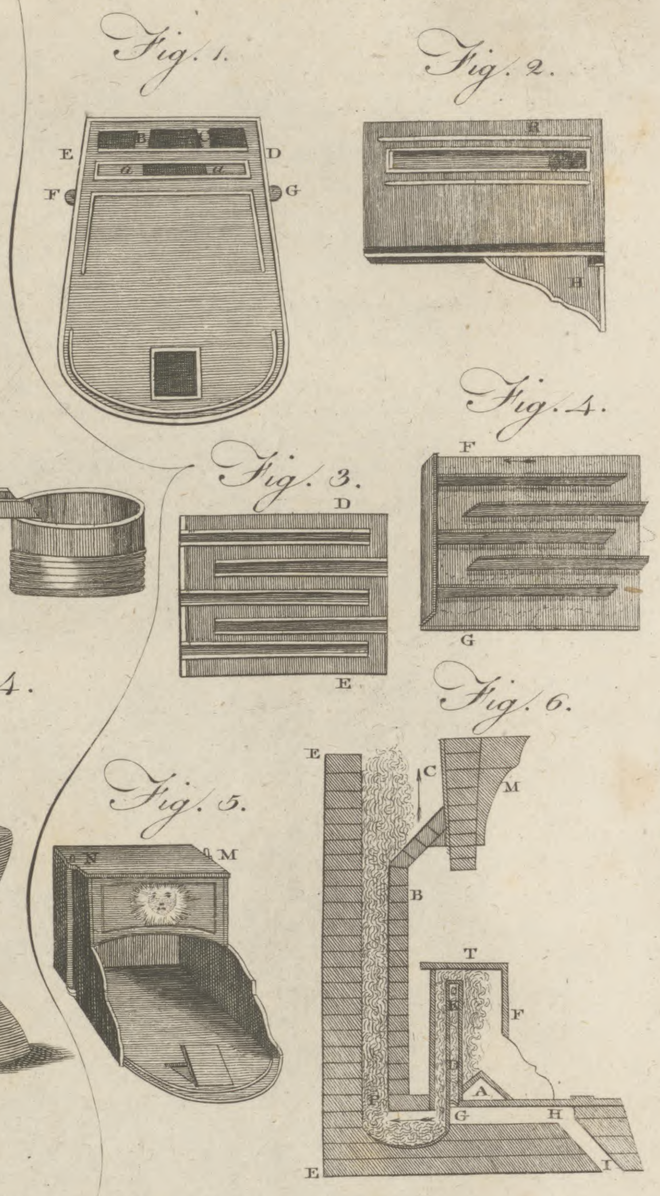

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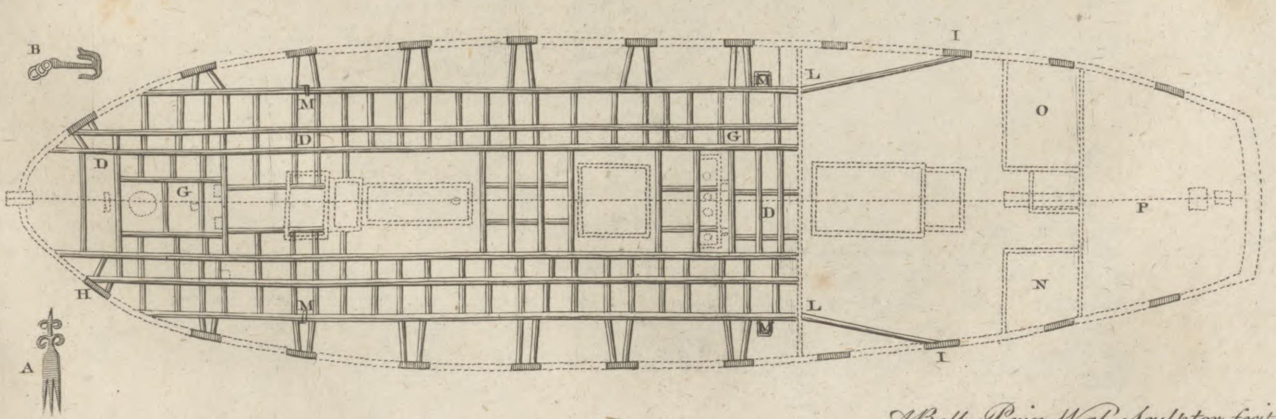

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Plutarch and Cornelius Nepos report, that Lucullus the Roman general first lost his reason, and afterwards his life, by one of them. Lucretius the poet ended his life by the same way; and Caius Caligula, as Suetonius reports, was driven into a fit of madness by a filter given him by his wife Cæsonia, which story is mentioned by the same poet. Ovid likewise assures us, that this was the usual effect of such potions.

The ingredients they were made of were of various sorts; several of which applied by themselves were thought effectual.

FILTRATION, the act of passing any liquor though a filtre, called also *colature*, *percolation*, and *transcolation*. See FILTRE.

FIMBRIÆ, *Fringes*. The extremities or borders of the tubæ Fallopianæ were formerly so called; the word signifying a *fringed border*, which that part resembles.

FIMBRIATED, in *Heraldry*, an ordinary with a narrow border or hem of another tincture.

FIN, in *Natural History*, a well known part of fishes, consisting of a membrane supported by rays, or little bony or cartilaginous ossicles.

The office of the fins has commonly been supposed to be analogous to that of feathers in fowls; and to assist the fish in its progressive motion, or swimming; but the later naturalists find this a mistake.

The tail is the great instrument of swimming: the fins only serve to keep the fish upright, and prevent vacillation or wavering. See ICHTHYOLOGY *Index*.

FINAL, in general, whatever terminates or concludes a thing; as *final* judgment, *final* sentence, &c.

FINAL Cause, is the end for which the thing is done. The final cause is the first thing in the intention of a person who does a thing; and the last in the execution. See CAUSE.

FINAL Letters, among the Hebrew grammarians, five letters so called, because they have a different figure at the end of words from what they have in any other situation.

FINAL, in *Geography*, a port town of Italy, subject to Genoa, and situated on the Mediterranean, about 37 miles south-west of that city. It was sold to the Genoese in 1713, by the emperor Charles VI.—E. Long. 9. 12. N. Lat. 44. 30.

FINANCES, in political economy, denote the revenues of a king or state: analogous to the treasury or exchequer of the English, and the fiscus of the Romans. The word is derived from the German *finantz*, "scraping, usury." Though Du Cange chooses rather to deduce it from the barbarous Latin *financia prestatio pecuniaria*.

Council of the FINANCES, under the former French government, corresponds to our lords commissioners of the treasury: the comptroller general of the *finances*, to our lord high treasurer, &c.

The French had a peculiar kind of figures, or numeral characters, which they call *chiffre de finance*.

FINCH-KIND, in *Ornithology*, a genus of birds known by the name of FRINGILLA. See FRINGILLA, ORNITHOLOGY *Index*.

FINCH, *Heneage*, earl of Nottingham, the son of Sir Heneage Finch, some time recorder of London, and of a younger branch of the Winchelsea family, was born in 1621. By his good parts and diligence, he became a noted proficient in the municipal laws; was made solicitor general by Charles II. on his restoration, and was very active in the prosecution of the regicides. In 1670 he was appointed attorney general; about three years after, lord keeper of the great seal, on the removal of the earl of Shaftesbury; and lord chancellor in 1675. He was created earl of Nottingham in 1681; and died in the year following, being quite worn out by the fatigues of business. He published several speeches on the trials of the judges of King Charles I. with some few other things; and left behind him Chancery Reports in MS.

FINE, that which is pure and without mixture. The term is particularly used in speaking of gold or silver.

FINE, in *Law*, hath divers applications. Sometimes it is used for a formal conveyance of lands or tenements, or of any thing inheritable, being *in esse temporis finis*, in order to cut off all controversies. Others define it to be a final agreement between persons, concerning any lands or rents, &c. of which any suit or writ is depending between them in any court.

FINE, sometimes signifies a sum of money paid for entering lands or tenements let by lease; and sometimes a pecuniary mulct for an offence committed against the king and his laws, or against the lord of the manor.

Blackst. Comment.

FINES for Alienation, in *Feodal Law*. One of the attendants or consequences of tenure by vassalship. *KNIGHT-Service*, was that of fines due to the lord for every alienation, whenever the tenant had occasion to make over his land to another. This depended on the nature of the feodal connexion; it not being reasonable, nor allowed, that a feudatory should transfer his lord's gift to another, and substitute a new tenant to do the service in his own stead, without the consent of the lord: and, as the feodal obligation was considered as reciprocal, the lord also could not alienate his seignory without the consent of his tenant, which consent of his was called an *attornment*. The restraint upon the lord soon wore away; that upon the tenant continued longer. For, when every thing came in process of time to be bought and sold, the lords would not grant a license to their tenants to aliene, without a fine being paid; apprehending that, if it was reasonable for the heir to pay a fine or relief on the renovation of his paternal estate, it was much more reasonable that a stranger should make the same acknowledgment on his admission to a newly purchased feud. In England, these fines seem only to have been exacted from the king's tenants *in capite*, who were never able to aliene without a license: but as to common persons, they were at liberty, by *magna charta*, and the statute of *quia emptores* (if not earlier), to aliene the whole of their estate, to be holden of the same lord as they themselves held it of before. But the king's tenants *in capite*, not being included under the general words of these statutes, could not aliene without a license: for if they did, it was in ancient strictness an absolute forfeiture of the land; though some have imagined otherwise. But this severity was mitigated by the statute 1 Edw. III. c. 12. which ordained, that in such case the lands should not be forfeited, but a reasonable fine be paid to the king. Upon which statute it was settled, that one-third of the yearly value should be paid

paid for a licenſe of alienation; but, if the tenant preſumed to aliene without a licenſe, a full year's value ſhould be paid. Theſe fines were at laſt totally taken away by ſtatute 12 Car. II. c. 24. See *Knight-Service*.

Fine-Drawing, or *Rentering*, a dexterous ſewing-up or rejoining the parts of any cloth, ſtuff, or the like, torn or rent in the dreſſing, wearing, &c.

It is prohibited to *fine-draw* pieces of foreign manufacture upon theſe of our own, as has formerly been practiſed. See Rentering.

Fine-Stiller, in the diſtillery. That branch of the art which is employed on the diſtilling the ſpirit from treacle or other preparations or recrements of ſugar, is called *fine-ſtilling*, by way of diſtinction from malt-ſtilling; and the perſon who exerciſes this part of the trade is called a *fine-ſtiller*.

The operation in procuring the ſpirit from ſugar is the ſame with that uſed in making the malt ſpirit; a waſh of the ſaccharine matter being made with water from treacle, &c. and fermented with yeaſt. It is uſual to add in this caſe, however, a conſiderable portion of malt, and ſometimes powdered jalap, to the fermenting backs. The malt accelerates the fermentation, and makes the ſpirit come out the cheaper, and the jalap prevents the riſe of any muſty head on the ſurface of the fermenting liquor, ſo as to leave a greater opportunity for the free acceſs of the air, and thus to ſhorten the work, by turning the foamy into a hiſſing fermentation.

FINERS *of* Gold *and* Silver, are thoſe who purify and part thoſe metals from other coarſer ones by fire and acids. They are alſo called *parters* in our old law books, and ſometimes *departers*.

FINERY, in the iron works, is one of the two forges at which they hammer the ſow or pig iron.

Into the finery they firſt put the pigs of iron, placing three or four of them together behind the fire, with a little of one end thruſt into it; where, ſoftening by degrees, they ſtir and work them with long bars of iron, and expoſe at different times different parts to the blaſt of the bellows, in order to refine it as equally as poſſible, till the metal runs together with a round maſs or lump, which they call a *half bloom*. They then take this out, and give it a few ſtrokes with their ſledges; afterwards they carry it to a great heavy hammer, raiſed by the motion of a water wheel; where, applying it dexterouſly to the blows, they preſently beat it out into a thick ſhort ſquare. This they put into the finery again, and heating it red hot, they work it under the ſame hammer till it comes to be in the ſhape of a bar in the middle, but with two ſquare knobs at the ends, which they call an *ancony*. It is then carried into the other forge called the *chaffry*.

FINEERING. See Veneering.

FINESSE, a French term, of late current in Engliſh. Literally, it is of no farther import than our Engliſh *fineneſs*; but among us it is chiefly uſed to denote that peculiar delicacy or ſubtility perceived in works of the mind, and the niceſt and moſt ſecret and ſublime parts of any ſcience or art.

It is ſometimes uſed to expreſs that kind of ſubtility made uſe of for the purpoſes of deception.

FINGAL, king of Morven, in ancient Caledonia. He flouriſhed in the third century: and according to the Iriſh hiſtories died in the year 283, although there is ſome reaſon from Oſſian's poems for placing his death a few years later. Fingal was deſcended in all probability from thoſe Celtic tribes who were the firſt inhabitants of Britain. Tradition, and the poems of Oſſian, give him a long line of royal anceſtors, ſuch as Combal, Trenmor, Trathal, &c. who had all reigned over the ſame territory. Whether this territory was bounded by the Caledonian foreſt, or extended ſomewhat farther to the ſouth, towards the Roman province, is uncertain; but there is no doubt of its having extended over all the north and weſt Highlands, comprehending the Hebrides, whoſe petty chiefs were all ſubject to the king of Morven. His principal place of reſidence was Selma, which was probably in the neighbourhood of Glenco, ſuppoſed to be the Cona of Oſſian; though ſome imagine it to have been in Strath-Conan in Moray. The truth ſeems to be, that as Fingal and his people lived by hunting, they often ſhifted their habitations. Hence, in all parts of the Highlands we find, in the names of places, buildings, &c. ſuch monuments as juſtify their ſeveral claims for the honour of Fingal's reſidence. Fingal acquired great fame by his proweſs in arms. He made many ſucceſsful incurſions into the Roman province, from whence he carried away thoſe ſpoils which his ſon ſo often mentions under the names of the *wine of the ſtranger*, and the *wax of the ſtranger*. By ſea we find him frequently making voyages to Scandinavia, the Orkneys, and Ireland; called by Oſſian *Lochlin*, *Inniſtore* and *Ullin*. Several of theſe expeditions were celebrated by his ſon in epic poems, of which two only remain, Fingal and Temora. In the laſt of theſe poems, we find Fingal fighting together with his grandſon Oſcar. How long he lived afterwards is uncertain. He is ſaid to have died a natural death; and therefore none of his ſon's poems relate to this event, though it is occaſionally mentioned in many of them. "Did thy beauty laſt, O Ryno? Stood the ſtrength of car-borne Oſcar? Fingal himſelf paſſed away; and the halls of his fathers have forgot his ſteps. The blaſt of the north opens thy gates, O king, and I behold thee ſitting on miſt, dimly gleaming in all thine arms. Thy form now is not the terror of the valiant: but like a watery cloud, when we ſee the ſtars behind it, with their weeping eyes. Thy ſhield is like the aged moon; thy ſword vapour half kindled with fire. Dim and feeble is the chief who travelled in brightneſs before. But thy ſteps are on the winds of the deſert, and the ſtorms darken in thy hand. Thou takeſt the ſun in thy wrath, and hideſt him in thy clouds. The ſons of little men are afraid, and a thouſand ſhowers deſcend.—*Berrathon*.

"The character of Fingal (Dr Blair obſerves) is is perhaps the moſt perfect that ever was drawn by a poet, for we may boldly defy all the writers of antiquity to ſhow us any hero equal to Fingal. Throughout the whole of Oſſian's works, he is preſented to us in all that variety of lights which give the full diſplay of a character. In him concur almoſt all the qualities that can ennoble human nature; that can either make us admire the hero, or love the man. He is not only unconquerable in war, but he makes his people happy by his wiſdom in the days of peace. He is truly the father of his people. He is known by the epithet of

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'Fingal of the mildest look,' and distinguished on every occasion by humanity and generosity. He is merciful to his foes, full of affection to his children, full of concern about his friends, and never mentions Agandecca, his first love, without the utmost tenderness. He is the universal protector of the distressed; none ever went sad from Fingal.—' O Oscar! bend the strong in arms, but spare the feeble hand. Be thou a stream of many tides against the foes of thy people; but like the gale that moves the grass to those who ask thine aid: so Trenmor lived; such Trathal was; and such has Fingal been. My arm was the support of the injured; the weak rested behind the lightning of my steel.' These were the maxims of true heroism, to which he formed his grandson. His fame is represented as everywhere spread; the greatest heroes acknowledge his superiority; his enemies tremble at his name; and the highest encomiums that can be bestowed on one whom the poet would most exalt, is to say, That his soul was like the soul of Fingal. Wherever he appears, we behold the hero. The objects he pursues are always great; to bend the proud, to protect the injured, to defend his friends, to overcome his enemies by generosity more than by force. Some strokes of human imperfection and frailty are what usually give us the most clear view and the most sensible impression of a character, because they present to us a man such as we have seen; they recal known features of human nature. When poets go beyond this range, and attempt to describe a faultless hero, they, for the most part, set before us a sort of vague undistinguishable character, such as the imagination cannot lay hold of, or realize to itself as the object of affection. But Fingal, though exhibited without any of the common human failings, is nevertheless a real man; a character which touches and interests every reader."

We may observe, that Fingal appears to have been no less a poet than a warrior; at least, in all those passages ascribed to him in the poems of his son, there is a grandeur and loftiness that elevates them above the common style even of Ossian. The following passage from the poem of *Carthon* may be taken as a specimen of Fingal's poetry. "—' Raise, ye bards,' said the mighty Fingal, ' the praise of the unhappy Moina. Call her ghost, with your songs, to our hills; that she may rest with the fair of Morven, the sunbeams of other days, and the delight of heroes of old.—I have seen the walls of Balclutha, but they were desolate. The fire had resounded in the halls; and the voice of the people is heard no more. The stream of Clutha was removed from its place by the fall of the walls. The thistle shook, there, its lonely head: the moss whistled to the wind. The fox looked out from the windows; the rank grass of the wall waved round his head. Desolate is the dwelling of Moina: silence is in the house of her fathers. Raise the song of mourning, O bards, over the land of strangers. They have but fallen before us; for, one day we must fall.—Why dost thou build the hall, son of the winged days? Thou lookest from thy towers to-day; yet a few years, and the blast of the desert comes; it howls in thy empty court, and whistles round thy half-worn shield.—And let the blast of the desert come! We shall be renowned in our day. The mark of my arm shall be in the battle, and my name in the song of bards. Raise the song; send round the shell: and let joy be heard in my hall. When thou, sun of heaven, shalt fail! if thou shalt fail, thou mighty light! if thy brightness is for a season, like Fingal; our fame shall survive thy beams.'—Such was the joy of Fingal in the day of his joy. His thousand bards leaned forward from their seats, to hear the voice of the king. It was like the music of the harp on the gale of the spring. Lovely were thy thoughts, O Fingal! Why had not Ossian the strength of thy soul? But thou standest alone, my father; and who can equal the king of Morven?" See OSSIAN.

FINGERS, in *Anatomy*, the extreme part of the hand divided into five members. See ANATOMY, N° 56.

FINING *of* LIQUORS. See CLARIFICATION.

FINISTERRE, the most westerly cape or promontory of Spain, in 10. 15. W. Long. and 43° N. Lat. This cape is likewise the most westerly part of the continent of Europe.

FINITE, something bounded or limited, in contradistinction to INFINITE.

FINLAND (the duchy of), is bounded on the west by the gulf of Bothnia, on the east by Muscovy, on the south by the gulf of Finland and Ingria, and on the north by Bothnia and Lapland. It is about 200 miles in length, and almost as much in breadth. It contains many lakes; on which are several islands, which are generally rocks or inaccessible mountains The inhabitants are small of stature, capable of enduring hardships, and good soldiers. The Russians have for some time rendered themselves masters of a good part of this province; the rest belongs to Sweden. It is divided into seven provinces; 1. Finland; 2. Cajana; 3. Thavasthia; 4. Nyeland; 5. Savolaxia; 6. Carelia; and, 7. Kexholmia.

Finland Proper is an agreeable country, and lies over-against the city of Stockholm, near the place where the gulfs of Bothnia and Finland meet. It is divided into South and North Finland. It is diversified with mountains, forests, lakes, meadows, and pleasant fields. The inhabitants salt the fish they do not consume themselves, and send it into foreign countries.

FINNINGIA, or FENNINIA, in *Ancient Geography*, the true reading for *Eningia* in Pliny, which he makes an island, but is more truly a peninsula. Now FINLAND, a province of Sweden. *Fenni*, or *Finni*, the people; whose ferocity was extraordinary, poverty extreme, herbs their food, skins their covering, and the ground their couch: regardless of man and of gods, they attained to a very difficult thing, not to have a single wish to form, (Tacitus.)

FIR-TREE. See PINUS, BOTANY *Index*.

FIRE, in *Physiology*, signifies that subtile invisible substance by which bodies are expanded or enlarged in bulk, and become hot to the touch; fluids are rarefied into vapour; solid bodies become fluid, and in like manner are at last dissipated, or, if incapable of being carried off in vapour, are at length melted into glass. It seems likewise to be the chief agent in nature on which animal and vegetable life have an immediate dependence, and without which it does not appear that nature itself could subsist a single moment.

The disputes concerning fire, which for a long time divided

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divided philoſophers, have now in a great meaſure, though not wholly, ſubſided. The celebrated philoſophers of the laſt century, Bacon, Boyle, and Newton, were of opinion, that fire was no diſtinct ſubſtance from other bodies, but that it conſiſted entirely in the violent motion of the parts of any body. As no motion, however, can be produced without a cauſe, they were obliged to have recourſe to a mechanical force or impulſe as the ultimate chuſe of fire in all caſes. Thus Boyle tells us, that when a piece of iron becomes hot by hammering, "there is *nothing* to make it ſo, except the forcible motion of the hammer impreſſing a vehement and variouſly determined agitation on the ſmall parts of the iron." Bacon defines *heat*, which he makes ſynonymous with fire, to be "an expanſive undulatory motion in the minute particles of a body, whereby they tend with ſome rapidity from a centre towards a circumference, and at the ſame time a little upwards." Sir Iſaac Newton ſaid nothing poſitive upon the ſubject; but conjectured that groſs bodies and light might be convertible into one another; and that great bodies of the ſize of our earth when violently heated, might continue and increaſe their heat by the mutual action and reaction of their parts.

But while the mechanical philoſophers thus endeavoured to account for the phenomena of fire upon the ſame principles which they judged ſufficient to explain thoſe of the univerſe in general, the chemiſts as ſtrenuouſly aſſerted that fire was a fluid of a certain kind, diſtinct from all others, and univerſally preſent throughout the whole globe. Boerhaave particularly maintained this doctrine; and in ſupport of it brought the following argument, that ſteel and flint would ſtrike fire, and produce the very ſame degree of heat, in Nova Zembla, which they would do under the equator. Other arguments were drawn from the increaſed weight of metalline calces, which they ſuppoſed to proceed from the fixing of the element of fire in the ſubſtance whoſe weight was thus increaſed. By theſe experiments Mr Boyle himſelf ſeems to have been ſtaggered; as he publiſhed a treatiſe on the poſſibility of making fire and flame ponderable; though this was directly contrary to his own principles already quoted. For a long time, however, the matter was moſt violently diſputed; and the mechanical philoſophers, though their arguments were equally inconcluſive with thoſe of their adverſaries, at laſt prevailed through the prejudice in favour of Sir Iſaac Newton, who indeed had ſcarce taken any active part in the conteſt.

That the cauſe of fire cannot be any mechanical motion which we can impreſs, is very evident; becauſe on mechanical principles an effect muſt always be proportionable to the cauſe. In the caſe of fire, however, the effect is beyond all calculation greater than the cauſe, ſuppoſing the latter to be only a mechanical percuſſion, as in the caſe of hammering iron till it be red hot. By a few ſtrokes of a hammer, the particles of a piece of iron, we ſhall allow, may be ſet in a violent motion, and thus produce fire. If, however, we direct the motion of theſe particles upon another body whoſe parts are at reſt, and in ſome degree coherent, it is plain that the latter will reſiſt and diminiſh that motion of the particles already moved, in proportion to their *vis inertiæ*, as well as the coheſion of the parts of the ſecond body, if indeed we can ſuppoſe the *vis inertiæ* of matter to be different from the effect of gravitation, coheſion, or ſome other power acting upon it. By no argumentation whatever, then, can we ſhow upon mechanical principles, why fire ſhould have ſuch a tendency to increaſe and multiply itſelf without end, as we ſee it has, even abſtracting from all conſideration of the neceſſity of air for continuing the action of fire.

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The action of the air in augmenting and continuing the power of fire, ſeems ſcarce at all to have been conſidered by thoſe who firſt undertook an inveſtigation of the ſubject. It evidently gave riſe to the Hutchinſonian hypotheſis, that fire, light, and air, were convertible into one another. This, however, is equally untenable with the mechanical hypotheſis; for later diſcoveries have ſhown, that our atmoſphere is compoſed of two diſtinct fluids, only one of which is fit for ſupporting flame; and if we ſhould ſuppoſe this to be the only proper air, it is in like manner demonſtrated, that this pure fluid is not homogeneous, but compoſed of a gravitating and non-gravitating ſubſtance; the latter of which only has the properties of fire; ſo that this element is ſtill as inviſible as ever; nor can it be ſhown by any experiment that *fire per ſe* has ever been changed into a palpable or gravitating ſubſtance.

The experiments which firſt ſeemed to bring this diſpute to a deciſion were thoſe of Dr Black, concerning what he called *latent heat;* on which ſome other names, ſuch as *abſolute heat*, *ſpecific fire*, &c. have been beſtowed, very little to the advancement of ſcience in general. From theſe diſcoveries it appears, that fire may exiſt in bodies in ſuch a manner as not to diſcover itſelf in any other way than by its action upon the minute parts of the body; but that ſuddenly this action may be changed in ſuch a manner as no longer to be directed upon the particles of the body itſelf, but upon external objects: in which caſe we then perceive its action by our ſenſe of feeling, or diſcover it by the thermometer, and call it *ſenſible heat*. This expreſſion, it muſt be owned, is improper; and the uſe of the word *heat*, inſtead of *fire*, has produced ſome confuſion, which it is not now eaſy to avoid in ſpeaking on theſe ſubjects. By the word *heat*, we ought always to underſtand the effect of fire, or the fluid acting in a certain manner, rather than the mere element itſelf, which, it is certain, from the experiments juſt mentioned, may exiſt in ſubſtances actually *cold* to the touch.

From this diſcovery made by Dr Black, along with many others in electricity, and recorded at length in various articles of this work, it is now almoſt univerſally allowed, that fire is a diſtinct fluid, capable of being transferred from one body to another. But when this was diſcovered, another queſtion no leſs perplexing occurred, viz. what kind of a fluid it was; or whether it bears any analogy to thoſe with which we are better acquainted? Here we find two fluids, viz. the ſolar light, and the electric matter, both of which occaſionally act as fire, and which therefore ſeem likely to be all the ſame at bottom. By the vulgar, indeed, the matter has long ago been determined; and the rays of the ſun as well as the electrical fluid, have been promiſcuouſly denominated *elementary fire*. Philoſophers, indeed, have withheld their aſſent; though their

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their reasons for so doing are by no means apparent. The most strange suppositions, however, have been made concerning the nature of both those fluids; and on the most slender grounds imaginable, or rather, on no grounds at all, they have been supposed to be phlogiston itself, or to contain a large proportion of it. Mr Scheele went so far in this way as to form an hypothesis, which he endeavoured to support by some experiments, that fire is composed of dephlogisticated air and phlogiston. But it is now ascertained beyond all possibility of dispute that the result of such a combination is not fire, but fixed air; so that we need not take any farther notice of this hypothesis than just to observe, that it would have been altogether untenable, even though this discovery had not been made; because the dephlogisticated air itself is not a simple but a compound substance, as has already been observed; and that in all cases of combustion the one part of the air is separated from the other.

It was long ago observed by Sir Isaac Newton, that heat was certainly conveyed by a medium more subtile than the common air; because two thermometers, one included in the vacuum of an air pump, the other placed in the open air, at an equal distance from the fire, would grow equally hot in near the same time. The consequence of this, had he pursued the thought, was, that fire itself was equally present in all places, and as active where there was no terrestrial matter as where there was. New improvements in the air pump have enabled succeeding philosophers to make more perfect vacuums, such as it has been supposed even the electric matter cannot pass through. It is not to be doubted, however, that, even there, the thermometer would be heated by a fire as well as in the open air. Fire, therefore, exists and acts where there is no other matter, and of consequence is a fluid *per se*, independent of every terrestrial substance, without being generated or compounded of any thing we are yet acquainted with. To determine the nature of the fluid, we have only to consider whether any other can be discovered which will pass through the perfect vacuum just mentioned, and act there as fire. Such a fluid we find in the solar light, which is well known to act even *in vacuo* as the most violent fire. The solar light will likewise act in the very same manner in the most intense cold; for M. de Saussure has found, that on the cold mountain top the sunbeams are equally, nay more powerful, than on the plain below. It appears, therefore, that the solar light will produce heat independent of any other substance whatever; that is, where no other body is present, at least as far as we can judge, except the light itself and the body to be acted upon. We cannot therefore avoid concluding, that a certain modification of the light of the sun is the cause which produces heat, expansion, vapour, &c. and answers to the rest of the characters given in our definition of fire, and that independent of any other substance whatever.

For a further discussion of this subject, see CHEMISTRY and ELECTRICITY *Index*.

Wild FIRE, a kind of artificial or factitious fire, which burns even under water, and that with greater violence than out of it.

It is composed of sulphur, naphtha, pitch, gum, and bitumen; and is only extinguishable by vinegar mixed with sand and urine, or by raw hides.

Its motion or tendency is said to be contrary to that of natural fire, and always follows the direction in which it is thrown; whether it be downwards, sidewise, or otherwise. The French call it *Greek fire*, or *feu Grequois*, because first used by the Greeks, about the year 660: as is observed by the Jesuit Petavius, on the authority of Nicetas, Theophanes, Cedrenus, &c.

The inventor, according to the same Jesuit, was an engineer of Heliopolis, in Syria, named *Callinicus*, who first applied it in the sea-fight commanded by Constantine Pogonates against the Saracens, near Cyzicus, in the Hellespont; and with such effect, that he burnt the whole fleet therewith wherein were 30,000 men. But others will have it of a much older date, and hold Marcus Gracchus the inventor: which opinion is supported by several passages both in the Greek and Roman writers, which shows it to have been anciently used by both these nations in their wars.

Constantine's successors used it on divers occasions with equal advantage as himself: and what is remarkable enough is, that they were so happy as to keep the secret of the composition to themselves, so that no other nation knew it in the year 960.

Hugh king of Burgundy, demanding ships of the emperor Leo, for the siege of Fresne, desired likewise the Greek fire.

F. Daniel gives a good description of the Greek fire, in his account of the siege of Damietta under St Louis. Every body, says that author, was astonished with the Greek fire, which the Turks then prepared; and the secret whereof is now lost. They threw it out of a kind of mortar; and sometimes shot it with an odd sort of cross-bow, which was strongly bent by means of a handle or winch, of much greater force than the mere arm. That thrown with the mortar sometimes appeared in the air of the size of a tun, with a long tail, and a noise like that of thunder. The French by degrees got the secret of extinguishing it, in which they succeeded several times.

Machine for preserving from FIRE. This machine consists of a pole, a rope, and a basket. The pole is of fir, or a common scaffold pole, of any convenient length from 36 to 46 feet; the diameter at bottom, or greatest end, about five inches; and at the top, or smallest end, about three inches. At three feet from the top is a mortise through the pole, and a pulley fixed to it of nearly the same diameter with the pole in that part. The rope is about three quarters of an inch diameter, and twice the length of the pole, with a spring hook at one end, to pass through the ring in the handle of the basket when used: it is put through the mortise over the pulley, and then drawn tight on each side to near the bottom of the pole, and made fast there till wanted. The basket should be of strong wicker-work, three feet and a half long, two feet and a half wide, rounded off at the corners, and four feet deep, rounding every way at the bottom. To the top of the basket is fixed a strong iron curve or handle, with an eye or ring in the middle; and to one side of the basket, near the top, is fixed a small cord or guide-rope of about the length of the pole. When the pole is raised, and set against a house over the window from which any persons are to escape, the manner of using it is so plain and obvious, that it needs not be described. The most convenient distance from the house for the foot of

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of the pole to ſtand, where practicable, is about 12 or 14 feet. If two ſtrong iron ſtraps, about three feet long, rivetted to a bar acroſs and ſpreading about 14 inches at the foot, were fixed at the bottom of the pole, this would prevent its turning round or ſlipping on the pavement. And if a ſtrong iron hoop, or ferrule, rivetted (or welded) to a ſemicircular piece of iron ſpreading about 12 inches, and pointed at the ends, were fixed on at the top of the pole, it would prevent its ſliding againſt the wall.

When theſe two laſt mentioned irons are fixed on, they give the pole all the ſteadineſs of a ladder; and becauſe it is not eaſy, except to perſons who have been uſed to it, to raiſe and ſet upright a pole of 40 feet or more in length, it will be convenient to have two ſmall poles or ſpars of about two inches diameter, fixed to the ſides of the great pole at about two or three feet above the middle of it, by iron eyes rivetted to two plates ſo as to turn every way; the lower end of theſe ſpars to reach within a foot of the bottom of the great pole, and to have ferrules and ſhort ſpikes to prevent ſliding on the pavement, when uſed occaſionally to ſupport the great pole like a tripod. There ſhould be two ſtrong aſh trundles let through the pole, one at four feet and one at five feet from the bottom, to ſtand out about eight inches on each ſide, and to ſerve as handles, or to twiſt the rope round in lowering a very heavy weight. If a block and pulley were fixed at about the middle of the rope, above the other pulley, and the other part of the rope made to run double, it would diminiſh any weight in the baſket nearly one half, and be very uſeful in drawing any perſon up, to the aſſiſtance of thoſe in the chambers, or for removing any effects out of a chamber, which it might be dangerous to attempt by the ſtairs.

It has been proved, by repeated trials, that ſuch a pole as we have been ſpeaking of can be raiſed from the ground, and two or three perſons taken out of the upper windows of a houſe, and ſet down ſafely in the ſtreet, in the ſpace of 35 ſeconds, or a little more than half a minute. Sick and infirm perſons, women, children, and many others, who cannot make uſe of a ladder, may be ſafely and eaſily brought down from any of the windows of a houſe on fire by this machine, and, by putting a ſhort pole through the handles of the baſket, may be removed to any diſtance without being taken out of the baſket. The pole muſt always have the rope ready fixed to it, and may be conveniently laid up upon two or three iron hooks under any ſhade or gateway, and the baſket ſhould be kept at the watch-houſe. When the poll is laid up, the two ſpars ſhould always be turned towards the head of it. The baſket ſhould be made of peeled rods, and the pole and ſpars painted of a light ſtone colour, to render it more viſible when uſed in the night.

Machines for extinguiſhing FIRE. In the year 1734, the ſtate of Sweden offered a premium of 20,000 crowns for the beſt method of ſtopping the progreſs of accidental fires; when one Mr Fuches, a German phyſician, made a preparation for that end, and the experiment was made on a houſe built on purpoſe of dry fir, at Legard iſland. In the building were placed ſeveral tubs of tar and pitch, and a great quantity of chips, all which were ſet on fire; flames iſſuing through the top of the houſe, windows, &c. when he threw in one of the barrels containing the preparation, which immediately quenched the flames; a ſecond barrel entirely cleared the ſmoke away; and the whole was executed to the ſatisfaction of the ſpectators, and to the no ſmall ſatisfaction of the inventor, who was about to return home, when unexpectedly the flames broke out again, ſuppoſed to be occaſioned by a ſmall quantity of combuſtible matter being introduced and ſet on fire ſecretly by ſome malicious perſon. Upon this the wrong-headed mob fell upon Mr Fuches, and beat him moſt unmercifully, ſo that he narrowly eſcaped with his life. He ſoon after left the country, and never could be prevailed on (though ſtrongly perſuaded by ſome of the moſt eminent citizens) to return. It is ſaid, another experiment of the ſame kind was tried in the year 1761 in Holland; but rendered abortive through the perverſeneſs of the populace.

Attempts of a ſimilar nature have met with a better reception in England. Of theſe the moſt ſucceſsful was that of Mr Godfrey, whoſe contrivance is thus deſcribed by Mr Ambroſe Godfrey, grandſon to the inventor. "The machine to be employed conſiſts of a ſmall portion of gunpowder cloſely confined; which, when animated by fire, acts by its elaſtic force upon a proper medium, and not only divideth it into the minuteſt atoms, but diſperſeth it alſo in every direction, ſo as immediately to extinguiſh any fire within a certain diſtance. This medium is a liquor ſtrongly impregnated with a preparation of antiphlogiſtic principles, which by their action upon burning materials extinguiſh the flames and reduce them in general to the ſtate of a black coal; and, by its oppoſite nature to fire, hinders the remaining ſparks, notwithſtanding the admiſſion of the air, from kindling the flames afreſh. By this means, the great point is obtained, in giving ſufficient time for totally extinguiſhing any remains of fire.

"They who preſume that water only will perform this will find themſelves greatly miſtaken, as the draught of air will certainly rekindle the neighbouring materials, which are very fit to receive a freſh flame, the fire not being extinguiſhed by the quantity of water, but rather by the expanſion and rarefaction of its particles. There are ſeveral ſizes of theſe machines, from five to fifty pounds weight, in a portable and rather ſmall compaſs, and may generally be carried to any place where a man can go himſelf.

"But though theſe machines will prevent great fires by a timely application, they will not extinguiſh them after they have reached a frightful height, and ſeveral houſes, perhaps near a whole ſtreet, are in flames. The floors muſt be ſtanding, and acceſs to the building ſafe, otherwiſe no perſon can be ſuppoſed to approach near enough to apply them in a proper manner. Every fire has its beginning for the moſt part in ſome apartment; and, as ſoon as diſcovered, the family, inſtead of loſing all preſence of mind, ſhould immediately apply one or more of theſe machines, which will then fully anſwer the intention. The proper time of applying them, ſuppoſes that they are ready at hand. It will be in vain to think of fetching them from any conſiderable diſtance, as it will then be too late for them to perform any important ſervice: except indeed being the probable means of ſaving ſome adjacent houſe, by extinguiſhing

tinguishing the flames as often as they break out, till the building first on fire is totally consumed, and, by falling into ruins, leaves the other in perfect safety."

On the 19th of May 1761, at noon, Mr Godfrey's experiment for extinguishing fire, was tried in a house erected for that purpose, near Mary-le-bone. Their royal highnesses, the duke of York, Prince William Henry, Prince Henry Frederick, a great number of persons of rank and distinction, and many of the learned world, gave their attendance on this singular occasion. The house, which was of brick, consisted of three rooms one above another, a staircase, chimney, lath and plaster ceilings, and a kind of wainscotting round the rooms, of rough deal. Exactly at 12 o'clock the ground room, and that up one pair of stairs, were set on fire by lighting the faggots and shavings laid in there for that purpose: in about 15 minutes the wainscot of the under room was thought to be sufficiently in flames, and three of the machines were thrown in; which, by almost immediate and sudden explosions, instantaneously extinguished the flames, and the very smoke in that apartment in a few minutes totally disappeared. By this time, the firemen, &c. who had the care of throwing in the machines, gave an alarm that the staircase had taken fire, and that it was necessary directly to go to work upon the next room; which was accordingly done, and with the same effect. The experiment, however, hitherto did not universally satisfy: in the last instance especially it was thought to be too hastily put in execution; and the populace without side the paling, who were supposed to amount to near 20,000, and whose curiosity, from the very nature of their situation, remained much dissatisfied, began to grow rather riotous, and talked of a second bottle conjuror. For the sake of the experiment, therefore, and to remove all manner of doubt, Mr Godfrey consented to a third experiment in the upper room, which was entirely of wood. The flames were now suffered to get to a considerable height, and even the window frames destroyed, before the machines were thrown in: which, however, answered exactly as the former had done; and, being quite in sight of the out-standers, met with universal approbation.

These machines of Mr Godfrey's, it is evident, would be of great use in extinguishing fires on shipboard; and might be considered as a no less necessary part of a ship's lading, than her stores or ammunition.

The hint of these machines is said to have been taken by Dr Godfrey from the invention of one Zachary Greyl, who exhibited machines similar to those of Dr Godfrey, before persons of the first rank, but without meeting with any encouragement. His machines were made of wood, and the liquor employed was only water, and consequently inferior to Dr Godfrey's in its power of extinguishing fire. The latter is said to have mixed his water with a certain quantity of oil of vitriol, or with sal ammoniac. These machines, however, as already observed, are found to be only serviceable in the beginning of a fire. When the roof had fallen in, they had no effect.

Composition for extinguishing Fire. For this purpose the following has been invented by M. Von Aken, of which the account is taken from *Nicholson's Journal*, vol. ii. 4to.

Burnt alum	30 lbs.
Green vitriol powdered	40
Cinabrese or red ochre in powder	20
Potter's clay, or other clay, also powdered	200
Water	630

With 40 measures of this mixture an artificial fire was extinguished under the direction of the inventor by three persons, which would have required the labour of 20 men and 1500 measures of common water. Sig. Fabbroni was commissioned to examine the value of this invention, and found in his comparative trials with engines of equal power, worked by the same number of men, that the mixture extinguished the materials in combustion in one-sixth part less time, and three-eighths less of fluid, than when common water was used. He observed, as might indeed have been imagined from the nature of the material, that the flame disappeared wherever the mixture fell, and that the saline, metallic, and earthy matters formed an impenetrable lute round the hot combustible matter, which prevented the access of the air, and consequently the renewal of the destructive process.

It is scarcely probable that this practice in the large way, with an engine throwing upwards of 200 gallons (value about 3l. 10s.) each minute, would be thought of or adopted, or that a sufficient store of the materials would be kept in readiness; since at this rate the expenditure for an hour would demand a provision to the amount of 210l. sterling. But in country places the process, or some variation of it, might be applied with sufficient profit in the result; more especially if it be considered that common salt or alum, or such saline matter as can be had and mixed with the water, together with clay, chalk, or lime, ochreous earth or common mud, or even these last without any salt, may answer the purpose of the lute with more or less effect, and extinguish an accidental fire with much greater speed and certainty than clear water would do.

Water-Engine for Extinguishing Fire. See Hydrostatics.

In using this machine we have the following improvement by Dr Hoffman, which promises to be of great efficacy. As soon as the engine is in readiness to work, stir into the water that immediately is to be discharged, seven or eight pounds of pearl ashes in powder, and continue to add it in this manner as occasion requires; taking care that it be directed against the timber or wainscot, &c. just beginning to burn, and not wasted against the brick-work: or, where time will admit, dissolve any quantity of pearl ashes in a copper with water, and as fast as it dissolves, which will be in a few minutes, mix a pailful with the water in the engine, pretty often; and whatever burning wood it is played upon, will be extinguished as if it was dipped in water, and will not burn afresh in the part extinguished.

Easy Method of Extinguishing Fire *in Chimneys.* It is well known, that the inner parts of chimneys easily take fire; the soot that kindles therein emits a greater flame, according as the tunnel is more elevated, because the inferior air feeds the fire. If this air could therefore be suppressed, the fire would soon be extinguished. In order to this, some discharge a pistol into the chimney, which produces no effect; others lay under

under the chimney a copper full of water; but the vapours that rise from it, far from extinguishing the fire, seem to give it new force. Water thrown into the chimney at top is equally of no effect, because it comes down through the middle of the tunnel, and not along the sides. It would be more advisable to stop with dung the upper orifices of the tunnel for quenching the fire. But the surest and readiest method is, to take a little gunpowder, and having humected it with spittle for binding it, to form it into small masses, and so throw it into the heart of the chimney. When it is burnt, and has produced a considerable vapour, a second, afterwards a third, are thrown, and so on, as much as is necessary. In a little time the fire is extinguished, and, as it were, choked by this vapour; and cakes of inflamed soot are seen to fall from the tunnel, till at last not the least vestige of fire appears.

Securing Buildings against FIRE. Dr Hales proposes to check the progress of fires by covering the floors of the adjoining houses with earth. The proposal is founded on an experiment which he made with a fir board half an inch thick, part of which he covered with an inch depth of damp garden mould, and then lighted a fire on the surface of the mould; though the fire was kept up by blowing, it was two hours before the board was burnt through, and the earth prevented it from flaming. The thicker the earth is laid on the floors, the better; however, Dr Hales apprehends that the depth of an inch will generally be sufficient; and he recommends to lay a deeper covering on the stairs, because the fire commonly ascends by them with the greatest velocity.

Mr Hartley made several trials in the years 1775 and 1776, in order to evince the efficacy of a method which he had invented for restraining the spread of fire in buildings. For this purpose thin iron plates are well nailed to the tops of the joists, &c. the edges of the sides and ends being lapped over, folded together, and hammered close. Partitions, stairs, and floors, may be defended in the same manner; and plates applied to one side have been found sufficient. The plates are so thin as not to prevent the floor from being nailed on the joists, in the same manner as if this preventive were not used: they are kept from rust by being painted or varnished with oil and turpentine. The expence of this addition, when extending through a whole building, is estimated at about five per cent. Mr Hartley has a patent for this invention, and parliament has voted a sum of money towards defraying the expence of his numerous experiments. The same preservative may also be applied to ships, furniture, &c.

Lord Mahon has also discovered and published a very simple and effectual method of securing every kind of building against all danger of fire. This method he has divided into three parts, viz. under-flooring, extra-lathing, and inter-securing.

The method of under-flooring is either single or double. In single under-flooring, a common strong lath of oak or fir, about one-fourth of an inch thick, should be nailed against each side of every joist, and of every main timber, supporting the floor which is to be secured. Other similar laths are then to be nailed along the whole length of the joists, with their ends butting against each other. The top of each of these laths or fillets ought to be at $1\frac{1}{2}$ inch below the top of the joists or timbers against which they are nailed; and they will thus form a sort of small ledge on each side of all the joists. These fillets are to be well bedded in a rough plaster hereafter mentioned, when they are nailed on, so that there may be no interval between them and the joists: and the same plaster ought to be spread with a trowel upon the tops of all the fillets, and along the sides of that part of the joists which is between the top of the fillets and the upper edge of the joists. In order to fill up the intervals between the joists that support the floor, short pieces of common laths, whose length is equal to the width of these intervals, should be laid in the contrary direction to the joists, and close together in a row, so as to touch one another: their ends must rest upon the fillets, and they ought to be well bedded in the rough plaster, but are not to be fastened with nails. They must then be covered with one thick coat of the rough plaster, which is to be spread over them to the level of the tops of the joists: and in a day or two this plaster should be trowelled over close to the sides of the joists, without covering the tops of the joists with it.

In the method of double flooring, the fillets and short pieces of laths are applied in the manner already described; but the coat of rough plaster ought to be little more than half as thick as that in the former method. Whilst this rough plaster is laid on, some more of the short pieces of laths above mentioned must be laid in the intervals between the joists upon the first coat, and be dipped deep in it. They should be laid as close as possible to each other, and in the same direction with the first layer of short laths. Over this second layer of short laths there must be spread another coat of rough plaster, which should be trowelled level with the tops of the joists without rising above them. The rough plaster may be made of coarse lime and hair; or, instead of hair, hay chopped to about three inches in length may be substituted with advantage. One measure of common rough sand, two measures of slaked lime, and three measures of chopped hay, will form in general a very good proportion, when sufficiently beat up together in the manner of common mortar. The hay should be put in after the two other ingredients are well beat up together with water. This plaster should be made stiff; and when the flooring boards are required to be laid down very soon, a fourth or fifth part of quicklime in powder, formed by dropping a small quantity of water on the limestone a little while before it is used, and well mixed with this rough plaster, will cause it to dry very fast. If any cracks appear in the rough plaster work near the joists when it is thoroughly dry, they ought to be closed by washing them over with a brush wet with mortar wash: this wash may be prepared by putting two measures of quicklime and one of common sand in a pail, and stirring the mixture with water till it becomes of the consistence of a thin jelly.

Before the flooring boards are laid, a small quantity of very dry common sand should be strewed over the plaster work, and struck smooth with a hollow rule, moved in the direction of the joists, so that it may lie rounding between each pair of joists. The plaster work and sand should be perfectly dry before the boards are laid, for fear of the dry rot. The method of under-flooring may be succefsfully applied to a wooden ftaircafe; but no fand is to be laid upon the rough plafter work. The method of extra-lathing may be applied to ceiling joifts, to floping roofs, and to wooden partitions.

The third method, which is that of inter-fecuring, is very fimilar to that of under-flooring; but no fand is afterwards to be laid upon it. Inter-fecuring is applicable to the fame parts of a building as the method of extra-lathing, but it is feldom neceffary.

Lord Mahon has made feveral experiments in order to demonftrate the efficacy of thefe methods. In moft houfes it is only neceffary to fecure the floors; and the extra expence of under-flooring, including all materials, is only about ninepence per fquare yard, and with the ufe of quicklime a little more. The extra expence of extra-lathing is no more than fixpence per fquare yard for the timber fide walls and partitions; but for the ceiling about ninepence per fquare yard. But in moft houfes no extra lathing is neceffary.

Fire-Eater. We have a great number of mountebanks who have procured the attention and wonder of the public by eating of fire, walking on fire, wafhing their hands in melted lead, and the like tricks.

The moft celebrated of thefe was our countryman Richardfon, much talked of abroad. His fecret, as related in the *Journal des Sçavans*, of the year 1680, confifted in a pure fpirit of fulphur, wherewith he rubbed his hands, and the parts that were to touch the fire; which burning and cauterizing the epidermis, hardened and enabled the fkin to refift the fire.

Indeed this is no new thing: Amb. Parée affures us he has tried it on himfelf; that after wafhing the hands in urine, and with unguentum aureum, one may fafely wafh them in melted lead.

He adds alfo, that by wafhing his hands in the juice of onions, he could bear a hot fhovel on them while it melted lead.

FIRE, in *Theology*. See HELL.

We read of the facred fire in the firft temple of Jerufalem, which came down from heaven: it was kept with the utmoft care, and they were forbidden to carry any ftrange fire into the temple. This fire is one of the five things which the Jews confefs were wanting in the fecond temple.

The Pagans had their facred fires, which they kept in their temples with the moft religious care, and which were never to be extinguifhed. Numa was the firft who built a temple to Fire as a goddefs at Rome, and inftituted an order of priefteffes for the prefervation of it. See VESTALS.

Fire was the fupreme god of the Chaldeans; the Magi were worfhippers of fire; and the Greeks and Armenians ftill keep up a ceremony called the *holy fire*, upon a perfuafion that every Eafter day a miraculous fire defcends from heaven into the holy fepulchre, and kindles all the lamps and candles there.

Fire kindled fpontaneoufly in the Human Body. See *Extraordinary Cafes of* BURNING.

Fire-Barrel. See FIRE-*Ship*, Note (B).

Fire-Bavins. Ibid. Note (D).

Fire-Arrow, in naval artillery, is a fmall iron dart furnifhed with fprings and bars, together with a match impregnated with fulphur and powder, which is wound about its fhaft. It is intended to fire the fails of the enemy, and is for this purpofe difcharged from a mufquetoon or fwivel gun. The match being kindled by the explofion, communicates the flame to the fail againft which it is directed, where the arrow is faftened by means of its bars and fprings. This weapon is peculiar to hot climates, particularly the Weft Indies, where the fails being extremely dry by reafon of the great heat, they inftantly take fire, and of courfe fet fire to the mafts and rigging, and laftly to the veffel itfelf.

Fire-Ball, in artillery, a compofition of meal powder, fulphur, faltpetre, pitch, &c. about the bignefs of a hand grenade, coated over with flax, and primed with the flow compofition of a fuze. This is to be thrown into the enemy's works in the night time, to difcover where they are, or to fire houfes, galleries, or blinds of the befiegers; but they are then armed with fpikes, or hooks of iron, that they may not roll off, but ftick or hang where they are defired to have any effect. See *Fire*-BALLS, and *Light*-BALLS.

Balls of Fire, in *Meteorology*, a kind of luminous bodies generally appearing at a great height above the earth, with a fplendour furpaffing that of the moon; and fometimes equalling her apparent fize. They generally proceed in this hemifphere from north to fouth with vaft velocity, frequently breaking into feveral fmaller ones, fometimes vanifhing with a report, fometimes not.

Thefe luminous appearances no doubt conftitute one part of the ancient prodigies, blazing ftars or comets, which laft they fometimes refemble in being attended with a train; but frequently they appear with a round and well-defined difk. The firft of thefe of which we have any accurate account, was obferved by Dr Halley and fome other philofophers at different places, in the year 1719. From the flight obfervations they could take of its courfe among the ftars, the perpendicular height of this body was computed at about 70 miles from the furface of the earth. The height of others has alfo been computed, and found to be various; though in general it is fuppofed to be beyond the limits affigned to our atmofphere, or where it lofes its refractive power. The moft remarkable of thefe on record appeared on the 18th of Auguft 1783, about nine o'clock in the evening. It was feen to the northward of Shetland, and took a foutherly direction for an immenfe fpace, being obferved as far as the fouthern provinces of France, and one account fays that it was feen at Rome alfo. During its courfe it appears frequently to have changed its fhape; fometimes appearing in the form of one ball, fometimes of two or more; fometimes with a train, fometimes without one. It paffed over Edinburgh nearly in the zenith, and had then the appearance of a well-defined round body, extremely luminous, and of a greenifh colour; the light which it diffufed on the ground giving likewife a greenifh caft to objects. After paffing the zenith it was attended by a train of confiderable length, which continually augmenting, at laft obliterated the head entirely; fo that it looked like a wedge, flying with the obtufe end foremoft. The motion was not apparently fwift, by reafon of its great height; though in reality it muft have moved with great rapidity, on account of the vaft fpace it travelled over in a fhort time. In other places its appearance

pearance was very different. At Greenwich we are told, that "two bright balls parallel to each other led the way, the diameter of which appeared to be about two feet; and were followed by an expulfion of eight others, not elliptical, feeming gradually to mutilate, for the laft was fmall. Between each two balls a luminous ferrated body extended, and at the laft a blaze iffued which terminated in a point. Minute particles dilated from the whole. The balls were tinted firft by a pure bright light, then followed a tender yellow, mixed with azure, red, green, &c.; which, with a coalition of bolder tints, and a reflection from the other balls, gave the moft beautiful rotundity and variation of colours that the human eye could be charmed with. The fudden illumination of the atmofphere, and the form and fingular tranfition of this bright luminary, tended much to make it awful: neverthelefs, the amazing vivid appearance of the different balls, and other rich connective parts not very eafy to delineate, gave an effect equal to the rainbow in the full zenith of its glory."

Dr Blagden, in a paper on this fubject in the 74th volume of the Philofophical Tranfactions, has not only given a particular account of this and other meteors of the kind, but added feveral conjectures relating to the probable caufes of them. The firft thing which occurred to philofophers on this fubject was, that the meteors in queftion were burning bodies rifing from the furface of the earth, and flying along the atmofphere with great rapidity. But this hypothefis was foon abandoned, on confidering that there was no power known by which fuch bodies could either be raifed to a fufficient height, or projected with the velocity of the meteors. The next hypothefis was, that they do not confift of one fingle body, but of a train of fulphureous vapours, extending a vaft way through the atmofphere, and being kindled at one time difplay the luminous appearances in queftion by the fire running from one end of the train to the other. To this hypothefis, which was invented by Dr Halley, Dr Blagden objects that no juft explanation is given of the nature of the vapours themfelves, the manner in which they are raifed up, or in which they can be regularly arranged in ftraight lines of fuch vaft extent; or how they can be fuppofed to burn in fuch rarefied air. "Indeed, (fays he) it is very difficult to conceive how vapours could be prevented, in thofe regions where there is in a manner no preffure, from fpreading out on all fides in confequence of their natural elafticity, and inftantly lofing that degree of denfity which feems neceffary for inflammation. Befides, it is to be expected, that fuch trains would fometimes take fire in the middle, and thus prefent the phenomenon of two meteors at the fame time, receding from one another in a direct line."

For thefe and other reafons this hypothefis of Dr Halley was abandoned, and another fubftituted in its place. This was, that the meteors we fpeak of are permanent folid bodies, not rifing from the earth, but revolving round it in very eccentric orbits, and thus in their perigeon moving with inconceivable rapidity. But the doctor fhows, that, even on this fuppofition, the velocity of fuch bodies muft fcarce be one third of that with which fire-balls move, and which has been calculated at upwards of 1000 miles per minute. The hypothefis is likewife liable to a number of other objections which cannot be anfwered, particularly from the variations in their appearance; for it is impoffible to fhow in what manner one folid and permanent body could affume the appearance of eight or ten, as was the cafe with the meteor of 1783: nor can it be fhown why a body, which in paffing over Edinburgh appeared with a difk evidently lefs than that of the fun, fhould, in paffing over Greenwich, affume the appearance of *two* bodies, each of which had a difk confiderably larger than the apparent difk of that luminary. To obviate, in fome meafure, objections of this kind, it has been fuppofed that the revolving bodies are furrounded by a kind of electrical atmofphere by which they are rendered luminous; "but (fays the doctor) I think, whoever carefully perufes the various accounts of fire-balls, and efpecially ours of the 18th of Auguft, when it divided, will perceive that their phenomena do not correfpond with the idea of a folid nucleus involved in a fubtile fluid, any more than with the idea of another learned gentleman, that they become luminous by means of a contained fluid, which occafionally explodes through the thick folid outer fhell."

Another hypothefis, which Dr Blagden has not mentioned, is, that the meteors in queftion are a kind of bodies which take fire as foon as they come within the atmofphere of the earth. But this cannot be fuppofed, without implying a previous knowledge of thefe bodies, which it is altogether impoffible we can have. The only opportunity we have of feeing them is when they are on fire. Before that time they are in an invifible and unknown ftate; and it is furely improper to argue concerning them in this ftate, or pretend to determine any one of their properties, when we have it not in our power to fee or inveftigate them in the leaft. As the meteors therefore never manifeft themfelves to our fenfes but when they are on fire, the only rational conclufion we can draw from thence is, that they have no exiftence in any other ftate; and confequently that their fubftance muft be compofed of that fluid which, when acting after a certain manner, becomes luminous and fhows itfelf as fire; remaining invifible and eluding our refearches in every other cafe. On this hypothefis we muft conclude that the fire-balls are great bodies of electric matter, moving from one part of the heavens where, to our conception, it is fuperabundant, to another where it is deficient. This opinion is adopted by Dr Blagden for the following reafons:

1. On account of their prodigious velocity, which is not lefs than 1200 miles in a minute, and feems incompatible with any other fubftance we know befides the electric fluid. "This (fays he) is perhaps the only cafe in which the courfe or direction of that fluid is rendered perceptible to our fenfes, in confequence of the large fcale on which thefe meteors move."

2. Various electrical phenomena have been obferved to attend them, fuch as lambent fires fettling upon men, horfes, &c. and fparks coming from them, "or the whole meteor itfelf (adds our author), it is faid, have damaged fhips, houfes, &c. after the manner of lightning." This laft circumftance, however, we can believe only of another kind of fire-balls, of which we fhall afterwards treat, which keep at a fmall diftance from the earth, or run along its furface; for the great meteors

Fire.

meteors of which we now ſpeak, flying at the diſtance of 50 or 60, or more, miles from the ſurface of the earth, cannot be leſs from their apparent ſize than a mile or a mile and a half in diameter. Such an immenſe body of electric matter deſcending on the earth, would by its exploſion ruin a large tract of country; and there is no probability that when engendered in ſuch a rare atmoſphere it could break through the whole body of groſs and denſe air which lies between theſe regions and the earth, and which we know reſiſts the paſſage of the electric fluid very ſtrongly. Notwithſtanding this, there is no impoſſibility that the atmoſphere may be electrified to a great degree by ſuch a meteor paſſing over it; and thus electrified appearances may attend theſe bodies without any actual emiſſion of their ſubſtance, as Dr Blagden ſuppoſes. "If there be really (ſays he) any hiſſing noiſe heard while the meteors are paſſing, it ſeems explicable on no other ſuppoſition than that of ſtreams of electric matter iſſuing from them, and reaching the earth with a velocity equal to that of the meteor, namely, in two or three ſeconds. Accordingly, in one of our late meteors, the hiſſing was compared to that of electricity iſſuing from a conductor. The ſparks flying off ſo perpetually from the body of fire-balls may poſſibly have ſome connexion with theſe ſtreams. In the ſame manner the ſound of exploſions may perhaps be brought to us quicker than if it were propagated to us by the air alone. Should theſe ideas be well founded, the change of direction, which meteors ſeem at times to undergo, may poſſibly be influenced by the ſtate of the ſurface of the earth over which they are paſſing, and to which the ſtreams are ſuppoſed to reach. A ſimilar cauſe may occaſion the apparent exploſion, the opening of more channels giving new vent and motion to the electric fluid. May not the deviation and exploſion which appear to have taken place in the fire-ball of the 18th of Auguſt over Lincolnſhire, have been determined by its approach towards the fens, and an attraction produced by that large body of moiſture?

The exploſion mentioned by our author over Lincolnſhire does not ſeem to have been the only one which happened during the courſe of this meteor. Several people heard reports after it had vaniſhed; and theſe were ſometimes ſingle and ſometimes double. At Edinburgh two reports were heard, the one immediately following the other, at the diſtance of ſix or ſeven minutes after the meteor had paſſed. Theſe reports no doubt indicated a temporary diſſolution of the body; but it is by no means probable that the diſſolution could have taken place either on account of the ſtate of the earth or atmoſphere. We muſt conſider that both earth and atmoſphere are always full of electric fluid; and if there happens to be what is called a *deficiency* in one of them, the other inſtantly ſupplies it. It is impoſſible, therefore, that either the earth or atmoſphere could receive ſuch an immenſe additional quantity in one part without a vent being provided for it ſomewhere elſe. In thunder ſtorms we naturally conclude that a vaſt quantity of electrical matter is put in motion; but from the effects of lightning it appears that this quantity muſt be very trifling in compariſon with what the meteor we now ſpeak of contained. A violent flaſh of lightning has been known to perforate a looking-glaſs, and make only a hole of about an inch diameter. Now we have no reaſon to ſuppoſe that the flaſh, tremendous as it might appear to our eyes, was any other than an electric ſpark of an inch in diameter. The meteor, on the other hand, appears not to have been leſs than a mile in diameter; ſo that the diſproportion betwixt it and a ſingle flaſh of lightning appears almoſt beyond calculation; and we may reaſonably conclude that it could not have been equalled by 10,000 thunder-ſtorms. Had this amazing body of electric fire deſcended through the atmoſphere and diſſipated itſelf on the fens of Lincolnſhire, it muſt have produced the moſt violent and unheard-of effects, not only in that place, but probably throughout the whole iſland. Its diſſipation muſt therefore have been in the higher regions, where there was ample ſpace to receive it; and where its exploſion, whatever concuſſion it might make among the ethereal matter itſelf, could not affect our earth or atmoſphere in any remarkable degree. Its re-appearance was owing to the ſame tendency in the fluid to circulate which had originally produced it; and which probably was the violent earthquake in Calabria, and the eruption in Iceland.

3. Another argument adduced by Dr Blagden in favour of the electrical origin of fire-balls, is their connexion with the aurora borealis, and the reſemblance they bear to theſe phenomena, which are now almoſt univerſally allowed to be electrical. "Inſtances (ſays he) are recorded, where northern lights have been ſeen to join, and form luminous balls, darting about with great velocity, and even leaving a train behind them like the common fire-balls. This train I take to be nothing elſe but the rarefied air left in ſuch an electrified ſtate as to be luminous; and ſome ſtreams of the northern lights are very much like it." The aurora borealis appears to occupy as high, if not a higher region above the ſurface of the earth, as may be judged from the very diſtant countries to which it has been viſible at the ſame time: indeed the great accumulation of electric matter ſeems to lie beyond the verge of our atmoſphere, as eſtimated by the ceſſation of twilight. Alſo with the northern lights a hiſſing noiſe is ſaid to be heard in ſome very cold climates: Gmelin ſpeaks of it in the moſt pointed terms, as frequent and very loud in the north-eaſtern parts of Siberia; and other travellers have related ſimilar facts."

4. Our author thinks that the ſtrongeſt argument for the electrical origin of theſe meteors is the direction of their courſe, which is conſtantly either from the north or north-weſt quarter of the heavens, or towards it; or, as our author thinks, nearly in the direction of the magnetical meridian. Such a courſe, however, ſeems only to belong to the very large fire-balls of which we now ſpeak; the ſmaller ones, called *Falling Stars*, being moved in all directions; "perhaps (ſays the doctor), becauſe they come further within the verge of our atmoſphere, and are thereby expoſed to the action of extraneous cauſes. That the ſmaller ſort of meteors, ſuch as ſhooting ſtars, are really lower down in the atmoſphere, is rendered very probable by their ſwifter apparent motion: perhaps it is this very circumſtance which occaſions them to be ſmaller, the electric fluid being more divided in more reſiſting air. But as thoſe maſſes of electric matter which move

where

where there is ſcarce any reſiſtance, ſo generally affect the direction of the magnetic meridian, the ideas which have been entertained of ſome analogy between theſe two obſcure powers of nature ſeem not altogether without foundation. If the foregoing conjectures be juſt, diſtinct regions are allotted to the electrical phenomena of our atmoſphere. Here below we have thunder and lightning, from the unequal diſtribution of the electric fluid among the clouds; in the loftier regions, whither the clouds never reach, we have the various gradations of falling ſtars; till, beyond the limits of our corpuſcular atmoſphere, the fluid is put into motion in ſufficient maſſes, to hold a determined courſe, and exhibit the different appearances of what we call *fire-balls*; and probably at a ſtill greater elevation above the earth, the electricity accumulates in a lighter and leſs condenſed form, to produce the wonderfully diverſified ſtreams and coruſcations of the aurora borealis."

The paper from whence theſe extracts are taken was written before Mr Morgan's account of the non-conducting power of a perfect vacuum made its appearance. The meteor in queſtion, and others of the ſame nature, afford a proof of the theory of the deficiency of electric fluid propoſed by ſome. Dr Halley, ſpeaking of the fire-ball of 1719, the height of which he calculated at very little leſs than 70 miles, expreſſes his ſurpriſe that ſound ſhould be propagated through a medium near 300,000 times rarer than the common air, and the next thing to a perfect vacuum. Now it remains, and for ever will remain, to be proved, that Mr Morgan's moſt perfect vacuum, formed by boiling quickſilver in a tube ever ſo long, contains a medium *more* than 300,000 times rarer than the common atmoſphere. From Mr Cavallo's experiments it appears, that when air is only rarefied 1000 times, the electric light is exceſſively weak; ſo that there is not the leaſt probability that in an aerial medium 300,000 times rarer than the preſent, if indeed ſuch a medium can exiſt, there could be any light made viſible in the ordinary experiments. We ſee, however, by the many examples of meteors which have occurred at prodigious heights in the atmoſphere, that the electric light in ſuch a rarefied atmoſphere is not only viſible, but acts as vigorouſly in every reſpect as if it were on the ſurface of the earth. This circumſtance therefore affords a complete demonſtration of the fallacy of Mr Morgan's argument, and a direct proof that the electric fluid pervades ſpace as completely diveſted of air as the beſt artificial vacuum we can make; nay, where it is generally believed by mathematicians that the atmoſphere has ceaſed altogether. His other arguments drawn *à priori* are ſtill more inconcluſive than that we have juſt mentioned. He tells us, that if a vacuum was a conductor, the whole quantity of electric matter contained in the earth and atmoſphere would be perpetually flying off through the regions of infinite ſpace, as being ſurrounded by a boundleſs conductor. But even this does not follow, though we ſhould ſuppoſe theſe regions to be an abſolute vacuity; for we know that electricity does not fly to a conducting ſubſtance merely becauſe it is a conductor, but becauſe it opens a paſſage to ſome place whither it has a tendency to go though the conductor was not there. Now, on the preſent hypotheſis, as the conductor would lead to *no place* to which the electric matter had any previous tendency, we cannot aſſign any reaſon why it ſhould acquire a tendency to fly off merely on account of the neighbourhood of a conductor, even though boundleſs. His other objection (that, on the ſuppoſition of a vacuum being capable of conducting electricity, the whole ſpace in the univerſe would be filled with electric fluid) may be admitted in its fulleſt extent, without any detriment whatever to ſcience; and indeed, if we allow the electric fluid to be only a modification of the light of the ſun, we muſt own that the whole univerſe is filled with it. The meteors in queſtion then will be no other than diſcharges of electricity from one part of the celeſtial ſpaces to another, ſimilar to the diſcharges between the poſitive and negative ſide of an electrified bottle; thus intimating, that a circulation has taken place in the fluid, which the meteor at once completes and puts an end to. See METEOROLOGY.

Beſides theſe already juſt mentioned of ſuch vaſt magnitude, there are others much ſmaller and nearer the ſurface of the earth, rolling upon it, or falling upon it, exploding with violence, as is the caſe with thoſe which appear in the time of thunder, and frequently produce miſchievous effects. One of theſe is mentioned by ſome authors as falling in a ſerene evening in the iſland of Jamaica; exploding as ſoon as it touched the ſurface of the ground, and making a conſiderable hole in it. Another is mentioned by Dr Prieſtley as rolling along the ſurface of the ſea, then riſing and ſtriking the top-maſt of a man of war, exploding, and damaging the ſhip. In like manner, we hear of an electrified cloud at Java in the Eaſt Indies; whence, without any thunder ſtorm, there iſſued a vaſt number of fire-balls which did incredible miſchief. This laſt phenomenon points out to us the true origin of balls of this kind, viz. an exceſſive accumulation of electricity in one part, or a violent tendency to circulate, when at the ſame time the place where the motion begins is at ſo great a diſtance, or meets with other obſtacles of ſuch a nature, that it cannot eaſily get thither. Urged on, however, by the vehement preſſure from behind, it is forced to leave its place; but being equally unable to diſplace the great quantity of the ſame fluid, which has no inclination to move the ſame way with itſelf, it is collected into balls, which run hither and thither, according as they meet with conductors capable of leading them, into ſome part of the circle. This is even confirmed by an experiment related at the end of Dr Prieſtley's fifth volume on Air. He relates, that a gentleman having charged, with a very powerful machine, a jar, which had the wire ſupporting the knob of a conſiderable length, and paſſed through the glaſs tube, a globe of fire was ſeen to iſſue out of it. This globe gradually aſcended up the glaſs tube till it came to the top of the knob, where it ſettled, turning ſwiftly on its axis, and appearing like a red-hot iron ball of three quarters of an inch diameter. On continuing to turn the machine, it gradually deſcended into the jar; which it had no ſooner done, than there enſued a moſt violent exploſion and flaſh, the jar being diſcharged and broken at the ſame time. This experiment, however, is ſingular in its kind; for neither the gentleman who performed it, nor any other, has yet been able to repeat it. Single as it is, however, we may yet gather from it, that a fire-ball will be the conſequence of a very

very violent electrification of any ſubſtance, provided at the ſame time that the air be in a very non-conducting ſtate, ſo that the electricity may not evaporate into it as faſt as it is collected; for this would produce only lucid ſtreams and flaſhes, as in the common experiments with the Leyden phial; and it is probably an inattention to this circumſtance which has hitherto prevented the repetition of the experiment above mentioned. The caſe is the ſame in thunder ſtorms, where an exceſſive accumulation of electric matter always produces fire-balls, the moſt miſchievous kind of lightning, as is explained under that article.

With regard to the uſes which fire-balls ſerve in the ſyſtem of nature, it is plain that they are the means of preſerving the equilibrium in the electric fluid in the atmoſphere, which would otherwiſe produce the moſt dreadful tempeſts. As there muſt be a conſtant current of electric matter through the bowels of the earth from the equator to the poles, and from the poles to the equator, through the atmoſphere, the great meteors ſerve for keeping up the equilibrium in this great atmoſpherical current, while the ſmaller ones anſwer a like purpoſe in the general maſs of electric matter diſperſed over the ſurface of the earth, and therefore are ſeen to move in all directions, as the equilibrium happens to require them in different parts. With regard to thoſe which are obſerved in the lower regions of the earth, or rolling on the ſurface of the ground itſelf, they undoubtedly anſwer purpoſes of a ſimilar kind in theſe lower regions; for as fire-balls in general are produced by a great exceſs of electricity in one place, there muſt of courſe be an equal deficiency in another; and to reſtore the equilibrium, or, to ſpeak more properly, to prevent a dangerous commotion from taking place throughout the whole maſs of electric fluid, the fire-ball breaks forth, and either puts a ſtop at once to the diſturbance by an exploſion, or by a ſilent and inviſible evaporation. From ſome accounts indeed it would ſeem that even the large celeſtial meteors detached part of their ſubſtance to accompliſh this purpoſe; though, for the reaſons already given, it would ſeem more probable that they operated by electrifying the atmoſphere, or ſetting the fluid contained in it in motion, ſo as to produce ſmall fire-balls of itſelf, rather than by detaching any part of their own bodies to ſuch a diſtance. Dr Blagden, in the paper above quoted, gives an account of an appearance of this kind. It was deſcribed in a letter to Sir Joſeph Banks from the Abbé Mann, director of the academy at Bruſſels. "It happened (ſays the Abbé) at Mariekercke, a ſmall village on the coaſt, about half a mile weſt of Oſtend. The curate of the village was ſitting in the duſk of the evening with a friend, when a ſudden light ſurpriſed them, and, immediately after, a ſmall ball of light-coloured flame came through a broken pane of glaſs, croſſed the room where they were ſitting, and fixed itſelf on the chink of a door oppoſite to the window where it entered, and there died gradually away. It appeared to be a kind of phoſphoric light carried along by the current of air. The curate and his friend, greatly ſurpriſed at what they ſaw, apprehended fire in the neighbourhood; but going out, found that the fire which had come in through the window had been detached from a large meteor in its paſſage."

Fire-Cocks. Churchwardens in London and within the bills of mortality, are to fix fire-cocks at proper diſtances in ſtreets, and keep a large engine and hand-engine for extinguiſhing fire, under the penalty of 10l. ſtat. 6 Ann. c. 31.

On the breaking out of any fire in London or Weſtminſter, the conſtables and beadles of pariſhes ſhall repair to the place with their ſtaves, and aſſiſt in extinguiſhing it, and cauſe the people to work for that end, &c.

Fire-Engine. See *Steam-Engine.*

Fire-Flair, in *Ichthyology*. See Raja, Ichthyology *Index.*

Fire-Flies, a ſpecies of flies common in Guiana, of which there are two ſpecies. The largeſt is more than an inch in length, having a very large head connected with the body by a joint of a particular ſtructure, with which at ſome times it makes a loud knock, particularly when laid on its back. The fly has two feelers or horns, two wings, and ſix legs. Under its belly is a circular patch, which, in the dark, ſhines like a candle; and on each ſide of the head near the eyes is a prominent, globular, luminous body, in ſize about one-third larger than a muſtard ſeed. Each of theſe bodies is like a living ſtar, emitting a bright, and not ſmall, light; ſince two or three of theſe animals, put into a glaſs veſſel, afford light ſufficient to read without difficulty, if placed cloſe to the book. When the fly is dead, theſe bodies will ſtill afford conſiderable light, though it is leſs vivid than before; and if bruiſed, and rubbed over the hands or face, they become luminous in the dark, like a board ſmeared over with phoſphorus. They have a reddiſh brown or cheſnut colour; and live in rotten trees in the day, but are always abroad in the night. The other kind is not more than half as large as the former: their light proceeds from under their wings, and is ſeen only when they are elevated, like ſparks of fire appearing or diſappearing at every ſecond. Of theſe the air is full in the night, though they are never ſeen in the day. They are common not only in the ſouthern but in the northern parts of America, during the ſummer.

Fire-Lock, or *Fuſil*, a ſmall gun which fires with a flint. It is diſtinguiſhed from an old muſket, or match-lock, which was fired with a match. The firelock is now in common uſe in the European armies.

Fire-Philoſophers, or *Philoſophi per ignem*, a fanatical ſect of philoſophers who appeared towards the cloſe of the 16th century, and made a figure in almoſt all the countries of Europe. The diſtinguiſhing tenet from which they derived this appellation was, that the intimate eſſences of natural things were only to be known by the trying efforts of fire, directed in a chemical proceſs. They were alſo called *Theoſophiſts*, from their declaring againſt human reaſon as a dangerous and deceitful guide, and repreſenting a divine and ſupernatural illumination as the only means of arriving at truth; they were likewiſe denominated *Paracelſiſts*, from the name of Paracelſus, the eminent phyſician and chemiſt, who was the chief ornament and leader of this extraordinary ſect. It was patronized in England by Robert Flodd or Fludd, who endeavoured to illuſtrate the philoſophy of Paracelſus in a great number of treatiſes: in France it was zealouſly propagated by Rivier; in Denmark, by Severinus; in Germany, by Kunrath, an eminent phyſician of Dreſden; and in other

other countries by warm and ſucceſsful votaries, who aſſumed a ſtriking air of piety and devotion, and propoſed to themſelves no other end than the advancement of the divine glory, and the reſtoration of peace and concord in a divided church: accordingly they were joined by ſeveral perſons eminent for their piety, and diſtinguiſhed by their zeal for the advancement of true religion. One of the moſt celebrated of theſe was Daniel Hoffman, profeſſor of divinity in the univerſity of Helmſtadt, who, availing himſelf of ſome unguarded paſſages in the writings of Luther, extravagantly maintained, that philoſophy was the mortal enemy of religion; that truth was diviſible into two branches, the philoſophical and theological; and that what was true in philoſophy was falſe in theology. Hoffman, was afterwards obliged, by the interpoſition of Henry Julius, duke of Brunſwick, to retract his invectives againſt philoſophy, and to acknowledge in the moſt open manner the harmony and union of ſound philoſophy with true and genuine theology.

Fire-Places are contrivances for communicating heat to rooms, and alſo for anſwering various purpoſes of art and manufacture. See Chimney, Furnace, and Stove.

The ingenious Dr Franklin, having recounted the inconveniences and advantages of fire-places in common uſe, propoſes a new contrivance for this purpoſe, called the *Pennſylvania fire-place*. 1. This machine conſiſts of a bottom-place, or hearth-piece, fig. 1. Plate CCXVII. with a riſing moulding before for a fender, two perforated ears *F*, *G*, for receiving two ſcrew-rods; a long air-hole *a a*, through which the outward air paſſes into an air-box; and three ſmoke-holes, repreſented by dark ſquares in *BC*, through which the ſmoke deſcends and paſſes away; beſides, double ledges for receiving between them the lower edges of the other plates. 2. A back-plate without holes, and furniſhed with a pair of ledges to receive, 3. The two ſide-plates, each of which has a pair of ledges to receive the ſide edges of the front plate, with a ſhoulder on which it reſts; two pair of ledges to receive the ſide edges of the two middle plates which form the air-box, and an oblong air-hole near the top, through which the air warmed in the box is diſcharged into the room, and a wing or bracket as *H*, and a ſmall hole as *R*, for the axis of the regiſter to turn in. See fig. 2. which repreſents one of theſe plates. 4. An air-box, compoſed of the two middle plates *DE* and *FG*, fig. 3. and 4. The firſt has five thin ledges or partitions caſt on it, the edges of which are received into ſo many pairs of ledges caſt in the other: the tops of all the cavities formed by theſe thin deep ledges are alſo covered by a ledge of the ſame form and depth caſt with them; ſo that when the plates are put together, and the joints luted, there is no communication between the air-box and the ſmoke. In the winding paſſages of this box, freſh air is warmed as it paſſes into the room. 5. A front plate, which is arched on the under ſide, and ornamented with foliages, &c. 6. A top plate with a pair of ears, *MN*, (fig. 5.) anſwerable to thoſe in the bottom plate, and perforated for the ſame purpoſe. It has alſo a pair of ledges running round the under ſide to receive the top edges of the front, back, and ſide plates. The air-box does not reach up to the top plate by $2\frac{1}{2}$ inches.

All theſe plates are of caſt iron; and when they are all in their proper places, they are bound firmly together by a pair of ſlender rods of wrought iron with ſcrews, and the machine appears as in fig. 5. There are alſo two thin plates of wrought iron, viz. 7. The ſhutter which is of ſuch a length and breadth as to cloſe well the opening of the fire-place, and ſerving to blow up the fire, and to ſecure it in the night. It is raiſed or depreſſed by means of two braſs knobs, and ſlides in a groove left between the foremoſt ledge of the ſide plates and the face of the front plate. 8. The regiſter, which is placed between the back plate and air-box, and furniſhed with a key; ſo that it may be turned on its axis, and made to lie in any poſition between level and upright. The operation of this machine, and the method of fixing it, may be underſtood by obſerving the profile of the chimney and fire-places in fig. 6. *M* is the mantle-piece or breaſt of the chimney; *C* the funnel; *B* the falſe back, made of brick work in the chimney, four inches or more from the true back, from the top of which a cloſing is to be made over to the breaſt of the chimney, that no air may paſs into the chimney except that which goes under the falſe back, and up behind it: *E* the true back of the chimney; *T* the top of the fire-place; *F* the front of it; *A* the place where the fire is made; *D* the air-box; *K* the hole in the ſide plate, through which the warmed air is diſcharged out of the air-box into the room; *H* the hollow, formed by removing ſome bricks from the hearth under the bottom plate filled with freſh air, entering at the paſſage *I*, and aſcending into the air-box through the air-hole in the bottom plate near *G*, the partition in the hollow, deſigned to keep the air and ſmoke apart; *P* the paſſage under the falſe back, and part of the hearth for the ſmoke; and the arrows in the figure ſhow the courſe of the ſmoke. The fire being made at *A*, the flame and ſmoke will aſcend, ſtrike the top *T*, and give it a conſiderable heat; the ſmoke will turn over the air box, and deſcend between it and the back plate to the holes near *G* in the bottom plate, heating in its paſſage all the plates of the machine; it will then proceed under and behind the falſe back, and riſe into the chimney. The air of the room contiguous to the ſeveral plates, and warmed by them, becomes ſpecifically lighter than the other air in the room, and is obliged to riſe; but being prevented by the cloſure over the fire-place from going up the chimney, is forced out into the room, and riſing by the mantle-piece to the ceiling, is again driven down gradually by the ſteam of newly-warmed air that follows; and thus the whole room becomes in a little time equally warmed. The air alſo, warmed under the bottom plate and in the air-box, riſes and comes out of the holes in the ſide plates, thus warming and continually changing the air of the room. In the cloſing of the chimney, a ſquare opening for a trap-door ſhould be left for the ſweeper to go up: the door may be made of ſlate or tin, and ſo placed, that by turning up againſt the back of the chimney when open, it cloſes the vacancy behind the falſe back, and ſhoots the ſoot that falls in ſweeping out upon the hearth. It will alſo be convenient to have a ſmall hole, about five or ſix inches ſquare, cut near the ceiling through into the funnel, and provided with a ſhutter; by occaſionally opening which,

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which, the heated air of the room and ſmoke of tobacco, &c. may be carried off without incommoding the company. For a farther account of the manner of uſing this fire-place, the advantages attending it, anſwers to objections, and directions to the bricklayer in fixing it, the curious reader may conſult Franklin's Letters and Papers on Philoſophical Subjects, p. 284—318. edit. 1769.

Fire-Pots, in the military art, ſmall earthen pots, into which is put a charged grenade, and over that powder enough till the grenade is covered; then the pot is covered with a piece of parchment, and two pieces of match acroſs lighted: this pot being thrown by a handle of matches where it is deſigned, it breaks and fires the powder, and burns all that is near it, and likewiſe fires the powder in the grenade, which ought to have no fuſe, to the end its operations may be the quicker.

Fire-Reeds. See the next article, Note (c)

Fire-Ship, an old veſſel filled with combuſtible materials, and fitted with grappling irons to hook, and ſet fire to, the enemies ſhips in battle, &c.

As there is nothing particular in the conſtruction of this ſhip, except the apparatus by which the fire is inſtantly conveyed from one part to another, and from thence to the enemy, it will be ſufficient to deſcribe the fire-room, where theſe combuſtibles are encloſed, together with the inſtruments neceſſary to grapple the ſhip intended to be deſtroyed.

The fire-room is built between decks, and limited on the after part by a *bulk-head*, *L*, behind the mainmaſt, from which it extends quite forward, as repreſented in Plate CCXVII. The train encloſed in this apartment is contained in a variety of wooden troughs, *D*, *G*, which interſect each other in different parts of the ſhip's length; being ſupported at proper diſtances by croſs pieces and ſtanchions. On each ſide of the ſhip are ſix or ſeven ports, *H*, about 18 inches broad and 15 inches high; and having their lids to open downward, contrary to the uſual method.

Againſt every port is placed an iron chamber (A) which, at the time of firing the ſhip, blows out the port-lid, and opens a paſſage for the flame. Immediately under the main and fore-ſhrouds is fixed a wooden funnel *M*; whoſe lower end communicates with a fire-barrel (B), by which the flame paſſing through the funnel is conducted to the ſhrouds. Between the funnels, which are likewiſe called *fire-trunks*, are two ſcuttles, or ſmall holes, in the upper deck, ſerving alſo to let out the flames. Both funnels muſt be ſtopped with plugs, and have ſailcloth or canvas nailed cloſe over them, to prevent any accident happening from above to the combuſtibles laid below.

Falconer's Marine Dictionary.

The ports, funnels, and ſcuttles, not only communicate the flames to the outſide and upper works of the ſhip and her rigging; but likewiſe open a paſſage for the inward air, confined in the fire-room, which is thereby expanded ſo as to force impetuouſly through thoſe outlets, and prevent the blowing up of the decks, which muſt of neceſſity happen from ſuch a ſudden and violent rarefaction of the air as will then be produced.

On each ſide of the bulk-head behind is cut a hole, *L*, of ſufficient ſize to admit a trough of the ſame dimenſions as the others. A leading trough, *LI*, whoſe foremoſt end communicates with another trough within the fire-room, is laid cloſe to this opening, from whence it extends obliquely to a ſally-port, *I*, cut through the ſhip's ſide. The decks and troughs are well covered with melted roſin. At the time of the firing

4 M 2

(A) The iron chambers are 10 inches long and 3.5 in diameter. They are breeched againſt a piece of wood fixed acroſs the ports, and let into another a little higher. When loaded, they are almoſt filled with corn-powder, and have a wooden tompion well driven into their muzzles. They are primed with a ſmall piece of quick-match thruſt through their vents into the powder, with a part of it hanging out. When the ports are blown open by means of the iron chambers, the port-lids either fall downward, or are carried away by the exploſion.

(B) The fire-barrels ought to be of a cylindrical form, as moſt ſuitable to contain the reeds with which they are filled, and more convenient for ſtowing them between the troughs in the fire-room. Their inſide chambers ſhould not be leſs than 21 inches, and 30 inches is ſufficient for their length. The bottom parts are firſt well ſtored with ſhort double-dipped reeds placed upright; and the remaining vacancy is filled with fire-barrel compoſition well mixed and melted, and then poured over them. The compoſition uſed for this purpoſe is a maſs of ſulphur, pitch, tar, and tallow.

There are five holes, of three-fourths of an inch in diameter and three inches deep, formed in the top of the compoſition while it is yet warm; one being in the centre, and the other four at equal diſtances round the ſides of the barrel. When the compoſition is cold and hard, the barrel is primed by filling theſe holes with fuſe compoſition, which is firmly driven into them, ſo as to leave a little vacancy at the top to admit a ſtrand of quick match twice doubled. The centre hole contains two ſtrands at their whole length, and every ſtrand muſt be driven home with meaſed powder. The looſe ends of the quick match being then laid within the barrel, the whole is covered with a dipped curtain, faſtened on with a hoop that ſlips over the head of the barrel, to which it is nailed.

The barrels ſhould be made very ſtrong, not only to ſupport the weight of the compoſition before firing, when they are moved or carried from place to place, but to keep them together whilſt burning: for if the ſtaves are too light and thin, ſo as to burn very ſoon, the remaining compoſition will tumble out and be diſſipated, and the intention of the barrels, to carry the flame aloft, will accordingly be fruſtrated.

The curtain is a piece of coarſe canvas, nearly a yard in breadth and length, thickened with melted compoſition, and covered with ſaw-duſt on both ſides.

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firing either of the leading troughs, the flame is immediately conveyed to the opposite side of the ship, whereby both sides burn together.

The spaces *N*, *O*, behind the fire-room, represent the cabins of the lieutenant and master, one of which is on the starboard, and the other on the larboard side. The captain's cabin, which is separated from these by a bulk-head, is exhibited also by *P*.

Four of the eight fire-barrels are placed under the four fire-trunks; and the other four between them, two on each side the fire-scuttles, where they are securely cleated to the deck. The longest reeds (C) are put into the fore and aft trough, and tied down: the shortest reeds are laid in the troughs athwart, and tied down also. The bavins (D), dipped at one end, are tied fast to the troughs over the reeds, and the curtains are nailed up to the beams, in equal quantities, on each side of the fire-room.

The remainder of the reeds are placed in a position nearly upright, at all the angles of every square in the fire-room, and there tied down. If any reeds are left, they are to be put round the fire-barrels, and other vacant places, and there tied fast.

Instructions to Prime.

Take up all your reeds, one after another, and strew a little composition at the bottom of all the troughs under the reeds, and then tie them gently down again: next strew composition upon the upper part of the reeds throughout the fire-room; and upon the said composition lay double quick match upon all the reeds, in all the troughs: the remainder of the composition strew over all the fire-room, and then lay your bavins loose.

Cast off all the covers of the fire-barrels, and hang the quick match loose over their sides, and place leaders of quick match from the reeds into the barrels, and from thence into the vent of the chambers, in such a manner as to be certain of their blowing open the ports, and setting fire to the barrels. Two troughs of communication from each door of the fire-room to the sally ports, must be laid with a strong leader of quick-match, four or five times double: also a cross-piece to go from the sally-port, when the ship is fired, to the communication trough, laid with leaders of quick-match, that the fire may be communicated in both sides at once.

What quick-match is left place so that the fire may be communicated to all parts of the room at once, especially about the ports and fire-barrels, and see that the chambers are well and fresh primed. [N. B. The port-fire used for firing the ship, burns about 12 minutes. Great care must be taken to have no powder on board when the ship is fired.]

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The sheer hooks (represented by *A*) are fitted so as to fasten on the yard-arms of the fire-ship, where they hook the enemy's rigging. The fire-grapplings (*B*) are either fixed on the yard-arms, or thrown by hand, having a chain to confine the ships together, or fasten those instruments wherever necessary.

When the commanding officer of a fleet displays the signal to prepare for action, the fire-ships fix their sheer hooks, and dispose their grapplings in readiness. The battle being begun, they proceed immediately to prime, and prepare their fire-works. When they are ready for grappling, they inform the admiral thereof by a particular signal.

To avoid being disabled by the enemy's cannon during a general engagement, the fire-ships continue sufficiently distant from their line of battle, either to windward or to leeward.

They cautiously shun the openings or intervals of the line, where they would be directly exposed to the enemy's fire, from which they are covered by lying on the opposite side of their own ships. They are attentively to observe the signals of the admiral or his seconds, in order to put their designs immediately in execution.

Although no ship of the line should be previously appointed to protect any fire-ship, except a few of the smallest particularly destined to this service, yet the ship before whom she passes in order to approach the enemy, should escort her thither, and assist her with an armed boat, or whatever succour may be necessary in her situation.

The captain of the fire-ship should himself be particularly attentive that the above instructions are punctually executed, and that the yards may be so braced when he falls alongside of the ship intended to be destroyed, that the sheer-hooks and grapplings fastened to the yard-arms, &c. may effectually hook the enemy. He is expected to be the last person who quits the vessel; and being furnished with every necessary assistance and support, his reputation will greatly depend on the success of his enterprise.

Lambent FIRES, as the shining of meat at certain seasons, the luminousness of the sea, of insects, vapours, &c. See LIGHT, CHEMISTRY *Index*; *Fire-Flies*, ENTOMOLOGY *Index*; *Glow-Worm*, &c.

Port-Fire. See *Port-Fire*.

Spur-Fire. See *Spur-Fire*.

Fire-Works, are preparations made of gunpowder, sulphur,

(C) The reeds are made up in small bundles of about a foot in circumference, cut even at both ends, and tied together in two places. They are distinguished into two kinds, viz. the long and short; the former of which are four feet, and the latter two feet five inches in length. One part of them are singly dipped, i. e. at one end; the rest are dipped at both ends in a kettle of melted composition. After being immersed about seven or eight inches in this preparation, and then drained, they are sprinkled over with pulverized sulphur upon a tanned hide.

(D) The bavins are made of birch, heath, or other brush-wood, which is tough and readily kindled. They are usually two or three feet in length, and have all their bush-ends lying one way, the other ends being tied together with small cords. They are dipped in composition at the bush-ends, whose branches are afterwards confined by the hand, to prevent them from breaking off by moving about; and also to make them burn more fiercely. After being dipped in the same manner as the reeds, they also are sprinkled with sulphur.

sulphur, and other inflammable and combustible ingredients, used on occasion of public rejoicings and other solemnities.

The invention of fire-works is by M. Mahudel attributed to the Florentines and people of Sienna; who found out likewise the method of adding decorations to them of statues, with fire issuing from their eyes and mouths.

The art of preparing and managing these is called *pyrotechny*. See PYROTECHNY.

FIRING, in the military art, denotes the discharge of the fire-arms; and its object is to do the utmost execution to the enemy.

The method of firing by platoons is said to have been invented by Gustavus Adolphus, and first used about the year 1618; the reason commonly given for this method is, that a constant fire may be always kept up. There are three different ways of platoon firing; viz. standing, advancing, and retreating. But previous to every kind of firing, each regiment or battalion must be told off in grand divisions, subdivisions, and platoons, exclusively of the grenadiers, which form two subdivisions or four platoons of themselves. In firing standing, either by divisions or platoons, the first fire is from the division or platoon on the right; the second fire from the left; the third from the right again; and so on alternately, till the firing comes to the centre platoon, which is generally called the *colour platoon*, and does not fire, remaining as a reserve for the colours. Firing advancing is performed in the same manner, with this addition, that before either division or platoon fires, it advances three paces forward. Firing retreating varies from either of the former methods; for before either division or platoon fires, if they are marching from the enemy, it must go to the right about, and after firing, to the left about again, and continue the retreat as slow and orderly as possible.

In hedge firing the men are drawn up two deep, and in that order both ranks are to fire standing. Oblique firing is either to the right and left, or from the right and left to the centre, according to the situation of the object. The Prussians have a particular contrivance for this purpose; if they are to level to the right, the rear ranks of every platoon make two quick but small paces to the left, and the body of each soldier turns one-eighth of a circle, and *vice versa*. Parapet firing depends on the nature of the parapet over which the men are to fire, and also upon that of the attack made to possess it. This method of firing is sometimes performed by single ranks stepping on the banquette and firing; each man instantly handing his arms to the centre rank of the same file, and taking his back in the room of it; and the centre rank giving it to the rear to load, and forwarding the arms of the rear to the front rank; by which means the front rank men can fire six or seven rounds in a minute with exactness. Parapet firing may also be executed two deep, when the banquette is three feet broad, or in field works where no banquettes are made. Square firing is performed by a regiment or body of men drawn up in a hollow square, in which case each front is generally divided into four divisions or firings, and the flanks of the square, being the weakest part, are covered by four platoons of grenadiers. The first fire is from the right division of each face; the second from the left division of each face, &c. and the grenadiers make the last fire. Street firing is practised in two ways; either by making the division or platoon that has fired to wheel by half-rank to the right and left outwards from the centre, and to march in that order by half divisions down the flanks on each side of the column, and to draw up in the rear, and go on with their priming and loading; or, to make the division or platoon, after firing, to face to the right and left outwards from the centre, and one half rank to follow the other; and in that order to march in one centre file down on each side of the column into the rear, and there draw up as before.

FIRING Iron, in *Farriery*, an instrument not unlike the blade of a knife; which being made red hot is applied to a horse's hams, or other places standing in need of it, as in preternatural swellings, farcy, knots, &c. in order to discuss them.

FIRKIN, an English measure of capacity for things liquid, being the fourth part of the barrel: it contains eight gallons of ale, soap, or herrings; and nine gallons of beer.

FIRLOT, a dry measure used in Scotland. The oat firlot contains $21\frac{1}{4}$th pints of that country; the wheat firlot contains about 2211 cubical inches; and the barley firlot, 31 standard pints. Hence it appears that the Scotch wheat firlot exceeds the English bushel by 33 cubical inches.

FIRMAMENT, in the ancient astronomy, the eighth heaven or sphere; being that wherein the fixed stars were supposed to be placed. It is called the *eighth*, with respect to the seven heavens or spheres of the planets which it surrounds.

It is supposed to have two motions; a diurnal motion, given it by the *primum mobile*, from east to west, about the poles of the ecliptic; and another opposite motion from west to east; which last it finishes, according to Tycho, in 25,412 years; according to Ptolemy, in 36,000; and according to Copernicus, in 258,000; in which time the fixed stars return to the same precise points wherein they were at the beginning. This period is commonly called Plato's year, or the great year.

In various places of Scripture the word *firmament* is used for the middle region of the air. Many of the ancients allowed, with the moderns, that the firmament is a fluid matter; though they, who gave it the denomination of *firmament*, must have taken it for a solid one.

FIRMAN, is a passport or permit granted by the Great Mogul to foreign vessels, to trade within the territories of his jurisdiction.

FIRMICUS, MATERNUS JULIUS, an ecclesiastical writer, who lived about the middle of the fourth century. Nothing is known with certainty respecting his country, profession, or character, as we find no mention made of him in the writings of ancient authors. Some say that he was by birth a Sicilian, and practised in the forum as a barrister for some time, becoming a convert to Christianity when far advanced in years; which appears to derive considerable support from different passages in his writings. He was author of a treatise *De errore profanarum religionum*, which was dedicated to the emperors Constantius and Constans. This work

must

muſt have been written between 340 and 350, in which Conſtans was ſlain by Magnentius. It is allowed to be a learned, able, and well written performance, in which the reaſonableneſs of the Chriſtian religion is ſtrongly contraſted with the abſurdity and immorality of the gentile creed. It muſt not be diſſembled, however, that he ſometimes betrays ſuch a ſpirit of intolerance as is wholly incompatible with the genius of the Chriſtian religion, which breathes nothing but benevolence towards the whole human race. The arguments employed by him in its defence are diſgraced by an exhortation to the civil power to propagate it by force of arms, and to cruſh the advocates of error by ſevere edicts. This work was firſt publiſhed at Straſburg in 1562, at Heidelberg in 1559, and at Paris in 1610.

The greater part of critics aſcribe to him a work entitled *Aſtronomicorum, ſeu de Matheſi*, lib. viii. In it he treats of the power and influence of the ſtars, agreeably to the doctrine of the Egyptians and Babylonians, blending a conſiderable degree of mathematical knowledge with the unmeaning jargon of judicial aſtrology. Thoſe who imagine that ſo good a man as Firmicus could not have been the author of ſuch an abſurd performance, ſhould remember that it was probably compoſed prior to his converſion, when ſuch abſurdities would conſtitute a part of his creed.

FIRMNESS, denotes the conſiſtence of a body, or that ſtate wherein its ſenſible parts cohere in ſuch a manner, that the motion of one part induces a motion in the reſt.

FIRST-BORN. See PRIMOGENITURE, for the literal meaning of the term.

In Scripture it is alſo uſed often in a figurative ſenſe for that which is firſt, moſt excellent, moſt diſtinguiſhed in any thing. Thus it is ſaid of Chriſt (Col. i. 5.), that he is "the firſt-born of every creature;" and in Revelation (i. 5.) he is called "the firſt-begotten of the dead;" that is, according to the commentators, begotten of the Father before any creature was produced; and the firſt who roſe from the dead by his own power. "The firſt-born of the poor," (Iſa. xiv. 30.) ſignifies, The moſt miſerable of all the poor; and in Job (xviii. 13.) The firſt-born of death;" that is, The moſt terrible of all deaths.

First Fruits (*primitiæ*), among the Hebrews, were oblations of part of the fruits of the harveſt, offered to God as an acknowledgment of his ſovereign dominion. The firſt of theſe fruits was offered in the name of the whole nation, being either two loaves of bread, or a ſheaf of barley which was thraſhed in the court of the temple. Every private perſon was obliged to bring his firſt fruits to the temple; and theſe conſiſted of wheat, barley, grapes, figs, apricots, olives, and dates.

There was another ſort of firſt fruits which were paid to God. When bread was kneaded in a family, a portion of it was ſet apart and given to the prieſt or Levite who dwelt in the place; if there was no prieſt or Levite there, it was caſt into the oven, and conſumed by the fire. Theſe offerings made a conſiderable part of the revenues of the Hebrew prieſthood.

Firſt Fruits are frequently mentioned in ancient Chriſtian writers as one part of the church revenue. One of the councils of Carthage enjoins, that they ſhould conſiſt only of grapes and corn; which ſhows, that this was the practice of the African church.

First Fruits, in the church of England, are the profits of every ſpiritual benefice for the firſt year, according to the valuation thereof in the king's books.

FISC, (*Fiſcus*), in the *Civil Law*, the treaſury of a prince or ſtate; or that to which all things due to the public do fall. The word is derived from the Greek φισκος, "a great baſket," uſed when they went to market.—By the civil law, none but a ſovereign prince has a right to have a fiſc or public treaſury.

At Rome, under the emperors, the term *ærarium* was uſed for the revenues deſtined for ſupport of the charges of the empire; the *fiſcus* for thoſe of the emperor's own family. The treaſury, in effect, belonged to the people, and the fiſcus to the prince. Hence the goods of condemned perſons, if appropriated to the uſe of the public, were ſaid *publicari*; if to the ſupport of the emperor or prince, *confiſcari*.

FISCAL, in the *Civil Law*, ſomething relating to the pecuniary intereſt of the prince or people. The officers appointed for the management of the fiſc, were called *procuratores fiſci*, and *advocati fiſci*; and among the caſes enumerated in the conſtitutions of the empire where it was their buſineſs to plead, one is againſt thoſe who have been condemned to pay a fine to the fiſc on account of their litigiouſneſs or frivolous appeals.

FISCUS. See FISC.

FISH, in *Natural Hiſtory*, an animal that lives in the waters as the natural place of its abode.

Fiſhes form the fourth claſs of animals in the Linnæan ſyſtem. Their moſt general or popular diviſion is into *freſh* and *ſalt* water ones. Some, however, are of opinion, that all fiſhes naturally inhabit the ſalt waters, and that they have mounted up into rivers only by accident. A few ſpecies only ſwim up into the rivers to depoſit their ſpawn; but by far the greateſt number keep in the ſea, and would ſoon expire in freſh water. There are about 400 ſpecies of fiſhes (according to Linnæus) of which we know ſomething: but the unknown ones are ſuppoſed to be many more; and as they are thought to lie in great depths of the ſea remote from land, it is probable that many ſpecies will remain for ever unknown.

For the ſubdiviſions, characters, and natural hiſtory of this claſs of animals, ſee ICHTHYOLOGY *Index*.

Blowing of Fish, is a practice ſimilar to that of blowing fleſh, poultry, and pigs, and adopted for the ſame deceitful purpoſes. The method of blowing fiſh, eſpecially cod and whitings, is by placing the end of a quill or tobacco-pipe at the vent, and pricking a hole with a pin under the fin which is next the gill; thereby making the fiſh appear to the eye large and full, which when dreſſed will be flabby, and little elſe than ſkin and bones. But this impoſition may be diſcovered by placing the finger and thumb on each ſide of the vent, and ſqueezing it hard; the wind may be perceived to go out, the ſkin will fall in, and the fiſh appear lank, and of little value.

Breeding of Fishes may be turned to great advantage; for, beſides furniſhing the table, obliging one's friends, and raiſing money, the land will be thereby greatly

Fish.

greatly improved, so as to yield more this way than by any other employment whatever. See *Fish Pond*.

Castration of Fish, is a method first practised by Mr Tull, in order to prevent the excessive increase of fish in some of his ponds, where the numbers did not permit any of them to grow to an advantageous size. But he afterwards found, that the castrated fish grew much larger than their usual size, were more fat, and always in season. This operation may be performed both on male and female fish; and the most eligible time for it is when the ovaries of the female have their ova in them, and when the vessels of the male, analogous to these, have their seminal matter in them; because, at this time, these vessels are more easily distinguished from the ureters, which convey the urine from the kidneys into the bladder, and are situated near the seminal vessels on each side of the spine; which, without sufficient attention, may be mistaken for the ovaries, especially when these last are empty. The time least proper for this operation, is just after they have spawned, because the fish are then too weak and languid to bear, with success, so severe an operation; however, with skill and care, it may be performed almost at any time. When a fish is to be castrated, it must be held in a wet cloth, with its belly upwards; then with a sharp penknife, having its point bent backwards, the operator cuts through the integuments of the rim of the belly, taking care not to wound any of the intestines. As soon as a small aperture is made, he carefully inserts a hooked pen-knife, and with this dilates the aperture from between the two fore-fins almost to the anus. He then, with two small blunt silver hooks, five or six inches long, and of this form P, by the help of an assistant, holds open the belly of the fish; and with a spoon or spatula, removes carefully the intestines from one side. When these are removed, you see the ureter, a small vessel, nearly in the direction of the spine, and also the ovary, a larger vessel, lying before it, nearer the integuments of the belly. This last vessel is taken up with a hook of the same kind with those before mentioned, and, after detaching it from the side far enough for the purpose, divided transversely with a pair of sharp scissars, care being taken that the intestines are not wounded or injured. After one of the ovaries has been divided, the operator proceeds to divide the other in the same manner; and then the divided integuments of the belly are sewed with silk, the stitches being inserted at a small distance from one another. Mr Tull observes farther, that the spawning time is very various; that trouts are full about Christmas; perch in February; pikes in March, and carp and tench in May; and that allowance must be made for climate and situation, with regard to the spawning of fish. When the fish are castrated, they are put into the water where they are intended to continue; and they take their chance in common with other fish, as though they were not castrated. With tolerable care, few die of the operation. *Phil. Trans.* vol. xlviii. Part 2. Art. 106.

Although we could not properly avoid inserting the above detail, it is presumed that few will be pleased with the invention. The operation is peculiarly cruel, and the purpose of it only a detestable piece of Apician refinement.

Feeding of Fishes. When they are fed in large pools or ponds, either malt boiled, or fresh grains, is the best food; thus carps may be raised and fed like capons, and tenches will feed as well. The care of feeding them is best committed to a gardener or the butler, who should be always at hand. When fed in a stew, any sort of grain boiled, especially peas, and malt coarsely ground, are proper food; also the grains after brewing, while fresh and sweet; but one bushel of malt not brewed will go as far as two of grains.

Stealing of Fish, by persons armed and disguised, is felony without benefit of clergy, by 9 Geo. I. cap. 22. See *Black Act*. And by 5 Geo. III. cap. 14. the penalty of transportation for seven years is inflicted on persons stealing or taking fish in any water, within a park, paddock, orchard, or yard; and on the receivers, aiders, and abettors; and a forfeiture of five pounds to the owner of the fishery is made payable by persons taking or destroying (or attempting so to do) any fish in any river or other water within any enclosed ground, being private property.

Preserving of Fish for Cabinets. Linnæus's method is, to expose them to the air; and when they acquire such a degree of putrefaction that the skin loses its cohesion to the body of the fish, it may be slid off almost like a glove; the two sides of this skin may then be dried upon paper like a plant, or one of the sides may be filled with plaster of Paris to give the subject a due plumpness. *Amæn. Acad.* tom. iii.

A fish may be prepared, after it has acquired this degree of putrefaction, by making a longitudinal incision on the belly, and carefully dissecting the fleshy part from the skin, which is but slightly attached to it in consequence of the putrescency. The skin is then to be filled with cotton and the antiseptic powder as directed for birds; and, lastly, to be sewed up where the incision was made.

Gold Fish. See Cyprinus, Ichthyology *Index*.

Gilding on Fish. In the posthumous papers of Mr Hooke, a method is described of gilding live craw fish, carps, &c. without injuring the fish. The cement for this purpose is prepared, by putting some burgundy pitch into a new earthen pot, and warming the vessel till it receives so much of the pitch as will stick round it; then strewing some finely powdered amber before the pitch when growing cold, adding a mixture of three pounds of linseed oil and one of oil of turpentine, covering the vessel, and boiling them for an hour over a gentle fire, and grinding the mixture, as it is wanted, with so much pumice-stone in fine powder as will reduce it to the consistence of paint. The fish being wiped dry, the mixture is spread upon it; and the gold-leaf being then laid on, and gently pressed down, the fish may be immediately put into water again, without any danger of the gold coming off, for the matter quickly grows firm in water.

Fish, in a ship, a plank or piece of timber, fastened to a ship's mast or yard, to strengthen it; which is done by nailing it on with iron spikes, and winding ropes hard about them.

Fishes, in *Heraldry*, are the emblems of silence and watchfulness; and are borne either upright, imbowed, extended, endorsed respecting each other, surmounting one another, fretted, &c.

In blazoning fishes, those borne feeding, should be termed *devouring*; all fishes borne upright and having fins, Fiſher.

fins, ſhould be blazoned *hauriant;* and thoſe borne tranſverſe the eſcutcheon, muſt be termed *naiant.*

Fish Ponds, thoſe made for the breeding or feeding of fiſh.

Fiſh ponds are no ſmall improvement of watery and boggy lands, many of which are fit for no other uſe. In making of a pond, its head ſhould be at the loweſt part of the ground, that the trench of the flood-gate or ſluice, having a good fall, may not be too long in emptying. The beſt way of making the head ſecure, is to drive in two or three rows of ſtakes above ſix feet long, at above four feet diſtance from each other, the whole length of the pond head, whereof the firſt row ſhould be rammed at leaſt about four feet deep. If the bottom is falſe, the foundation may be laid with quicklime; which ſlaking, will make it as hard as a ſtone. Some lay a layer of lime, and another of earth dug out of the pond, among the piles and ſtakes; and when theſe are well covered, drive in others as they ſee occaſion, ramming in the earth as before, till the pond head be of the height deſigned.

The dam ſhould be made ſloping on each ſide, leaving a waſte to carry off the over abundance of water in times of floods or rains; and as to the depth of the pond, the deepeſt part need not exceed ſix feet, riſing gradually in ſhoals towards the ſides, for the fiſh to ſun themſelves, and lay their ſpawn. Gravelly and ſandy bottoms, eſpecially the latter, are beſt for breeding; and a fat ſoil with a white fat water, as the waſhings of hills, commons, ſtreets, ſinks, &c. is beſt for fattening all ſorts of fiſh. For ſtoring a pond, carp is to be preferred for its goodneſs, quick growth, and great increaſe, as breeding five or ſix times a-year. A pond of an acre, if it be a feeding and not breeding one, will every year feed 200 carps of three years old, 300 of two years old, and 400 of a year old. Carps delight in ponds that have marl or clay bottoms, with plenty of weeds and graſs, whereon they feed in the hot months.

Ponds ſhould be drained every three or four years, and the fiſh ſorted. In breeding ones, the ſmaller ones are to be taken out, to ſtore other ponds with; leaving a good ſtock of females, at leaſt eight or nine years old, as they never breed before that age. In feeding ponds, it is beſt to keep them pretty near of a ſize.

FISHER, John, biſhop of Rocheſter, was born at Beverly in Yorkſhire, in the year 1459, and educated in the collegiate church of that place. In 1484, he removed to Michael houſe in Cambridge, of which college he was elected maſter in the year 1495. Having applied himſelf to the ſtudy of divinity, he took orders; and, becoming eminent as a divine, attracted the notice of Margaret counteſs of Richmond, mother of Henry VII. who made him her chaplain and confeſſor. In 1501, he took the degree of doctor of divinity, and the ſame year was elected chancellor of the univerſity. In the year following, he was appointed Lady Margaret's firſt divinity profeſſor; and in 1504, conſecrated biſhop of Rocheſter; which ſmall biſhopric he would never reſign, though he was offered both Ely and Lincoln. It is generally allowed, that the foundation of the two colleges of Chriſt church and St John's, in Cambridge, was entirely owing to Biſhop Fiſher's perſuaſion and influence with the counteſs of Richmond: he not only formed the deſign, but ſuperintended the execution. On the promulgation of Martin Luther's doctrine, our biſhop was the firſt to enter the liſts againſt him. On this occaſion he exerted all his influence, and is generally ſuppoſed to have written the famous book by which Henry VIII. obtained the title of *Defender of the Faith.* Hitherto he continued in favour with the king; but in 1527, oppoſing his divorce, and denying his ſupremacy, the implacable Harry determined, and finally effected, his deſtruction. In 1543, the parliament found him guilty of miſpriſion of treaſon, for concealing certain prophetic ſpeeches of a fanatical impoſtor, called the *Holy Maid of Kent*, relative to the king's death; and condemned him, with five others, in loſs of goods, and impriſonment during his majeſty's pleaſure; but he was releaſed on paying 300l. for the king's uſe.

Fiſher, Fiſhery.

King Henry being now married to Anne Boleyn, his obſequious parliament took an oath of allegiance proper for the occaſion. This oath the biſhop of Rocheſter ſteadily refuſed; alleging, that his conſcience could not be convinced that the king's firſt marriage was againſt the law of God. For refuſing this oath of ſucceſſion, he was attainted by the parliament of 1534; and committed to the Tower, where he was cruelly treated, and were he would probably have died a natural death, had not the pope created him a cardinal. The king, now poſitively determined on his deſtruction, ſent Rich, the ſolicitor general, under the pretence of conſulting the biſhop on a caſe of conſcience, but really with a deſign to draw him into a converſation concerning the ſupremacy. The honeſt old biſhop ſpoke his mind without ſuſpicion or reſerve, and an indictment and conviction of high treaſon was the conſequence. He was beheaded at Tower Hill, on the 22d of June 1535, in the 77th year of his age. Thus died this good old prelate; who, notwithſtanding his inflexible enmity to the Reformation, was undoubtedly a learned, pious, and honeſt man. He wrote ſeveral treatiſes againſt Luther, and other works, which were printed at Wurtzburg, in 1597, in one volume folio.

FISHERY, a place where great numbers of fiſh are caught.

The principal fiſheries for ſalmon, herring, mackrel, pilchards, &c. are along the coaſts of Scotland, England, and Ireland: for cod, on the banks of Newfoundland: for whales, about Greenland; and for pearls, in the Eaſt and Weſt Indies.

Free Fishery, in *Law*, or an excluſive right of fiſhing in a public river, is a royal franchiſe; and is conſidered as ſuch in all countries where the feodal polity has prevailed: though the making ſuch grants, and by that means appropriating, what it ſeems unnatural to reſtrain, the uſe of running water, was prohibited for the future by King John's Great Charter; and the rivers that were fenced in his time were directed to be laid open, as well as the foreſts to be disforeſted. This opening was extended by the ſecond and third charters of Henry III. to thoſe alſo that were fenced under Richard I.; ſo that a franchiſe of free fiſhery ought now to be as old at leaſt as the reign of Henry II. This differs from a *ſeveral of piſcary*, becauſe he that has a ſeveral fiſhery muſt alſo be the owner of the ſoil, which in a free fiſhery is not requiſite. It differs alſo from a *common* fiſhery in that the free fiſhery is an excluſive right, *Blackſtone's Comment.*

Fishery.

right, the common fishery is not so: and therefore, in a free fishery, a man has property in the fish before they are caught; in a common piscary, not till afterwards. Some indeed have considered a *free* fishery not as a royal franchise; but merely as a private grant of a liberty to fish in the *several* fishery of the grant. But the considering such right as originally a flower of the prerogative, till restrained by Magna Charta, and derived by royal grant (previous to the reign of Richard I.) to such as now claim it by prescription, may remove some difficulties in respect to this matter with which our law books are embarrassed.

FISHERY, denotes also the commerce of fish, more particularly the catching them for sale.

Were we to enter into a very minute and particular consideration of fisheries, as at present established in this kingdom, this article would swell beyond its proper bounds; because, to do justice to a subject of such concernment to the British nation, requires a very ample and distinct discussion. We shall, however, observe, that since the Divine Providence hath so eminently stored the coasts of Great Britain and Ireland with the most valuable fish; and since fisheries, if successful, become permanent nurseries for breeding expert seamen; it is not only a duty we owe to the Supreme Being, not to despise the wonderful plenty he hath afforded us, by neglecting to extend this branch of commerce to the utmost; but it is a duty we owe to our country, for its natural security, which depends upon the strength of our royal navy. No nation can have a navy where there is not a fund of business to breed and employ seamen without any expence to the public, and no trade is so well calculated for training up these useful members of society as fisheries.

The situation of the British coasts is the most advantageous in the world for catching fish: the Scottish islands, particularly those to the north and west, lie most commodious for carrying on the fishing trade to perfection; for no country in Europe can pretend to come up to Scotland in the abundance of the finest fish, with which its various creeks, bays, rivers, lakes, and coasts, are replenished. Of these advantages the Scots seem indeed to have been abundantly sensible; and their traffic in herrings, the most valuable of all the fisheries, is noticed in history so early as the ninth century. The frequent laws which were enacted in the reigns of James III. IV. and V. discover a steady determined zeal for the benefit of the native subjects, and the full restoration of the fisheries, which the Dutch had latterly found means to engross; and do honour to the memory of those patriots whom modern times affect to call barbarians.

The expedition of James V. to the Hebrides and western parts of the Highlands and his assiduity in exploring and sounding the harbours, discovered a fixed resolution in that active prince, to civilize the inhabitants, to promote the valuable fisheries at their doors, and to introduce general industry. His death, at an early period, and the subsequent religious and civil commotions in the kingdom, frustrated those wise designs, and the western fisheries remained in their original state of neglect. At length, 1602, James VI. resumed the national purposes which had been thus chalked out by his grandfather. "Three towns (says Dr Robertson) which might serve as a retreat for the industrious, and a nursery for arts and commerce, were appointed to be built in different parts of the Highlands; one in Cantire, another in Lochaber, and a third in the isle of Lewis; and in order to draw the inhabitants thither, all the privileges of the royal boroughs were to be conferred upon them. Finding it, however, to be no easy matter to inspire the inhabitants of those countries with the love of industry, a resolution was taken to plant amongst them colonies of people from the more industrious counties. The first experiment was made in the isle of Lewis; and as it was advantageously situated for the fishing trade (a source from which Scotland ought naturally to derive great wealth), the colony transported thither was drawn out of Fife, the inhabitants of which were well skilled in that branch of commerce. But before they had remained there long enough to manifest the good effects of this institution, the islanders, enraged at seeing their country occupied by those intruders, took arms, and surprising them in the night time, murdered some of them, and compelled the rest to abandon the settlement. The king's attention being soon turned to other objects, particularly to his succession to the English crown, we hear no more of this salutary project."

The Scottish fisheries were, however, resumed by Charles I. who "ordained an association of the three kingdoms, for a general fishing within the hail seas and coasts of his majesty's said kingdoms; and for the government of the said association, ordained, that there should be a standing committee chosen and nominated by his majesty, and his successors from time to time." &c. &c. Several persons of distinction embarked in the design, which the king honoured with his patronage, and encouraged by his bounty. He also ordered lent to be more strictly observed; prohibited the importation of fish taken by foreigners; and agreed to purchase from the company his naval stores and the fish for his fleets. Thus the scheme of establishing a fishery in the Hebrides began to assume a favourable aspect; but all the hopes of the adventurers were frustrated by the breaking out of the civil wars, and the very tragical death of their benefactor.

In 1661, Charles II. the duke of York, Lord Clarendon, and other persons of rank and fortune, resumed the business of the fisheries with greater vigour than any of their predecessors. For this purpose the most salutary laws were enacted by the parliaments of England and Scotland; in virtue of which, all materials used in, or depending upon, the fisheries, were exempted from all duties, excises, or imposts whatever. In England, the company were authorised to set up a lottery, and to have a voluntary collection in all parish churches; houses of entertainment, as taverns, inns, ale-houses, were to take one or more barrels of herrings, at the stated price of 30s. per barrel; and 2s. 6d. per barrel was to be paid to the stock of this company on all imported fish taken by foreigners. Some Dutch families were also invited, or permitted, to settle in Stornaway: the herrings cured by the Royal English company gave general satisfaction, and, as mentioned above, brought a high price for those days. Every circumstance attending this new establishment seemed to be the result of a judicious plan and thorough knowledge of the business, Fishery. business, when the necessities of the king obliged him to withdraw his subscription or bounty; which gave such umbrage to the parties concerned, that they soon after dissolved.

In 1677, a new royal company was established in England, at the head of which was the duke of York, the earl of Derby, &c. Besides all the privileges which former companies had enjoyed, the king granted this new company a perpetuity, with power to purchase lands; and also 20l. to be paid them annually, out of the customs of the port of London, for every dogger or buss they should build and send out for seven years to come. A stock of 10,980l. was immediately advanced, and afterwards 1600l. more. This small capital was soon exhausted in purchasing and fitting out busses, with other incidental expences. The company, made, however, a successful beginning; and one of their busses or doggers actually took and brought home 32,000 cod fish; other vessels had also a favourable fishery. Such favourable beginnings might have excited fresh subscriptions, when an unforeseen event ruined the whole design beyond the possibility of recovery. Most of the busses had been built in Holland, and manned with Dutchmen; on which pretence the French, who were then at war with Holland, seized six out of seven vessels, with their cargoes and fishing tackle: and the company being now in debt, sold, in 1680, the remaining stores, &c. A number of gentlemen and merchants raised a new subscription of 60,000l. under the privileges and immunities of the former charter. This attempt also came to nothing, owing to the death of the king, and the troubles of the subsequent reign.

Soon after the Revolution this business was again resumed, and upon a more extensive scale; the proposed capital being 300,000l. of which 100,000l. was to have been raised by the surviving patentees or their successors, and 200,000l. by new subscribers. Copies of the letters patent, the constitution of the company, and terms of subscription, were lodged at sundry places in London and Westminister, for the perusal of the public, while the subscription was filling. It is probable, that King William's partiality to the Dutch fisheries, the succeeding war, or both of these circumstances, frustrated this new attempt; of which we have no farther account in the annals of that reign or since.

The Scottish parliament had also, during the three last reigns, passed sundry acts for erecting companies and promoting the fisheries; but the intestine commotions of that country, and the great exertions which were made for the Darien establishment, enfeebled all other attempts, whether collectively or by individuals, within that kingdom.

In 1749, his late majesty having, at the opening of the parliament, warmly recommended the improvement of the fisheries, the house of commons appointed a committee to inquire into the state of the herring and white fisheries, and to consider of the most probable means of extending the same. All ranks of men were elevated with an idea of the boundless riches that would flow into the kingdom from this source. A subscription of 500,000l. was immediately filled in the city, by a body of men who were incorporated for 21 years by the name of *The Society of the Free British Fishery*. Every encouragement was held out by government, both to the society, and to individuals who might embark in this national business. A bounty of 36s. per ton was to be paid annually out of the customs, for 14 years, to the owners of all decked vessels or busses, from 20 to 80 tons burden, which should be built after the commencement of the act, for the use of, and fitted out and employed in, the said fisheries, whether by the society or any other persons. At the same time numerous pamphlets and newspaper essays came forth; all pretending to elucidate the subject, and to convince the public with what facility the herring fisheries might be transferred from Dutch to British hands. This proved, however, a more arduous task than had been foreseen by superficial speculators. The Dutch were frugal in their expenditures and living; perfect masters of the arts of fishing and curing, which they had carried to the greatest height and perfection. They were in full possession of the European markets; and their fish, whether deserving or otherwise, had the reputation of superior qualities to all others taken in our seas. With such advantages, the Dutch not only maintained their ground against this formidable company, but had also the pleasure of seeing the capital gradually sinking, without having procured an adequate return to the adventurers; notwithstanding various aids and efforts of government from time to time in their favour, particularly in 1757, when an advance of 20s. per ton was added to the bounty.

In 1786 the public attention was again called to the state of the British fisheries, by the suggestions of Mr Dempster in the house of commons, and by different publications that appeared upon the subject: in consequence of which the minister suffered a committee to be named, to inquire into this great source of national wealth. To that committee it appeared, that the best way of improving the fisheries was to encourage the inhabitants living nearest to the seat of them to become fishers: And it being found that the north-western coast of the kingdom, though abounding with fish and with fine harbours, was utterly destitute of towns, an act was passed for incorporating certain persons therein named, by the style of "*The British Society* for extending of the fisheries and improving the sea coasts of the kingdom;" and to enable them to subscribe a joint stock, and therewith to purchase lands, and build thereon free towns, villages, and fishing stations, in the Highlands and islands in that part of Great Britain called Scotland, and for other purposes. The isle of Mull, Loch Broom, the isles of Sky and of Cannay, have already been pitched upon as proper situations for some of these towns. The progress of such an undertaking from its nature must be slow, but still slower when carried on with a limited capital arising from the subscriptions of a few public-spirited individuals. But it is not to be doubted but that it will ultimately tend to the increase of our fisheries, and to the improvement of the Highland part of this kingdom. Its tendency is also to lessen the emigration of a brave and industrious race of inhabitants, too many of whom have already removed with their families to America.

1. *Anchovy Fishery.* The anchovy is caught in the months of May, June, and July, on the coasts of Catalonia, Provence, &c. at which season it constantly repairs up the straits of Gibraltar, into the Mediterranean.

Collins

Fishery. Collins says they are also found in plenty on the western coasts of England and Wales.

The fishing for them is chiefly in the night time; when a light being put on the stern of their little fishing vessels, the anchovies flock round, and are caught in the nets. But then it is asserted to have been found by experience, that anchovies taken thus by fire, are neither so good, so firm, nor so proper for keeping, as those which are taken without fire.

When the fishery is over, they cut off the heads, take out their gall and guts, and then lay them in barrels, and salt them. The common way of eating anchovies is with oil, vinegar, &c. in order to which they are first boned, and the tails, fins, &c. slipped off.—Being put on the fire, they dissolve almost in any liquor. Or they are made into a sauce by minching them with pepper, &c. Some also pickle anchovies in small delft or earthen pots, made on purpose, of two or three pounds weight, more or less, which they cover with plaster to keep them the better. Anchovies should be chosen small, fresh pickled, white on the outside and red within. They must have a round back; for those which are flat or large are often nothing but sardines. Besides these qualities, the pickle, on opening the pots or barrels, must be of a good taste, and not have lost its flavour.

2. *Cod Fishery*. There are two kinds of cod fish; the one green or white cod, and the other dried or cured cod; though it is all the same fish, differently prepared; the former being sometimes salted and barrelled, then taken out for use; and the latter, having lain some competent time in salt, dried in the sun or smoke. We shall therefore speak of each of these apart; and first of the

Green. The chief fisheries for green cod are in the bay of Canada, on the great bank of Newfoundland, and on the isle of St Peter, and the isle of Sable; to which places vessels resort from divers parts both of Europe and America. They are from 100 to 150 tons burden, and will catch between 30,000 and 40,000 cod each. The most essential part of the fishery is, to have a master who knows how to cut up the cod, one who is skilled to take off the head properly, and above all a good salter, on which the preserving of them, and consequently the success of the voyage depends. The best season is from the beginning of February to the end of April; the fish, which in the winter retire to the deepest water, coming then on the banks, and fattening extremely. What is caught from March to June keeps well; but those taken in July, August, and September, when it is warm on the banks, are apt to spoil soon. Every fisher takes but one at a time: the most expert will take from 350 to 400 in a day; but that is the most, the weight of the fish and the great coldness on the bank fatiguing very much. As soon as the cod are caught, the head is taken off; they are opened, gutted, and salted; and the salter stows them in the bottom of the hold, head to tail, in beds a fathom or two square; laying layers of salt and fish alternately, but never mixing fish caught on different days. When they have lain thus three or four days to drain off the water, they are replaced in another part of the ship, and salted again; where they remain till the vessel is loaded. Sometimes they are cut in thick pieces, and put in barrels for the conveniency of carriage. Fishery.

Dry. The principal fishery for this article is, from Cape Rose to the Bay des Exports, along the coast of Placentia, in which compass there are divers commodious ports for the fish to be dried in. These, though of the same kind with the fresh cod, are much smaller, and therefore fitter to keep, as the salt penetrates more easily into them. The fishery of both is much alike; only this latter is most expensive, as it takes up more time and employs more hands, and yet scarce half so much salt is spent in this as in the other. The bait is herrings, of which great quantities are taken on the coast of Placentia. When several vessels meet and intend to fish in the same part, he whose shallop first touches ground becomes entitled to the quality and privileges of admiral: he has the choice of his station, and the refusal of all the wood on the coast at his arrival. As fast as the masters arrive, they unrigg all their vessels, leaving nothing but the shrouds to sustain the masts; and in the mean time the mates provide a tent on shore, covered with branches of trees, and sails over them, with a scaffold of great trunks of pines, 12, 15, 16, and often 20 feet high, commonly from 40 to 60 feet long, and about one-third as much in breadth. While the scaffold is preparing, the crew are a-fishing; and as fast as they catch, they bring their fish ashore, and open and salt them upon moveable benches; but the main salting is performed on the scaffold. When the fish have taken salt, they wash and hang them to drain on rails; when drained, they are laid on kinds of stages, which are small pieces of wood laid across, and covered with branches of trees, having the leaves stripped off for the passage of the air. On these stages, they are disposed, a fish thick, head against tail, with the back uppermost, and are turned carefully four times every 24 hours. When they begin to dry, they are laid in heaps 10 or 12 thick, in order to retain their warmth; and every day the heaps are enlarged till they become double their first bulk; then two heaps are joined together, which they turn every day as before: lastly, they are salted again, beginning with those first salted; and being laid in huge piles, they remain in that situation till they are carried on board the ships, where they are laid on the branches of trees disposed for that purpose, upon the ballast, and round the ship, with mats to prevent their contracting any moisture.

There are four sorts of commodities drawn from cod, viz. the sounds, the tongues, the roes, and the oil extracted from the liver. The first is salted at the fishery together with the fish, and put in barrels from 600 to 700 pounds. The tongues are done in like manner, and brought in barrels from 400 to 500 pounds. The roes are also salted in barrels, and serve to cast into the sea to draw fish together, and particularly pilchards. The oil comes in barrels, from 400 to 520 pounds, and is used in dressing leather. In Scotland, they catch a small kind of cod on the coasts of Buchan, and all along the Murray frith on both sides; as also in the friths of Forth, Clyde, &c. which is much esteemed. They salt and dry them in the sun upon rocks, and sometimes in the chimney.

3. *Coral Fishery*. See Coral.

Fishery.

4. *Herring* FISHERY. Our great ſtations for this fiſhery are off the Shetland and Weſtern iſles, and off the coaſt of Norfolk, in which the Dutch alſo ſhare. There are two ſeaſons for fiſhing herring; the firſt from June to the end of Auguſt; and the ſecond in autumn, when the fogs become very favourable for this kind of fiſhing. The Dutch begin their herring fiſhing on the 24th of June, and employ a vaſt number of veſſels therein, called *buſſes*, being between 45 and 60 tons burden each, and carrying three or four ſmall cannon. They never ſtir out of port, without a convoy, unleſs there be enough together to make about 18 or 20 cannon among them, in which caſe they are allowed to go in company. Before they go out they make a verbal agreement, which has the ſame force as if it were in writing. The regulations of the admiralty of Holland are partly followed by the French and other nations, and partly improved and augmented with new ones; as, that no fiſher ſhall caſt his net within 100 fathoms of another boat: that while the nets are caſt, a light ſhall be kept on the hind part of the veſſel: that when a boat is by any accident obliged to leave off fiſhing, the light ſhall be caſt into the ſea; that when the greater part of a fleet leaves off fiſhing, and caſts anchor, the reſt ſhall do the ſame, &c.

‡ *Hiſt. of Commerce.*

Mr Anderſon ‡ gives to the Scots a knowledge of great antiquity in the herring fiſhery. He ſays that the Netherlanders reſorted to theſe coaſts as early as A. D. 836, to purchaſe ſalted fiſh of the natives, but, impoſing on the ſtrangers, they learned the art, and took up the trade, in after-times of ſuch immenſe emolument to the Dutch.

Sir Walter Raleigh's obſervations on that head, extracted from the ſame author, are extremely worthy the attention of the curious, and excite reflections on the vaſt ſtrength reſulting from the wiſdom of well applied induſtry.

In 1603, he remarks, the Dutch ſold to different nations as many herrings as amounted to 1,759,000l. ſterling. In the year 1615, they at once ſent out 2000 buſſes, and employed in them 37,000 fiſhermen. In the year 1618, they ſent out 3000 ſhips, with 50,000 men to take the herrings, and 9000 more ſhips to tranſport and ſell the fiſh; which by ſea and land employed 150,000 men, beſides thoſe firſt mentioned. All this wealth was gotten on our coaſts, while our attention was taken up in a diſtant whale fiſhery.

The Scottiſh monarchs for a long time ſeemed to direct all their attention to the preſervation of the ſalmon fiſhery, probably becauſe their ſubjects were ſuch novices in ſea affairs. At length James III. endeavoured to ſtimulate his great men to theſe patriotic undertakings: for by an act of his third parliament, he compelled "certain lords ſpiritual and temporal, and burrows, to make ſhips, buſſes, and boats, with nets and other pertinents, for fiſhing. That the ſame ſhould be made in each burgh; in number according to the ſubſtance of each burgh, and the leaſt of them to be of twenty tons: and that all idle men be compelled by the ſheriffs in the country to go on board the ſame."

Numerous indeed have been the attempts made at different periods to ſecure this treaſure to ourſelves, but without ſucceſs. In the late reign, a very ſtrong effort was made, and bounties allowed for the encouragement of Britiſh adventurers: the firſt was of 30s. per ton to every buſs of 70 tons and upwards. This bounty was afterwards raiſed to 50s. per ton, to be paid to ſuch adventurers as were entitled to it by claiming it at the places of rendezvous. The buſſes are from 20 to 90 tons burden, but the beſt ſize is 80. A veſſel of 80 tons ought to take ten laſts, or 120 barrels of herrings, to clear expences, the price of the fiſh to be admitted to be a guinea a barrel. A ſhip of this ſize ought to have 18 men, and three boats: one of 20 tons ſhould have ſix men; and every five tons above require an additional hand. To every ton are 280 yards of nets; ſo a veſſel of 80 tons carries 20,000 ſquare yards: each net is 12 yards long, and 10 deep, and every boat takes out from 20 to 30 nets, and puts them together, ſo as to form a long train; they are ſunk at each end of the train by a ſtone, which weighs it down to the full extent: the top is ſupported by buoys, made of ſheepsſkin, with a hollow ſtick at the mouth faſtened tight: through this the ſkin is blown up, and then ſtopped with a peg, to prevent the eſcape of the air. Sometimes theſe buoys are placed at the top of the nets: at other times the nets are ſuffered to ſink deeper, by the lengthening the cords faſtened to them, every cord being for that purpoſe 10 or 12 fathoms long. But the beſt fiſheries are generally in more ſhallow water.

§ *Voyage to the Hebrides.*

Of the Scots fiſhery in the Weſtern Iſles, the following account is given by Mr Pennant §. "The fiſhing is always performed in the night, unleſs by accident. The buſſes remain at anchor, and ſend out their boats a little before ſunſet; which continue out, in winter and ſummer, till day light; often taking up and emptying their nets, which they do 10 or 12 times in a night, in caſe of good ſucceſs. During winter it is a moſt dangerous and fatiguing employ, by reaſon of the greatneſs and frequency of the gales in theſe ſeas, and in ſuch gales are the moſt ſucceſsful captures: but by the Providence of heaven, the fiſhers are ſeldom loſt; and, what is wonderful, few are viſited with illneſs. They go out well prepared, with a warm great coat, boots, and ſkin aprons, and a good proviſion of beef and ſpirits. The ſame good fortune attends the buſſes, which in the tempeſtuous ſeaſon, and in the darkeſt nights, are continually ſhifting, in theſe narrow ſeas, from harbour to harbour. Sometimes 80 barrels of herrings are taken in a night by the boats of a ſingle veſſel. It once happened, in Loch Slappan, in Sky, that a buſs of 80 tons might have taken 200 barrels in one night, with 10,000 ſquare yards of net; but the maſter was obliged to deſiſt, for want of a ſufficient number of hands to preſerve the capture. The herrings are preſerved by ſalting, after the entrails are taken out. This laſt is an operation performed by the country people, who get three halfpence per barrel for their trouble; and ſometimes, even in the winter, can gain fifteen pence a-day. This employs both women and children; but the ſalting is only intruſted to the crew of the buſſes. The fiſh are laid on their backs in the barrels, and layers of ſalt between them. The entrails are not loſt, for they are boiled into an oil: 8000 fiſh will yield ten gallons, valued at one ſhilling the gallon. A veſſel of 80 tons takes out 144 barrels of ſalt; a drawback of 2s. 8d. is allowed for each barrel uſed by the foreign or Iriſh exportation of the fiſh; but there is a duty of 1s. per barrel for the home conſumption, and the ſame

Fishery.

for those sent to Ireland. The barrels are made of oak staves chiefly from Virginia; the hoops from several parts of our own island, and are either of oak, birch, hazel or willow; the last from Holland, liable to a duty. The barrels cost about 3s. each, they hold from 500 to 800 fish, according to the size of the fish; and are made to contain 32 gallons. The barrels are inspected by proper officers; a cooper examines if they are statutable and good; if faulty, he destroys them, and obliges the maker to stand to the loss.

"Loch Broom has been celebrated for three or four centuries as the resort of herrings. They generally appear here in July; those that turn into this bay are part of the brigade that detaches itself from the western column of that great army which annually deserts the vast depths of the arctic circle, and comes, heaven-directed, to the seats of population, offered as a cheap food to millions, whom wasteful luxury or iron-hearted avarice hath deprived, by enhancing the price, of the wonted supports of the poor. The migration of these fish from their northern retreat is regular; their visits to the Western isles and coasts certain; but their attachment to one particular loch extremely precarious. All have their turns: that which swarmed with fish one year, is totally deserted the following; yet the next loch to it may be crowded with the shoals. These changes of place give often full employ to the busses, who are continually shifting their harbour in quest of news respecting these important wanderers. They commonly appear here in July; the latter end of August they go into deep water, and continue there for some time, without any apparent cause: in November, they return to the shallows, when a new fishery commences, which continues till January: at that time the herrings become full of roe, and are useless as articles of commerce. Some doubt, whether those herrings that appear in November are not part of a new migration; for they are as fat, and make the same appearance, as those that composed the first. The signs of the arrival of the herrings are flocks of gulls, who catch up the fish while they skim on the surface, and of gannets, who plunge and bring them up from considerable depths. Both these birds are closely attended to by the fishers. Cod fish, haddocks, and dog fish, follow the herrings in vast multitudes: these voracious fish keep on the outsides of the columns, and may be a concurrent reason of driving the shoals into bays and creeks. In summer, they come into the bays generally with the warmest weather, and with easy gales. During winter, the hard gales from north-west are supposed to assist in forcing them into shelter. East winds are very unfavourable to the fishery."

Herrings are cured either white or pickled, or red.

Of the *first*, those done by the Dutch are the most esteemed, being distinguished into four sorts, according to their sizes; and the best are those that are fat, fleshy, firm, and white, salted the same day they are taken, with good salt, and well barrelled. The British cured herrings are little inferior, if not equal, to the Dutch: for in spite of all their endeavours to conceal the secret, their method of curing, lasting, or casking the herrings, has been discovered, and is as follows. After they have hauled in their nets, which they drag in the stern of their vessels backwards and forwards in traversing the coast, they throw them upon the ship's deck, which is cleared of every thing for that purpose: the crew is separated into sundry divisions, and each division has a peculiar task; one part opens and guts the herrings, leaving the milts and roes; another cures and salts them, by lining or rubbing their inside with salt; the next packs them, and between each row and division they sprinkle handfuls of salt; lastly, the cooper puts the finishing hand to all, by heading the casks very tight, and stowing them in the hold.

Red herrings must lie 24 hours in the brine, inasmuch as they are to take all their salt there; and when they are taken out, they are spitted, that is, strung by the head on little wooden spits, and then hung in a chimney made for that purpose. After which, a fire of brushwood, which yields a deal of smoke, but no flame, being made under them, they remain there till sufficiently smoked and dried, and are afterwards barrelled up for keeping.

5. *Lobster* FISHERY. Lobsters are taken along the British channel, and on the coast of Norway, whence they are brought to London for sale; and also in the frith of Edinburgh, and on the coast of Northumberland. By 10 and 11 W. III. cap. 24. no lobster is to be taken under eight inches in length, from the peak of the nose to the end of the middle fin of the tail; and by 9 G. II. cap. 33. no lobsters are to be taken on the coast of Scotland from the 1st of June to the 1st of September.

6. *Mackerel* FISHERY. The mackerel is a summer fish of passage, found in large shoals, in divers parts of the ocean, not far north; but especially on the French and English coasts. The fishing is usually in the months of April, May, and June, and even July, according to the place. They enter the English channel in April, and proceed up to the straits of Dover as the summer advances; so that by June they are on the coasts of Cornwall, Sussex, Normandy, Picardy, &c. where the fishery is most considerable. They are an excellent food fresh; and not to be despised, when well prepared, pickled, and put up in barrels; a method of preserving them chiefly used in Cornwall.

The fish is taken two ways; either with a line or nets: the latter is the more considerable, and is usually performed in the night-time. The rules observed in the fishing for mackerel are much the same as those already mentioned in the fishery of herrings.

There are two ways of pickling them: the first is, by opening and gutting them, and filling the belly with salt, crammed in as hard as possible with a stick; which done, they range them in strata or rows, at the bottom of the vessel, strewing salt between the layers. In the second way, they put them immediately into tubs full of brine, made of fresh water and salt; and leave them to steep, till they have imbibed salt enough to make them keep; after which, they are taken out, and barrelled up, taking care to press them close down.

Mackerel are not cured or exported as merchandise, except a few by the Yarmouth and Leostoff merchants, but are generally consumed at home; especially in the city of London, and the sea-ports between the Thames and Yarmouth, east, and the Land's End of Cornwall, west.

7. Oyster

Fishery.

‡ See *Ostrea*, Conchology Index.

7. *Oyster* FISHERY ‡. This fishery is principally carried on at Colchester in Essex; Feversham and Milton in Kent; the Isle of Wight; the Swales of the Medway; and Tenby on the coast of Wales. From Feversham, and adjacent parts, the Dutch have sometimes loaded a hundred large hoys with oysters in a year. They are also taken in great quantities near Portsmouth, and in all the creeks and rivers between Southampton and Chichester: many of which are carried about by sea to London and to Colchester, to be fed in the pits about Wavenhoe and other places.

8. *Pearl* FISHERY. See PEARL, CONCHOLOGY *Index*, and CEYLON.

9. *Pilchard* FISHERY. The chief pilchard fisheries are along the coasts of Dalmatia, on the coast of Bretagne, and along the coasts of Cornwall and Devonshire. That of Dalmatia is very plentiful: that on the coasts of Bretagne employs annually about 300 ships. Of the pilchard fishery on the coast of Cornwall the following account is given by Dr Borlase: "It employs a great number of men on the sea, training them thereby to naval affairs; employs men, women, and children, on land, in salting, pressing, washing and cleaning; in making boats, nets, ropes, casks, and all the trades depending on their construction and sale. The poor are fed with the offals of the captures, the land with the refuse of the fish and salt; the merchant finds the gains of commission and honest commerce, the fisherman the gains of the fish. Ships are often freighted hither with salt, and into foreign countries with the fish, carrying off at the same time part of our tin. Of the usual produce of the great number of hogsheads exported each year for ten years from 1747 to 1756 inclusive, from the four ports of Fowey, Falmouth, Penzance, and St Ives, it appears that Fowey has exported yearly 1732 hogsheads; Falmouth, 14,631 hogsheads and two thirds; Penzance and Mounts-Bay 12,149 hogsheads and one third; St Ives, 1280 hogsheads: in all amounting to 29,795 hogsheads. Every hogshead for ten years last past, together with the bounty allowed for each hogshead exported, and the oil made out of each hogshead, has amounted, one year with another at an average, to the price of 1l. 13s. 3d.; so that the cash paid for pilchards exported has, at a medium, annually amounted to the sum of 49,532l. 10s."—The numbers that are taken at one shooting out of the nets are amazingly great. Mr Pennant says, that Dr Borlase assured him, that on the 5th of October 1767, there were at one time enclosed in St Ives's Bay 7000 hogsheads, each hogshead containing 35,000 fish, in all 245 millions.

The pilchards naturally follow the light, which contributes much to the facility of the fishery; the season is from June to September. On the coasts of France they make use of the roes of the cod fish as a bait; which, thrown into the sea, makes them rise from the bottom, and run into the nets. On our coasts there are persons posted ashore, who, spying by the colour of the water where the shoals are, make signs to the boats to go among them to cast their nets. When taken, they are brought on shore to a warehouse, where they are laid up in broad piles, supported with backs and sides; and as they are piled, they salt them with bay salt; in which lying to soak for 30 or 40 days, they run out a deal of blood, with dirty pickle and bittern: then they wash them clean in sea water; and, when dry, barrel and press them hard down to squeeze out the oil, which issues out at a hole in the bottom of the cask.

† See *Salmo*, Ichthyology Index.

10. *Salmon* FISHERY. The chief salmon fisheries in Europe are in England, Scotland, and Ireland, in the rivers, and sea coasts adjoining to the river mouths. The most distinguished for salmon in Scotland are, the river Tweed, the Clyde, the Tay, the Dee, the Don, the Spey, the Ness, the Bewly, &c. in most of which it is very common, about the height of summer, especially if the weather happens to be very hot, to catch four or five score salmon at a draught. The chief rivers in England for salmon are, the Tyne, the Trent, the Severn, and the Thames. The fishing is performed with nets, and sometimes with a kind of locks or wears made on purpose, which in certain places have iron or wooden grates so disposed, in an angle, that being impelled by any force in a contrary direction to the course of the river, they may give way and open a little at the point of contact, and immediately shut again, closing the angle. The salmon, therefore, coming up into the rivers, are admitted into these grates, which open, and suffer them to pass through, but shut again, and prevent their return. The salmon is also caught with a spear, which they dart into him when they see him swimming near the surface of the water. It is customary likewise to catch them with a candle and lanthorn, or wisp of straw set on fire; for the fish naturally following the light, are struck with the spear, or taken in a net spread for that purpose, and lifted with a sudden jerk from the bottom.

‡ Brit. Zool. III. 289.

"The capture of salmon in the Tweed, about the month of July (says Mr Pennant †) is prodigious. In a good fishery, often a boat load, and sometimes near two, are taken in a tide: some few years ago there were above 700 fish taken at one hawl, but from 50 to 100 is very frequent. The coopers in Berwick then begin to salt both salmon and grilses in pipes and other large vessels, and afterwards barrel them to send abroad, having then far more than the London markets can take off their hands.

"Most of the salmon taken before April, or to the setting in of the warm weather, is sent fresh to London in baskets: unless now and then the vessel is disappointed by contrary winds of sailing immediately; in which case the fish is brought ashore again to the coopers offices, and boiled, pickled, and kitted, and sent to the London markets by the same ship, and fresh salmon put in the baskets in lieu of the stale ones. At the beginning of the season, when a ship is on the point of sailing, a fresh clean salmon will sell from a shilling to eighteen pence a pound; and most of the time that this part of the trade is carried on, the prices are from five to nine shillings per stone; the value rising and falling according to the plenty of fish, or the prospect of a fair or foul wind. Some fish are sent in this manner to London the latter end of September, when the weather grows cool; but then the fish are full of large roes, grow very thin bellied, and are not esteemed either palatable or wholesome.

"The season for fishing in the Tweed begins November 30th, but the fishermen work very little till after Christmas: it ends on Michaelmas day; yet the corporation of Berwick (who are conservators of the river)

Fishery. river) indulge the fishermen with a fortnight past that time, on account of the change of the style.

"There are on the river 41 considerable fisheries, extending upwards about 14 miles from the mouth, (the others above being of no great value), which are rented for near 5400l. per annum: the expence attending the servants wages, nets, boats, &c. amount to 5000l. more; which together makes up the sum 10,400l. Now, in consequence, the produce must defray all, and no less than 20 times that sum of fish will effect it; so that 208,000 salmon must be caught there one year with another.

"Scotland possesses great numbers of fine fisheries on both sides of that kingdom. The Scotch in early times had most severe laws against the killing of this fish; for the third offence was made capital, by a law of James IV. Before that, the offender had power to redeem his life. They were thought in the time of Henry VI. a present worthy of a crowned head: for in that reign the queen of Scotland sent to the duchess of Clarence 10 casks of salted salmon; which Henry directed to pass duty free. The salmon are cured in the same manner as at Berwick, and a great quantity is sent to London in the spring; but after that time, the adventurers begin to barrel and export them to foreign countries; but we believe that commerce is far less lucrative than it was in former times, partly owing to the great increase of the Newfoundland fishery, and partly to the general relaxation of the discipline of abstinence in the Romish church.

"Ireland (particularly the north) abounds with this fish: the most considerable fishery is at Cranna, on the river Ban, about a mile and a half from Coleraine. When I made the tour of that hospitable kingdom in 1754, it was rented by a neighbouring gentleman for 620l. a-year; who assured me, that the tenant, his predeceffor, gave 1600l. per annum, and was a much greater gainer by the bargain, for the reasons before mentioned, and on account of the number of the poachers who destroy the fish in the fence months.

"The mouth of this river faces the north; and is finely situated to receive the fish that roam along the coast in search of an inlet into some fresh water, as they do all along that end of the kingdom which opposes itself to the northern ocean. We have seen near Ballicastle, nets placed in the sea at the foot of the promontories that jut into it, which the salmon strike into as they are wandering close to shore; and numbers are taken by that method.

"In the Ban they fish with nets 18 score yards long, and are continually drawing night and day the whole season, which we think lasts about four months, two sets of 16 men each alternately relieving one another. The best drawing is when the tide is coming in: we were told, that at a single draught there were once 840 fish taken.

"A few miles higher up the river is a wear where a considerable number of fish that escape the nets are taken. We were lately informed, that, in the year 1760, about 320 tons were taken in the Cranna fishery."

Curing Salmon. When the salmon are taken, they open them along the back, take out the guts and gills, and cut out the greatest part of the bones, endeavouring to make the inside as smooth as possible: they then salt the fish in large tubs for the purpose, where they lie a considerable time soaking in brine; and about October, they are packed close up in barrels, and sent to London, or exported up the Mediterranean. They have also in Scotland a great deal of salmon salted in the common way, which after soaking in brine a competent time, is well pressed, and then dried in smoke: this is called *kipper*, and is chiefly made for home consumption; and if properly cured and prepared, is reckoned very delicious.

Sturgeon † FISHERY. The greatest sturgeon fishery is in the mouth of the Volga, on the Caspian sea: where the Muscovites employ a great number of hands, and catch them in a kind of enclosure, formed by huge stakes representing the letter Z repeated several times. These fisheries are open on the side next the sea, and close on the other; by which means the fish ascending in its season up the river, is embarrassed in these narrow angular retreats, and so is easily killed with a harping iron. Sturgeons, when fresh, eat deliciously; and in order to make them keep, they are salted or pickled in large pieces, and put up in cags from 30 to 50 pounds. But the great object of this fishery is the roe, of which the Muscovites are extremely fond, and of which is made the cavear, or kavia, so much esteemed by the Italians. See CAVEAR.

† See *Accipenser, Ichthyology Index.*

Tunny Fishery. The tunny (a species of SCOMBER), was a fish well known to the ancients, and made a great article of commerce: And there are still very considerable tunny fisheries on the coasts of Sicily, as well as several other parts of the Mediterranean.

The nets are spread over a large space of sea by means of cables fastened to anchors, and are divided into several compartments. The entrance is always directed, according to the season, towards that part of the sea from which the fish are known to come. A man placed upon the summit of a rock high above the water, gives a signal of the fish being arrived; for he can discern from that elevation what passes under the waters infinitely better than any person nearer the surface. As soon as notice is given that the shoal of fish has penetrated as far as the inner compartment, or the chamber of death, the passage is drawn close, and the slaughter begins.

The undertakers of these fisheries pay an acknowledgment to the king, or the lord upon whose land they fix the main stay or foot of the tonnara; they make the best bargain they can: and, till success has crowned their endeavours, obtain this leave for a small consideration; but the rent is afterwards raised in proportion to their capture.

The tunny enters the Mediterranean about the vernal equinox, travelling in a triangular phalanx, so as to cut the waters with its point, and to present an extensive base for the tides and currents to act against, and impel forwards. These fish repair to the warm seas of Greece to spawn, steering their course thither along the European shores, but as they return, approach the African coast; the young fry is placed in the van of the squadron as they travel. They come back from the east in May, and abound on the coast of Sicily and Calabria about that time. In autumn they steer northward, and frequent the neighbourhood of Amalfi and Naples; but during the whole season stragglers are occasionally caught.

When

When taken in May, the usual time of their appearance in the Calabrian bays, they are full of spawn, and their flesh is then esteemed unwholesome, apt to occasion headachs and vapours; the milts and roes are particularly so at that season. To prevent these bad effects, the natives fry them in oil, and afterwards salt them. The quantity of this fish consumed annually in the Two Sicilies almost exceeds the bounds of calculation. From the beginning of May to the end of October it is eaten fresh, and all the rest of the year it is in use salted. The most delicate part is the muzzle. The belly salted was called *tarantallum*, and accounted a great delicacy by the Romans; its present name is *Surra*. The rest of the body is cut into slices, and put into tubs.

Turbot FISHERY. Turbots grow to a large size, some of them weighing from 23 to 30 pounds. They are taken chiefly off the north coast of England, and others off the Dutch coast. The large turbot (as well as several other kinds of flat fish) are taken by the hook and line, for they lie in deep water; the method of taking them in wears or staked nets being very precarious. When the fishermen go out to fish, each person is provided with three lines, which are coiled on a flat oblong piece of wicker work; the hooks being baited, and placed regularly in the centre of the coil. Each line is furnished with 14 score of hooks, at the distance of six feet two inches from each other. The hooks are fastened to the lines upon sneads of twisted horse hair 27 inches in length. When fishing, there are always three men in each coble, and consequently nine of these lines are fastened together, and used in one line, extending in length near three miles, and furnished with 2520 hooks. An anchor and a buoy are fixed at the first end of the line, and one more of each at the end of each man's lines; in all four anchors, which are common perforated stones, and four buoys made of leather or cork. The line is always laid across the current. The tides of flood and ebb continue an equal time upon our coast, and, when undisturbed by winds, run each way about six hours; they are so rapid that the fishermen can only shoot and haul their lines at the turn of tide, and therefore the lines always remain upon the ground about six hours; during which time the *myxine glutinosa* of Linnæus will frequently penetrate the fish that are on the hooks, and entirely devour them, leaving only the skin and bones. The same rapidity of tides prevents their using hand lines; and therefore two of the people commonly wrap themselves in the sail, and sleep while the other keeps a strict look-out, for fear of being run down by ships, and to observe the weather. For storms often rise so suddenly, that it is with extreme difficulty they can sometimes escape to the shore, leaving their lines behind.

Besides the coble, the fishermen have also a five men boat, which is 40 feet long and 15 broad, and 25 tons burden; it is so called, though navigated by six men and a boy, because one of the men is commonly hired to cook, &c. and does not share in the profits with the other five. This boat is decked at each end, but open in the middle, and has two large lug sails. All our able fishermen go in these boats to the herring fishery at Yarmouth in the latter end of September, and return about the middle of November. The boats are then laid up till the beginning of Lent, at which time they go off in them to the edge of the Dogger, and other places, to fish for turbot, cod, ling, skates, &c. They always take two cobles on board; and when they come upon their ground, anchor the boat, throw out the cobles, and fish in the same manner as those do who go from the shore in a coble; with this difference only, that here each man is provided with double the quantity of lines, and instead of waiting the return of the tide in the coble, return to their boat and bait their other lines; thus hawling one set and shooting another every turn of tide. They commonly run into harbour twice a-week to deliver their fish.

The best bait is fresh herring cut in pieces of a proper size; the five men boats are always furnished with nets for taking them. Next to herrings are the lesser lampreys. The next baits in esteem are small haddocks cut in pieces, sand worms, and limpets, here called *flidders*; and when none of these can be had, they use bullock's liver. The hooks are two inches and a half long in the shank, and near an inch wide between the shank and the point. The line is made of small cording, and is always tanned before it is used.

Turbots are extremely delicate in their choice of baits; for if a piece of herrring or haddock has been 12 hours out of the sea, and then used as bait, they will not touch it.

Whale FISHERY. See BALÆNA, CETOLOGY *Index*.

Whales are chiefly caught in the north seas; the largest sort are found about Greenland or Spitzbergen. At the first discovery of this country, whales not being used to be disturbed, frequently came into the very bays, and were accordingly killed almost close to the shore; so that the blubber being cut off was immediately boiled into oil on the spot. The ships in those times took in nothing but the pure oil and the whalebone, and all the business was executed in the country; by which means a ship could bring home the product of many more whales than she can, according to the present method of conducting this trade. The fishery also was then so plentiful, that they were obliged sometimes to send other ships to fetch off the oil they had made, the quantity being more than the fishing ships could bring away. But time and change of circumstances have shifted the situation of this trade. The ships coming in such numbers from Holland, Denmark, Hamburgh, and other northern countries, all intruders upon the English, who were the first discoverers of Greenland, the whales were disturbed, and gradually, as other fish often do, forsaking the place, were not to be killed so near the shore as before; but are now found, and have been so ever since, in the openings and space among the ice, where they have deep water, and where they go sometimes a great many leagues from the shore.

The whale fishery begins in May, and continues all June and July; but whether the ships have good or bad success, they must come away, and get clear of the ice, by the end of August; so that in the month of September at farthest they may be expected home; but a ship that meets with a fortunate and early fishery in May may return in June or July.

But, for the manner of taking whales, and for a farther account of the whale fishery, as a trade, see CETOLOGY.

FISHGARD, or FISGARD, a town of Pembrokeshire, situated on a steep cliff on the sea-shore, 254 miles from

from London, at the influx of the river Gwaine into the sea, which here forms a spacious bay. It is governed by a mayor, a bailiff, and other officers; and here vessels may lie safely in five or six fathoms water. The inhabitants have a good trade in herrings, and annually cure, between Fisgard and Newport, above 1000 barrels of them. The town sends one member to parliament.

FISHING, in general, the art of catching fish, whether by means of nets, of spears, or of the line and hook.

Fishing in the great, performed by the net, spear, or harpoon, for fish that go in shoals, has been explained in the preceding article. That performed by the rod, line, and hook, for solitary fish, is usually termed Angling: See that article; and for the particular manner of angling for the different kinds of fish, see their respective names, as Dace, Eel, Perch, under Ichthyology.

Here we shall give an account of the following:

1. The *Barbel* †, so called on account of the barb or beard that is under his chops), though a coarse fish, gives considerable exercise to the angler's ingenuity. They swim together in great shoals, and are at their worst in April, at which time they spawn, but come soon in season; the places whither they chiefly resort, are such as are weedy and gravelly rising grounds, in which this fish is said to dig and root with his nose like a swine. In the summer he frequents the strongest, swiftest, currents of water; as deep bridges, wears, &c. and is apt to settle himself among the piles, hollow places, and moss, or weeds; and will remain there immoveable; but in the winter he retires into deep waters, and helps the female to make a hole in the sands to hide her spawn in, to hinder its being devoured by other fish. He is a very curious and cunning fish; for if his baits be not sweet, clean, well scoured, and kept in sweet moss, he will not bite; but well ordered and curiously kept, he will bite with great eagerness. The best bait for him is the spawn of a salmon, trout, or any other fish; and if you would have good sport with him, bait the places where you intend to fish with it a night or two before, or with large worms cut in pieces; and the earlier in the morning or the later in the evening that you fish, the better it will be. Your rod and line must be both strong and long, with a running plummet on the line; and let a little bit of lead be placed a foot or more above the hook, to keep the bullet from falling on it; so the worm will be at the bottom, where they always bite; and when the fish takes the bait, your plummet will lie and not choke him. By the bending of your rod you may know when he bites, as also with your hand you will feel him make a strong snatch; then strike, and you will rarely fail, if you play him well; but if you manage him not dexterously, he will break your line. The best time for fishing is about nine in the morning, and the most proper season is the latter end of May, June, July, and the beginning of August.

† See Cyprinus, Ichthyology Index.

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2. The *Bleak* ‡, is an eager fish, caught with all sorts of worms bred on trees or plants; as also with flies, paste, sheep's blood, &c. They may be angled for with half a score of hooks at once, if they can be all fastened on; he will also in the evening take a natural or artificial fly. If the day be warm and clear, there is no fly so good for him as the small fly at the top of the water, which he will take at any time of the day, especially in the evening; but if the day is cold and cloudy, gentles and caddis are the best; about two feet under water. No fish yields better sport to a young angler than the bleak. It is so eager, that it will leap out of the water for a bait.

‡ See Cyprinus, Ichthyology Index.

There is another way of taking bleak, which is by whipping them in a boat, or on a bank side in fresh water in a summer's evening, with a hazel top about five or six feet long and a line twice the length of the rod. But the best method is with a drabble, thus: Tie eight or ten small hooks across a line two inches above one another; the biggest hook the lowermost, (whereby you may sometimes take a better fish), and bait them with gentles, flies, or some small red worms, by which means you may take half a dozen or more at a time.

3. For the *Bream* ||, observe the following directions, which will also be of use in carp fishing.—Procure about a quart of large red worms; put them into fresh moss well washed and dried every three or four days, feeding them with fat mould and chopped fennel, and they will be thoroughly scoured in about three weeks.

|| See Cyprinus, Ichthyology Index

Let your lines be silk and hair, but all silk is the best; let the floats be either swan-quills or goose-quills. Let your plumb be a piece of lead in the shape of a pear, with a small ring at the little end of it; fasten the lead to the line, and the line hook to the lead, about ten or twelve inches space between lead and hook will be enough; and take care the lead be heavy enough to sink the float. Having baited your hook well with a strong worm, the worm will draw the hook up and down in the bottom, which will provoke the bream to bite the more eagerly. It will be best to fit up three or four rods and lines in this manner, and set them as will be directed, and this will afford you much the better sport. Find the exact depth of the water if possible, that your float may swim on its surface directly over the lead; then provide the following ground bait. Take about a peck of sweet gross-ground malt; and having boiled it a very little, strain it hard through a bag, and carry it to the water side where you have sounded; and in the place where you suppose the fish frequent, there throw in the malt by handfuls squeezed hard together, that the stream may not separate it before it comes to the bottom; and be sure to throw it in at least a yard above the place where you intend the hook shall lie, otherwise the stream will carry it down too far. Do this about nine o'clock at night, keeping some of the malt in the bag, and go to the place about three the next morning; but approach very warily, lest you should be seen by the fish; for it is certain that they have their centinels watching on the top of the water, while the rest are feeding below. Having baited your hook so that the worm may crawl to and fro, the better to allure the fish to bite, cast it in at the place where you find the fish to stay most, which is generally in the broadest and deepest part of the river, and so that it may rest about the midst of your bait that is on the ground. Cast in your second line so that it may rest a yard above that, and a third about a yard below it. Let your rods lie on the bank with some stones to keep them down at the great ends; and then withdraw yourself, yet not so far but that you can have your eye upon

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Fishing. upon all the floats; and when you see one bitten and carried away, do not be too hasty to run in, but give time to the fish to tire himself, and then touch him gently. When you perceive the float sink, creep to the water side, and give it as much line as you can. If it is a bream or carp, they will run to the other side; which strike gently, and hold your rod at a bent a little while; but do not pull, for then you will spoil all; but you must first tire them before they can be landed, for they are very shy. If there are any carps in the river, it is an even wager that you take one or more of them; but if there are any pike or perch, they will be sure to visit the ground bait, though they will not touch it, being drawn thither by the great resort of the small fish; and until you remove them, it is in vain to think of taking the bream or carp. In this case, bait one of your hooks with a small bleak, roach, or gudgeon, about two feet deep from your float, with a little red worm at the point of your hook; and if a pike be there, he will be sure to snap at it. This sport is good till nine o'clock in the morning; and, in a gloomy day, till night; but do not frequent the place too much, lest the fish grow shy.

† See *Carp*, and *Cyprinus*.

4. The *carp* †. A person who angles for carp must arm himself with abundance of patience, because of its extraordinary subtility and policy; they always choose to lie in the deepest places, either of ponds or rivers, where there is but a small running stream.

Further, observe, that they will seldom bite in cold weather; and you cannot be too early or too late at the spot in hot weather; and if he bite, you need not fear his hold; for he is one of those leather-mouthed fish that have their teeth in their throat.

Neither must you forget, in angling for him, to have a strong rod and line; and since he is so very wary, it will be proper to entice him, by baiting the ground with a coarse paste.

He seldom refuses the red worm in March, the caddis in June, or the grasshopper in June, April, and September.

This fish does not only delight in worms, but also in sweet paste; of which there is great variety; the best is made of honey and sugar, and ought to be thrown into the water some hours before you begin to angle; neither will small pellets thrown into the water two or three days before be worse for this purpose, especially if chickens guts, garbage, or blood mixed with bran and cow dung, be also thrown in.

But more particularly, as to a paste very proper for this use, you may make it in the manner following: Take a sufficient quantity of flour, and mingle it with veal, cut small, making it up with a compound of honey; then pound all together in a mortar till they are so tough as to hang upon the hook without washing off. In order to effect which the better, mingle whitish wool with it; and if you keep it all the year round, add some virgin wax and clarified honey.

Again, If you fish with gentles, anoint them with honey, and put them on your hook, with a deep scarlet dipped in the like, which is a good way to deceive the fish.

Honey and crumbs of wheat bread, mixed together, make also a very good paste.

In taking a carp either in pond or river, if the angler intends to add profit to his pleasure, he must take a peck of ale-grains, and a good quantity of any blood to mix with the grains, baiting the ground with it where he intends to angle. This food will wonderfully attract the scale-fish, as carp, tench, roach, dace, and bream.

Let him angle in a morning, plumbing his ground, and angling for carp with a strong line: the bait must be either paste or a knotted red worm; and by this means he will have sport enough.

Description of proper Baits for the several sorts of Fish *referred to in the annexed Table.*

Flies.] 1. Stone fly, found under hollow stones at the sides of rivers, is of a brown colour, with yellow streaks on the back and belly, has large wings, and is in season from April to July. 2. Green drake, found among stones by river sides, has a yellow body ribbed with green, is long and slender, with wings like a butterfly, his tail turns on his back, and from May to Midsummer is very good. 3. Oak-fly, found in the body of an oak or ash, with its head downwards, is of a brown colour, and excellent from May to September. 4. Palmer fly or worm, found on leaves of plants, is commonly called a *caterpillar*, and when it comes to a fly is excellent for trout. 5. Ant fly, found in ant hills from June to September. 6. The May fly is to be found playing at the river side, especially against rain. 7. The black fly is to be found upon every hawthorn after the buds are come off.

Pastes.] 1. Take the blood of sheep's hearts, and mix it with honey and flour worked to a proper consistence. 2. Take old cheese grated, a little butter sufficient to work it, and colour it with saffron: in winter use rusty bacon instead of butter. 3. Crumbs of bread chewed or worked with honey or sugar, moistened with gum ivy water. 4. Bread chewed, and worked in the hand till stiff.

Worms.] 1. The earth bob, found in sandy ground after ploughing; it is white, with a red head, and bigger than a gentle: another is found in heathy ground, with a blue head. Keep them in an earthen vessel well covered, and a sufficient quantity of the mould they harbour in. They are excellent from April to November. 2. Gentles, to be had from putrid flesh: let them lie in wheat bran a few days before used. 3. Flag worms, found in the roots of flags; they are of a pale yellow colour, are longer and thinner than a gentle, and must be scowered like them. 4. Cow-turd bob, or clap bait, found under a cow turd from May to Michaelmas; it is like a gentle, but larger. Keep it in its native earth like the earth bob. 5. Caddis worm, or cod bait, found under loose stones in shallow rivers; they are yellow, bigger than a gentle, with a black or blue head, and are in season from April to July. Keep them in flannel bags. 6. Lob worm, found in gardens; it is very large, and has a red head, a streak down the back, and a flat broad tail. 7. Marsh-worms, found in marshy ground; keep them in moss ten days before you use them: their colour is a bluish red, and are a good bait from March to Michaelmas. 8. Brandling red worms, or blood worms found in rotten dunghills and tanners bark; they are small red worms, very good for all small fish, have sometimes a yellow tail, and are called *tag-tail*.

Fish and Insects.] 1. Minnow. 2. Gudgeon. 3. Roach. 4. Dace. 5. Smelt. 6. Yellow frog. 7. Snail slit. 8. Grasshopper.

Fishing Fly, a bait used in angling for divers kinds of fish. See Fishing.

The fly is either *natural* or *artificial*.

I. *Natural* flies are innumerable. The more usual for this purpose are mentioned in the preceding page.

The are two ways to fish with natural flies; either on the surface of the water, or a little underneath it.

In angling for chevin, roach, or dace, move not your natural fly swiftly when you see the fish make at it: but rather let it glide freely towards him with the stream: but if it be in a still and slow water, draw the fly slowly sidewise by him, which will make him eagerly pursue.

II. The *artificial* fly is seldom used but in blustering weather, when the waters are so troubled by the winds, that the natural fly cannot be seen, nor rest upon them. Of this artificial fly there are reckoned no less than 12 sorts, of which the following are the principal.

1. For March, the dun fly; made of dun wool, and the feathers of the partridge's wing; or the body made of black wool, and the feathers of a black drake. 2. For April, the stone fly; the body made of black wool, dyed yellow under the wings and tail. 3. For the beginning of May, the ruddy fly; made of red wool, and bound about with black silk, with the feathers of a black capon hanging dangling on his sides next his tail. 4. For June, the greenish fly; the body made of black wool, with a yellow list on either side, the wings taken off the wings of a buzzard, bound with black broken hemp. 5. The moorish fly, the body made of duskish wool, and the wings of the blackish mail of a drake. 6. The tawny fly, good till the middle of June; the body made of tawny wool, the wings made contrary one against the other of the whitish mail of a white drake. 7. For July, the wasp fly; the body made of black wool, cast about with yellow silk, and the wings of drakes feathers. 8. The steel fly; good in the middle of July; the body made with greenish wool, cast about with the feathers of a peacock's tail, and the wings made of those of the buzzard. 9. For August, the drake fly; the body made with black wool cast about with black silk; his wings of the mail of a black drake, with a black head.

The best rules for artificial fly fishing are,

1. To fish in a river somewhat disturbed with rain: or in a cloudy day, when the waters are moved by a gentle breeze: the south wind is best; and if the wind blow high, yet not so but that you may conveniently guard your tackle, the fish will rise in plain deeps; but if the wind be small, the best angling is in swift streams. 2. Keep as far from the water side as may be; fish down the stream with the sun at your back, and touch not the water with your line. 3. Ever angle in clear rivers, with a small fly and slender wings; but in muddy places, use a larger. 4. When, after rain, the water becomes brownish, use an orange fly; in a clear day, a light-coloured fly; a dark fly for dark waters, &c. 5. Let the line be twice as long as the rod, unless the river be encumbered with wood. 6. For every sort of fly, have several of the same differing in colour, to suit with the different complexions of several waters and weathers. 7. Have a nimble eye, and active hand, to strike presently with the rising of the fish; or else he will be apt to spue out the hook. 8. Let the fly fall first into the water, and not the line, which will scare the fish. 9. In slow rivers, or still places, cast the fly across the river, and let it sink a little in the water, and draw it gently back with the current.

Salmon flies should be made with their wings standing one behind the other, whether two or four. This fish delights in the gaudiest colours that can be; chiefly in the wings, which must be long, as well as the tail.

Fishing by means of birds, a method peculiar to the Chinese, who train certain birds for the purpose in the same manner as falcons are taught to pursue game. For this purpose they have trained a species of pelican, resembling the common corvorant, which they call the *Leu-tze*, or fishing bird. Sir George Staunton, who, when the embassy was proceeding on the southern branch of the great canal, saw those birds employed, tells us, that on a large lake, close to the east side of the canal, are thousands of small boats and rafts, built entirely for this species of fishery. On each boat or raft are ten or a dozen birds, which, at a signal from the owner, plunge into the water; and it is astonishing to see the enormous size of fish with which they return, grasped within their bills. They appeared to be so well trained, that it did not require either ring or cord about their throats to prevent them from swallowing any portion of their prey, except what their master was pleased to return to them for encouragement and food. The boat used by these fishermen is of a remarkable light make, and is often carried to the lake, together with the fishing birds, by the men who are there to be supported by it.

The same author saw the fishermen busy on the great lake Wee-chaung-hee; and he gives the following account of a very singular method practised by them for catching the fish of the lake without the aid of birds, of net, or of hooks. To one side of a boat a flat board, painted white, is fixed, at an angle of about 45 degrees, the edge inclining towards the water. On moonlight nights the boat is so placed that the painted board is turned to the moon, from whence the rays of light striking on the whitened surface, give to it the appearance of moving water; on which the fish being tempted to leap as on their element, the boatmen raising with a string the board, turn the fish into the boat.

Water-fowl are much sought after by the Chinese, and are taken upon the same lake by the following ingenious device. Empty jars or gourds are suffered to float about upon the water, that such objects may become familiar to the birds. The fisherman then wades into the lake with one of those empty vessels upon his head, and walks gently towards a bird; and lifting up his arm, draws it down below the surface of the water without any disturbance or giving alarm to the rest, several of whom he treats in the same manner, until he fills the bag he had brought to hold his prey. The contrivance itself is not so singular, as it is that the same exactly should have occurred in the new continent, as

Fishing. Ulloa asserts, to the natives of Carthagena, upon the lake Cienega de Tesias.

Fishing Floats, are little appendages to the line, serving to keep the hook and bait suspended at the proper depth, to discover when the fish has hold of them, &c. Of these there are divers kinds; some made of Muscovy duck quills, which are the best for slow waters; but for strong streams, sound cork, without flaws or holes, bored through with a hot iron, into which is put a quill of a fit proportion, is preferable: pare the cork to a pyramidal form, and make it smooth.

Fishing Hook, a small instrument made of steel wire, of a proper form to catch and retain fish.

The fishing hook, in general, ought to be long in the shank, somewhat thick in the circumference, the point even and straight; let the bending be in the shank.

An Epitome of the whole art of Fishing, wherein is shown (at one view), the harbours, seasons, and depths, for catching all sorts of fish usually angled for; also the various baits for each, so digested as to contain the essence of all the treatises ever written on the subject, exempt from the superfluities, which tend more to perplex than instruct.

Names.	*Where found.*	*Season.*	*Time to ang.*	*Depth from ground.*	*Proper Baits.*			
					Flies. N°	Pastes. N°	Worms. N°	Fish and Insects. N° 8.
Bream	Rough str. river or mid. pond	Apr. to Mich.	Sunrise to 9 3 to Sunset	Touch ground	-	1 3	1 to 7	
Barbel	Gravel banks in currents under bridges	Apr. to Aug.	Very early or late	Ditto	-	2	2 6 7	-
Bleak	Sandy bottom, deep rivers, ships sterns	May to Oct.	All day	Six inches from bottom	1 2	2	2 3 8	-
Carp	Still deep mud bottom, pond or river	May to Aug.	Sunrise to 9 3 to Sunset	Three inches from bottom Hot weather, mid water	-	1 3 4	1 2 3 4 7	-
Chub or Chevin	Ditto	May to Dec.	Ditto	Ditto	1 to 5	2	1 2 4 5	7 8
Dace	Sandy bottom deep rivers, ships sterns	May to Oct.	All day	Six to 12 inches from bottom	Ditto	3 4	1 to 5 & 8	-
Gudgeon	Gravel shoals	May to Oct.	Ditto	Near or on the ground	-	Ditto	2 8	-
Pike	Near clay banks	All the year.	Ditto	Mid water	Wh. stro. and snap	Line float Hook fixt	- On shore	1 2 3 4 5 6 7
Perch	River in stream / Pond deepest part { gravel or weedy bottom	May to Aug. Aug. to May	Sunrise to 10 2 to Sunset Mid day	Ditto Six inches from bottom	2	1	3 5 7 8	1 6
Pope	Deep holes in rivers	May to Oct.	All day	Ditto	5	-	All	-
Roach	Sandy bottom, deep rivers, ships sterns	May to Oct.	Ditto	Six to 12 inches	1 2 4 5	3 4	Ditto	8
Salmon	Deep rivers	Mar. to Sept.	8 to 9, 3 to 6	Mid way to the bottom	All large	-	1 5 6 7	1
Smelts	Ships sterns and docks	Apr. to Oct.	All day	Mid way to the bottom Variable	All small	-	1 2 5	Bits of smelts
Trout	Purling stream and eddies of stony bottom river	Mar. to Mich.	Ditto	Cold weather, 6 inches to 9 Hot weather, top to mid wat.	1 to 5	-	1 2 5 to 8	1 8
Tench	Mud bottom river or pond	All the year.	Sunrise to 9 3 to Sunset	Cold wea. 3 inches from bot. Hot weather, mid water	-	1 3 4	1 3 4 to 7	-
Umber or Grayling	Clay bottom, swift stream	All the year.	All day	Cold weather, 6 to 9 inches Hot weather, top to mid wat.	1 to 5	-	All	1 8

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For

For setting the hook on, use strong but small silk, laying the hair on the inside of your hook; for if it be on the outside, the silk will fret and cut it asunder.

There are several sizes of these fishing hooks, some big, some little: and of these, some have peculiar names; as, 1. Single hooks. 2. Double hooks; which have two bendings, one contrary to the other. 3. Snappers, or gorgers, which are the hooks to whip the artificial fly upon, or bait with the natural fly. 4. Springers, or spring hooks; a kind of double hooks, with a spring, which flies open upon being struck into any fish, and so keeps its mouth open.

Fishing-Line, is either made of hair twisted; or silk; or the Indian grass. The best colours are the sorrel, white, and gray; the two last for clear waters, the first for muddy ones. Nor is the pale watery green despisable; this colour is given artificially, by steeping the hair in a liquor made of alum, soot, and the juice of walnut leaves, boiled together.

Fishing Rod, a long slender rod or wand, to which the line is fastened, for angling.—Of these there are several sorts; as, 1. A troller, or trolling rod, which has a ring at the end of the rod, for the line to go through when it runs off a reel. 2. A whipper, or whipping rod; a top rod, that is weak in the middle, and top heavy, but all slender and fine. 3. A dropper; which is a strong rod and very light. 4. A snapper, or snap rod; which is a strong pole, peculiarly used for the pike. 5. A bottom rod; being the same as the dropper, but somewhat more pliable. 6. A snigging or procking stick; a forked stick, having a short strong line, with a needle, baited with a lob worm: this is only for eels in their holes.

Fishing Frog, or *Angler*. See Lophius.

Right of Fishing, and property of fish. It has been held, that where the lord of the manor hath the soil on both sides of the river, it is a good evidence that he hath a right of fishing; and it puts the proof upon him who claims *liberam piscariam*: but where a river ebbs and flows, and is an arm of the sea, there it is common to all, and he who claims a privilege to himself must prove it; for if the trespass is brought for fishing there, the defendant may justify, that the place where is *brachium maris, in quo unusquisque subditus domini regis habet et habere debet liberam piscariam.* In the Severn the soil belongs to the owners of the land on each side; and the soil of the river Thames is in the king, but the fishing is common to all. He who is owner of the soil of a private river, hath *separalis piscaria*; and he that hath *libera piscaria*, hath a property in the fish, and may bring a possessory action for them; but *communis piscaria* is like the case of all other commons. One that has a close pond in which there are fish, may call them *pisces suos*, in an indictment, &c. but he cannot call them *bona et catalla*, if they be not in trunks. There needs no privilege to make a fish pond, as there doth in the case of a warren. See Franchise.

Jacob's Law Dict.

FISSURES, in *Geology*, certain interruptions, that in a horizontal or parallel manner divide the several strata of which the body of our globe is composed. See Geology *Index*.

Fissure of the Bones, in *Surgery*, is when they are divided either transversely or longitudinally, not quite through, but cracked after the manner of glass, by any external force. See Surgery.

FISTULA, in the ancient music, an instrument of the wind kind, resembling our flute or flageolet.

The principal wind instruments of the ancients, were the tibia and the fistula. But how they were constituted, wherein they differed, or how they were played upon, does not appear. All we know is, that the fistula was at first made of reeds, and afterwards of other matters. Some had holes, some none; some again were single pipes; others a combination of several; witness the syringa of Pan.

Fistula, in *Surgery*, a deep, narrow, and callous ulcer, generally arising from abscesses.

It differs from a *sinus*, in its being callous, the latter not. See Surgery *Index*.

Fistula, in *Farriery*. See Farriery *Index*.

FISTULARIA, or Tobacco-Pipe Fish; a genus of fishes, belonging to the order of abdominales. See Ichthyology *Index*.

FIT. See Paroxysm.

Dr Cheyne is of opinion, that fits of all kinds, whether epileptic, hysteric, or apoplectic, may be cured solely by milk diet, of about two quarts of cows milk a-day, without any other medicine.

FITCHES, in *Husbandry*, a sort of pulse, more generally known by the name of *chick-pea*. See Cicer, Botany and Agriculture *Index*.

Fitches are cultivated either for feeding cattle, or improving the land. They make a wholesome and nourishing food, whether given in the straw or thrashed out. When sown only to improve the soil, they are ploughed in just as they begin to blossom, by which means a tough stiff clay soil is much enriched.

FITCHET, a name used in some places for the weasel, called also the *foumart*. See Mustela, Mammalia *Index*.

FITCHY, in *Heraldry*, (from the French *fishé*, i. e. *fixed*); a term applied to a cross when the lower branch ends in a sharp point: and the reason of it Mackenzie supposes to be, that the primitive Christians were wont to carry crosses with them wherever they went; and when they stopped on their journey at any place, they fixed those portable crosses in the ground for devotion's sake.

FITZ, makes part of the surname of some of the natural sons of the kings of England, as *Fitz-roy*; which is purely French, and signifies the "king's son."

FITZHERBERT, Sir Anthony, a very learned lawyer in the reign of King Henry VIII. was descended from an ancient family, and born at Norbury in Derbyshire. He was made one of the judges of the court of common pleas in 1523; and distinguished himself by many valuable works, as well as by such an honourable discharge of the duties of his office, as made him esteemed an oracle of the law. His writings are, *The Grand Abridgement; The Office and Authority of Justices of Peace; the Office of Sheriffs, Bailiffs of Liberties, Escheators, Constables, Coroners, &c.; Of the Diversity of Courts; The New Natura Brevium; Of the Surveying of Lands*, and *The Book of Husbandry*. He died in 1538.

FITZ-STEPHEN, William, a learned monk of Canterbury, of Norman extraction, but born of respectable parents in the city of London. He lived in the 12th century; and being attached to the service of Archbishop Becket, was present at the time of his murder.

In

In the year 1174, he wrote in Latin, *The Life of St Thomas, archbiſhop and martyr;* in which, as Becket was a native of the metropolis, he introduces a deſcription of the city of London, with a miſcellaneous detail of the manners and uſages of the citizens: this is deſervedly conſidered as a great curioſity, being the earlieſt profeſſed account of London extant. Fitz-Stephen died in 1191.

FIVES, or VIVES. See FARRIERY.

FIXATION, in *Chemiſtry*, the rendering any volatile ſubſtance fixed, ſo as not to fly off upon being expoſed to a great heat: hence,

FIXED BODIES, are thoſe which bear a conſiderable degree of heat without evaporating, or loſing any of their weight. Some of the moſt fixed bodies are diamonds, gold, &c.

FIXED, or *Fixable Air*, an inviſible and permanently elaſtic fluid, ſuperior in gravity to common atmoſpheric air and moſt other aerial fluids, exceedingly deſtructive to animal life; produced in great quantities, naturally from combuſtible bodies, and artificially by many chemical proceſſes. From its acid properties it has obtained the name of *aerial acid*, *cretaceous acid*, and *carbonic acid;* from its noxious qualities, it has been called *mephitic air;* or *mephitic gas;* and, from the circumſtance of being produced in vaſt quantities during the combuſtion of charcoal, it firſt obtained from Van Helmont the name of *gas ſylveſtre*. The term *fixed air* has been given from its property of readily loſing its elaſticity, and fixing itſelf in many bodies, particularly thoſe of the calcareous kind; and though ſome objected to the propriety of the term, the fluid in queſtion is ſo well known by the name of fixed air, that we chooſe ſtill to retain it. See CHEMISTRY *Index*. For an account of the apparatus for impregnating water with fixed air or carbonic acid, ſee MATERIA MEDICA *Index*.

FIXED Stars, are ſuch as conſtantly retain the ſame poſition and diſtance with reſpect to each other; by which they are diſtinguiſhed from *erratic* or *wandering* ſtars, which are continually ſhifting their ſituation and diſtance. The fixed ſtars are properly called *ſtars;* the reſt have the peculiar denomination of *planet* and *comet*. See ASTRONOMY *Index*.

FIXITY, or FIXEDNESS, in *Chemiſtry*, is in a peculiar manner uſed for the affection oppoſite to volatility; i. e. the property whereby bodies bear the action of the fire, without being diſſipated in fumes.

FIXLMILLNER, PLACIDUS, an eminent aſtronomer, was born at Achleiten near Linz, in Auſtria, on the 28th of May, 1720. He received the rudiments of his education in the monaſtery of Kremſmunſter, of which his uncle Alexander was abbot. Here he ſtudied during ſix years, and delighted ſo much in drawing ſtraight and curve-lined figures, that his mother called him the *almanack-maker*. He went afterward to Salzburg, where he ſtudied a regular courſe of philoſophy, and particularly turned his attention to mathematics under a profeſſor Stuard, whoſe method of teaching that ſcience was truly extraordinary, as he never made uſe of any figures, and yet conveyed ſuch a clear idea of every propoſition as made it perfectly eaſy. He was admitted as a novice into Kremſmunſter in 1737, and the next year he took the ſolemn vow in preſence of his uncle. After being two years in this monaſtery, during which time he devoted every leiſure hour to the ſtudy of mathematics and philoſophy, he went to Salzburg to finiſh his ſtudies in divinity and juriſprudence, acquiring at that time a competent knowledge of oriental and modern languages, hiſtory and antiquities. In the year 1745, he obtained the degree of D. D. after which he received prieſt's orders in his own monaſtery, and was created profeſſor of eccleſiaſtical law, which office he held for 40 years, diſcharging the duties belonging to it till within a few days of his death. He was alſo choſen dean of the higher ſchools, and regent of the young nobility, which he retained during life.

He wrote a commentary on the *Jus Canonicum*, notwithſtanding his extenſive epiſtolary correſpondence, and the management of the whole buſineſs of the monaſtery; but this work was never publiſhed. He was, by the intreaties of his friends, induced to publiſh his *Reipublicæ ſacræ origines divinæ, ſeu Eccleſiæ Chriſti exterior junctura, imperium, et hierarchia, ex primigenia ejus inſtitutione eruta et demonſtrata*. His commendable diligence procured him univerſal eſteem, but it was his knowledge of aſtronomy which rendered him illuſtrious. His uncle Alexander fitted up an apartment for containing the inſtruments neceſſary for the diſſemination of mathematical knowledge, and he alſo erected an obſervatory, which was begun in 1748, and completed in 1758, under the direction of Anſelm Dering of Emſdorf, a celebrated architect. While the obſervatory was building, Fixlmillner led a life of retirement and ſevere ſtudy, his favourite ſubject during theſe ten years being aſtronomy. When it was finiſhed, one Dobler, a celebrated mathematician, was appointed firſt aſtronomer; but the ſucceſſors of Fixlmillner's uncle having diſcovered his extenſive mathematical knowledge, made him an offer of the aſtronomical department, and the ſole direction of the obſervatory. This place he accepted in the year 1762, ſtill retaining his chair as profeſſor of eccleſiaſtical law. He was not yet maſter of the learning which practical aſtronomy requires, to remedy which defect he attentively peruſed Lalande's *Expoſition du Calcul Aſtronomique*, ſoon after which he obtained the large aſtronomical work of the ſame great man, and in 1766 he publiſhed his *Meridianus ſpeculæ Aſtronomicæ Cremifanenſis*, by which he acquired conſiderable reputation. Ten years after this period he gave the world his *Decennium Aſtronomicum*, containing many curious and important particulars reſpecting the theory and practice of aſtronomy. His *Acta Aſtronomica Cremifanenſis*, which did not appear till after his deceaſe, ſtill farther increaſed his aſtronomical reputation; and he was a large contributor to many periodical publications in different countries.

He made and collected a number of obſervations of the planet Mercury, which were at that period both ſcarce and difficult, the importance of which was publicly acknowledged by Lalande, as they greatly aſſiſted him in conſtructing his tables of that planet. Fixlmillner was one of the firſt aſtronomers who calculated the orbit of the new planet Uranus (Georgium Sidus), and his tables reſpecting it may be ſeen in the Berlin almanack for 1789. He alſo proved the truth of what was formerly conjecture, that the 34th ſtar of Taurus, which Flamſtead obſerved in 1690, was the new planet. It may be ſaid of moſt philoſophers, that they obſerve a great

great deal, and calculate little, but the conduct of Fixlmillner was exactly the reverse. He turned his attention to the observation of the solar spots more than any of his predecessors, which he noticed in the years 1767, 1776, 1777, 1778, and 1782, from which he deduced important inferences respecting the revolution of the sun on his axis.

He had a genius uncommonly adapted to the study of mechanics, by which he was enabled to invent a new micrometer, and a machine for grinding concentric circles. As an additional proof of his profound inventive genius, he resided in the country, by which means he was in a great measure deprived of literary assistance, yet to the very close of life he was a singular instance of the most indefatigable zeal, diligence, and perseverance. He was little subject to the influence of the turbulent passions;—perhaps less so than most other men. Like the laws of nature which it was his chief delight to study, he was simple, uniform and constant; and such were the mildness and integrity of his character, that he could not fail to acquire the love and esteem of mankind. His high reputation never inspired him with vanity, and he rather wished to conceal than to propagate what was written in his praise. It gave general joy to his monastic brethren to celebrate the anniversary of the fiftieth year of his residence in it, which he did not survive. His health was very much impaired by his intense application, and he finished his career on the 27th of August 1791, in the 71st year of his age.

FLACCUS, Caius Valerius, an ancient Latin poet, of whom we have very imperfect accounts remaining. He wrote a poem on the Argonautic expedition; of which, however, he did not live to finish the eighth book, dying at about 30 years of age. John Baptisto Pius, an Italian poet, completed the eighth book of the Argonautics; and added two more from the fourth of Apollonius; which supplement was first added to Aldus's edition in 1523.

FLAGS, in the army, are small banners of distinction stuck in the baggage waggons to distinguish the baggage of one brigade from another; and of one battalion from another; that they may be marshalled by the waggon-master general according to the rank of their brigades, to avoid the confusion that might otherwise arise.

Flag, in the marine, a certain banner or standard, by which an admiral is distinguished at sea from the inferior ships of his squadron; also the colours by which one nation is distinguished from another. See Plate CCXVIII.

In the British navy, flags are either red, white, or blue; and are displayed from the top of the main-mast, fore-mast, or mizen-mast, according to the rank of the admiral. When a flag is displayed from the flag-staff on the main-mast, the officer distinguished thereby is known to be an admiral; when from the fore-mast, a vice-admiral; and when from the mizen-mast a rear admiral.

The first flag in Great Britain is the royal standard, which is only to be hoisted when the king or queen are on board the vessel: the second is that of the anchor of hope, which characterizes the lord high admiral, or lords commissioners of the admiralty: and the third is the union flag, in which the crosses of St George and St Andrew are blended. This last is appropriated to the admiral of the fleet, who is the first military officer under the lord high admiral.

The next flag after the union is that of the white squadron at the main-mast head; and the last, which characterizes an admiral, is the blue, at the same mast head.

For a vice-admiral, the first flag is the red, the second the white, the third the blue, at the flag staff on the fore-mast.

The same order proceeds with regard to the rear admirals, whose flags are hoisted on the top of the mizen-mast: the lowest flag in our navy is accordingly the blue on the mizen mast.

To Lower or Strike the Flag, in the marine, is to pull it down upon the cap, or to take it in, out of the respect, or submission, due from all ships or fleets inferior to those any way justly their superiors. To lower or strike the flag in an engagement is a sign of yielding.

The way of leading a ship in triumph is to tie the flags to the shrouds, or the gallery, in the hind part of the ship and let them hang down towards the water, and to tow the vessels by the stern. Livy relates, that this was the way the Romans used those of Carthage.

To Heave out the Flag, is to put out or put abroad the flag.

To Hang out the White Flag, is to ask quarter; or it shows when a vessel is arrived on a coast, that it has no hostile intention, but comes to trade, or the like. The red flag is a sign of defiance and battle.

Flag is also used for a sedge, a kind of rush.

Corn-Flag. See Gladiolus, Botany *Index*.

Sweet-scented Flag. See Acorus, Botany *Index*.

Flag-Officers, those who command the several squadrons of a fleet; such are the admirals, vice-admirals, and rear admirals.

The flag officers in our pay, are the admiral, vice-admiral, and rear-admiral, of the white, red, and blue. See Admiral, Flag, and Fleet.

Flag-Ship, a ship commanded by a general or flag-officer, who has a right to carry a flag, in contradistinction to the secondary vessels under the command thereof.

Flag-Stone, a kind of sand-stone of a slaty structure, on account of which it is much employed for the purpose of paving foot paths or the floors of apartments in which wood is unsuitable.

FLAGELLANTES, a set of wild fanatics who chastised and disciplined themselves with whips in public.

The sect of the Flagellantes had its rise in Italy in the year 1260; its author was one Rainier a hermit; and it was propagated from hence through almost all the countries of Europe. It was in all probability no more than the effect of an indiscreet zeal. A great number of persons of all ages and sexes made processions, walking two by two with their shoulders bare, which they whipped till the blood ran down, in order to obtain mercy from God, and appease his indignation against the wickedness of the age. They were then called the *devout;* and having established a superior, he was called the *general of the devotion*. Though the primitive Flagellantes were exemplary in point of morals,

morals, yet they were joined by a turbulent rabble, who were infected with the moſt ridiculous and impious opinions; ſo that the emperors and pontiffs thought proper to put an end to this religious frenzy, by declaring all devout whipping contrary to the divine law, and prejudicial to the ſoul's eternal intereſt.

This ſect revived in Germany towards the middle of the next century, and rambling through many provinces, occaſioned great diſturbances. They held, among other things, that flagellation was of equal virtue with baptiſm and the other ſacraments; that the forgiveneſs of all ſins was to be obtained by it from God without the merits of Jeſus Chriſt; that the old law of Chriſt was ſoon to be aboliſhed, and that a new law enjoining the baptiſm of blood to be adminiſtered by whipping was to be ſubſtituted in its place: upon which Clement VII. by an injudicious as well as unrighteous policy, thundered out anathemas againſt the Flagellantes, who were burnt by the inquiſitors in ſeveral places; but they were not eaſily extirpated. They appeared again in Thuringia and Lower Saxony in the 15th century; and rejected not only the ſacraments, but every branch of external worſhip; and placed their only hopes of ſalvation in faith and flagellation, to which they added other ſtrange doctrines concerning evil ſpirits. Their leader Conrad Schmidt and many others were committed to the flames by German inquiſitors in and after the year 1414.

FLAGEOLET, or FLAJEOLET, a little flute, uſed chiefly by ſhepherds and country people. It is made of box or other hard wood, and ſometimes of ivory; and has ſix holes beſides that at the bottom, the mouth-piece, and that behind the neck.

FLAIL, an inſtrument for thraſhing corn. It conſiſts of the following parts. 1. The hand-ſtaff, or piece held in the thraſher's hand. 2. The ſwiple, or that part which ſtrikes out the corn. 3. The caplins, or ſtrong double leathers, made faſt to the tops of the hand-ſtaff and ſwiple. 4. The middle band, being the leather thong or fiſh ſkin that ties the caplins together.

FLAIR, in ſea language. The ſeamen ſay that the work doth flair over, when a ſhip is houſed in near the water, ſo that the work hangs over a little too much, and this is let out broader aloft than the due proportion will allow.

FLAKE, in the cod fiſhery, a ſort of ſcaffold or platform, made of hurdles, and ſupported by ſtanchions, uſed for drying cod fiſh in Newfoundland. Theſe flakes are uſually placed near the ſhores of fiſhing harbours.

FLAKE, in *Gardening*, a name given by the floriſts to a ſort of carnations which are of two colours only, and have very large ſtripes, all of them going quite through the leaves.

White FLAKE, in *Painting*, is lead corroded by means of the preſſing of grapes, or a ceruſe prepared by the acid of grapes. It is brought from Italy; and far ſurpaſſes, both with regard to the purity of its whiteneſs and the certainty of its ſtanding, all the ceruſe or white lead made with us in common. It is uſed in oil or varniſh painting for all purpoſes where a very clean white is required. The white flake ſhould be procured in lumps as it is brought over, and levigated by thoſe who uſe it; becauſe that which the colourmen ſell in a prepared ſtate is levigated and mixed up with ſtarch, and often with white lead, and worſe ſophiſtications.

FLAMBEAU, or FLAMBOY, a luminary made of ſeveral thick wicks, covered over with wax, ſerving to burn at nights in the ſtreets; as alſo at funeral proceſſions, illuminations, &c.

Flambeaux differ from links, torches, and tapers.—They are made ſquare, ſometimes of white wax and ſometimes of yellow. They uſually conſiſt of four wicks or branches near an inch thick, and about three feet long, made of a ſort of coarſe hempen yarn half twiſted. They are made with the ladle much as torches or tapers are; viz. by firſt pouring the melted wax on the top of the ſeveral ſuſpended wicks, and letting it run down to the bottom. This they repeat twice. After each wick has thus got its proper cover of wax, then lay them to dry; then roll them on a table and ſo join four of them together by means of a red hot iron. When joined, they pour on more wax till the flambeau is brought to the ſize required, which is uſually from a pound and half to three pounds. The laſt thing is to finiſh their form or outſide, which they do with a kind of poliſhing inſtrument of wood by running it along all the angles formed by the union of the branches.

The flambeaux of the ancients were different from ours. They were made of woods dried in furnaces or otherwiſe. They uſed divers kinds of wood for this purpoſe; the wood moſt uſual was pine. Pliny ſays, that in his time they frequently alſo burnt oak, elm, and hazel. In the ſeventh book of the Æneid, mention is made of a flambeau of pine; and Servius on that paſſage remarks, that they alſo made them of the cornel-tree.

FLAMBOROUGH HEAD, in *Geography*, a cape or promontory on the eaſtern coaſt of Yorkſhire, five miles eaſt of Burlington, and 216 from London.—E. Long. 20°. N. Lat. 54. 15.—This was the *Fleamburg* of the Saxons; ſo called, as ſome think, from the lights made on it to direct the landing of Ina, who in 547 joined his countrymen in theſe parts with a large reinforcement from Germany, and founded the kingdom of Northumberland. In the time of Edward the Confeſſor, Flamborough was one of the manors of Harold, earl of the Weſt Saxons, afterwards king of England. On his death, the Conqueror gave it to Hugh Lupus; who, in perpetual alms, beſtowed it on the monaſtery of Whitby.—The town is on the north ſide; and conſiſts of about 150 ſmall houſes, entirely inhabited by fiſhermen; few of whom, as is ſaid, die in their beds, but meet their fate in the element they are ſo converſant in. The cliffs of the Head are of a tremendous height and amazing grandeur. Beneath are ſeveral vaſt caverns; ſome cloſed at the end, others pervious, formed with a natural arch. In ſome places the rocks are inſulated, and of a pyramidal figure, ſoaring up to a vaſt height. The baſes of moſt are ſolid, but in ſome pierced through and arched. The colour of all theſe rocks is white, from the dung of the innumerable flocks of migratory birds, which quite cover the face of them, filling every little projection, every hole that will give them leave to reſt.

FLAME, is a general name for every kind of luminous vapour, provided the light it emits hath any conſiderable degree of intenſity. The name *flame*, however, Flame.

ever, is most generally applied to such as are of a conical figure, like those arising from our common fires; without this, they are commonly called *luminous vapours*, or simply *lights*.

According to Sir Isaac Newton, flame is only *red-hot smoke*, or the vapour of any substance raised from it by fire, and heated to such a degree as to emit light copiously. This definition seems to be the most accurate and expressive of any. It is certain, that bodies are capable of emitting flame only in proportion to the quantity of vapour that rises from them. Thus wood, coals, &c. which emit a great quantity of vapour, flame violently; while lead, tin, &c. which emit but a small fume, can scarce be perceived to flame at all.

This rule, however, is by no means to be depended upon in all cases. Some vapours *seem* to be in their own nature uninflammable, and capable of extinguishing flame; as those of water, the mineral acids, sal-ammoniac, arsenic, &c.: while others take fire on the slightest approach of a flaming substance; such as ether, spirit of wine, &c. These last mentioned substances also exhibit a remarkable phenomenon; namely, that they cannot be made to flame without the approach of some substance actually in flames beforehand. Thus, spirit of wine poured on a red-hot iron, though instantly dissipated in vapour, will not flame; but if a burning candle touches its surface, the whole is set in a flame at once. The case is otherwise with oils, especially those of the grosser kind; for the vapours will readily be changed into flame by the mere increase of heat, without the approach of any flaming substance.

There is, however, no kind of vapour, perhaps, that is incapable of being converted into flame, provided it is exposed to a sufficient degree of heat. Thus the vapour of water made to pass through burning coals produces an exceedingly strong and bright flame.—It is remarkable, that this kind of vapour seems to be more powerful than almost any other in absorbing heat, and detaining it in a latent state. When any quantity of aqueous vapour is condensed, more heat will be separated from it than would have been sufficient to heat an equal bulk of iron red-hot.—It is most probably to this property which all vapours have of absorbing heat, and detaining it in a latent state, that we are to attribute the phenomena of flame, and also the exceeding great elasticity of steam. It is certain, that vapours, of water at least, have a much greater power of absorbing and retaining heat, than the water from which they are raised. In open vessels, water cannot be heated more than to 212 degrees of Fahrenheit's thermometer; but in Papin's digester, where the vapour is forcibly confined, it has been heated to 400 of the same degrees; and, no doubt, might have been heated a great deal more, had the vessels been strong enough to bear the expansile force of the steam. On opening the vessels, however, the excess of heat was found to have resided entirely in the vapour; for the water in the vessel very soon sunk down to 212, while the steam issued forth with great violence.

From these experiments it appears, that the steam of water, after it has absorbed as much heat in a latent state as it can contain, continues to absorb, or detain among its particles, an unlimited quantity of sensible heat; and if the steam could be confined till this quantity became great enough to be visible by its emission of light, there cannot be the least doubt that the vapour would then be converted into flame.

Flame, Flamen.

In what manner the heat is detained among the particles of steam, is perhaps impossible to be explained; but to this heat we must undoubtedly ascribe the violent expansive force of steam of every kind. It seems probable, that when smoke is converted into flame, the latent heat with which the vapour had combined, or rather that which made an essential part of it, breaks forth, and adds to the quantity of sensible heat which is already present. This seems probable, from the sudden explosion with which all flames break out. If a vessel full of oil is set over the fire, a smoke or vapour begins to arise from it; which grows gradually thicker and thicker; and at last begins to shine in some places very near the surface of the oil, like an electric light, or sulphur just kindled. At this time the oil is very hot, as well as the steam which issues from it. But this last is continually giving off its sensible heat into the atmosphere; so that at the distance of an inch or two from the surface of the oil, the heat of the steam will not exceed 400 degrees of Fahrenheit, or perhaps may not be so much; but if a burning candle is held in the steam for a moment, the whole is immediately converted into flame, with something like an explosion; after which, the oil burns quietly until it is all consumed. The flame, as soon as it appears, is not only much hotter than the steam from whence it was produced, but even than the oil which lies below it. Whence, then, has this sudden and great increase of heat arisen? It could not be the *sensible* heat of the vapour, for that was greatly inferior; nor could it be communicated from the oil, for that could communicate no more than it had to itself. The candle, indeed, would communicate a quantity of heat to the vapour which touched its flame; but it is impossible that this quantity should extend permanently over a surface perhaps 100 times larger than the flame of the candle, in such a manner as to make every part of that surface equally hot with the flame of the candle itself; for this would be to suppose it to communicate 100 times more heat than really was in it. The heat therefore must have originally resided in the vapour itself; and as, in the freezing of water, its latent heat is extricated and becomes sensible, and the water thereupon loses its fluidity; so, in the ascension of vapour, the latent heat breaks forth with a bright flash, and the vapour is then totally decomposed, and converted into soot, ashes, or water, according to the different nature of the substances which produce it, or according to the intensity of the heat.—Several other hypotheses have been invented to solve the phenomena of burning and flaming bodies; for an account of which, see IGNITION and HEAT, CHEMISTRY *Index*.

Flames are of different colours, according to the substances from which they are produced. Thus, the flame of sulphur and spirit of wine is blue; the flame of nitre and zinc, of a bright white; that of copper, of a greenish blue, &c.—These varieties afford an opportunity of making a number of agreeable representations in fireworks, which could not be done if the flame produced from every different substance was of the same colour. See PYROTECHNICS.

FLAMEN, in Roman antiquity, the name of an order

order of priests, instituted by Romulus or Numa; authors not being agreed on this head.

They were originally only three, viz. the *Flamen Dialis*, *Flamen Martialis*, and *Flamen Quirinalis*. The Flamen Dialis was sacred to Jupiter, and a person of the highest consequence and authority in the state. He discharged several religious duties which properly belonged to the kings, and was honoured with many eminent privileges beyond all other officers, but was obliged to observe several superstitious restraints. The Flamen Martialis was sacred to Mars, and was ordained to inspect the rites of that god. The Flamen Quirinalis was sacred to, and superintended the rites of, Quirinus Romulus. The Flamines last mentioned, though of high authority, were much inferior to the Flamen Dialis. All three were chosen by the people, and consecrated by the Pontifex Maximus.—In latter times several priests of the same order and name were added to them, but inferior in power. The whole number at last amounted to 15: the three first of whom were senators, and called *Flamines majores;* the other 12, taken from among the people, being denominated *Flamines minores*.—Some authors tell us the Romans had a Flamen for every deity they worshipped. The greater Flamines wore the robe edged with purple, like the great magistrates; had an ivory chair, and a seat in the senate. They wore a little band of thread about their heads, whence their name is said to be derived, *quasi Filamines*.—The wife of the Flamen Dialis was called *Flaminica*, and wore a flame-coloured habit, on which was painted a thunderbolt, and above her head-dress she had green oak boughs, to indicate that she belonged to Jupiter the thunderer, to whom the oak was sacred. The Flamines wore each of them a hat or cap called *Flammeum* or *Apex*.

FLAMINGO, in *Ornithology*. See PHOENICOPTERUS, ORNITHOLOGY *Index*.

FLAMINIUS, or FLAMININUS, T. Q. a celebrated Roman, raised to the consulship in the year of Rome 554, though under the age of 30. He was trained in the art of war against Hannibal; and he showed himself capable in every respect to discharge with honour the great office with which he was intrusted. He was sent at the head of the Roman troops against Philip king of Macedon, and in his expedition he met with uncommon success. The Greeks gradually declared themselves his firmest supporters; and he totally defeated Philip on the confines of Epirus, and made all Locris, Phocis, and Thessaly, tributary to the Roman power. He granted peace to the conquered monarch, and proclaimed all Greece free and independent at the Isthmian games. This celebrated action procured the name of Patrons of Greece to the Romans, and insensibly paved their way to universal dominion. Flaminius behaved among them with the greatest policy; by his ready compliance to their national customs and prejudices, he gained uncommon popularity, and received the name of father and deliverer of Greece. He was afterwards sent ambassador to King Prusias, who had given refuge to Hannibal; and there his prudence and artifice hastened out of the world a man who had long been the terror of the Romans. Flaminius was found dead in his bed, after a life spent in the greatest glory, in which he had imitated with success the virtues of his model Scipio.

FLAMINIUS or FLAMINIO, *Mark Antony*, one of the best Latin poets in the 16th century, of Imola in Italy, son and grandson of very learned men. The pope had chosen him secretary to the council in 1545; but he refused that employment, because, favouring the new opinions, he would not employ his pen in an assembly where he knew these opinions were to be condemned.—He paraphrased 38 of the psalms in Latin verse, and also wrote notes on the Psalms; and some letters and poems which are esteemed. He died at Rome in 1550.

FLAMSTED, a town of Hertfordshire in England, five miles from St Albans and Dunstable, stands on the river Verlam and was of old called Verlamstede. The land in the vicinity is a clay so thickly mixed with flints, that, after a shower, nothing appears but a heap of stones; and yet it bears good corn even in dry summers. This fertility is imputed to a warmth in the flint, which preserves it from cold in the winter; and to its closeness, which keeps it from the scorching rays of the sun in the summer. Edward VI. when an infant, was brought hither for his health; and, it is said, the bedstead he lay on, which is curiously wrought, is still preserved in the manor house near the town.

FLAMSTEED, JOHN, an eminent English astronomer, and the first who obtained the appointment of astronomer-royal, was born at Derby in the year 1646. He was educated at the free school of Derby, where he was head scholar at 14 years of age, at which period his constitution, naturally tender and delicate, was much tried by a severe illness. When some of his companions went to the university, the state of his health prevented him from accompanying them. He afterwards met with a book *De Sphæra*, written by John Sacrobosco, which was perfectly suited to the natural turn of his genius, and therefore he perused it with uncommon satisfaction, translating as much of it into English as he thought would be necessary for him; and from the *Astronomia Carolinæ* of Strut he learned the method of calculating eclipses, and ascertaining the places of the planets. Mr Hatton, a mathematician, sent him Kepler's *Tabulæ Rudolphinæ*, and *Riccioli's Almagestum Novum*, together with some other astronomical works to which he was as yet a stranger. In 1669 he calculated an eclipse of the sun, which had been omitted in the Ephemerides for the following year, together with five appulses of the moon to fixed stars, and sent them to Lord Brouncker, president of the Royal Society, who submitted them to the examination of that learned body, by which they were greatly applauded, and he received a letter of thanks from Mr Oldenburg the secretary. He likewise received a letter of thanks from Mr Collins, one of the members. In 1670 he was invited to come up to London by his father, that he might become personally acquainted with his learned correspondents, of which he gladly accepted, and had an interview with Mr Oldenburg and Mr Collins, by the latter of whom he was introduced to Sir Jonas Moore, who became the warm friend and patron of Mr Flamsteed. In consequence of this journey he became acquainted with many astronomical instruments, and was presented by Sir Jonas Moore with Townley's micrometer, who also assisted him in procuring glasses at a moderate rate for the construction of telescopes. On his way home again he returned by Cambridge, where he paid a visit to the celebrated Dr

Flamsteed, Flanders.

Barrow and Sir Isaac, then Mr Newton, and entered a student of Jesus college.

In the year 1672, he made large extracts from the letters of Gascoigne and Crabtree, by which his knowledge of dioptrics was very much improved; and during the same year he made a number of celestial observations when the weather would permit, which were afterwards published in the Philosophical Transactions. In 1673 he composed a treatise on the true and apparent diameters of the planets, when at their greatest and least distance from the earth, which even the great Newton did not scruple to borrow, and made some use of it in his Principia in 1685. He published an Ephemeris in 1674, in which he exposed the folly and absurdity of astrology, and the same year he drew up a table of the tides for the use of the king, with an astronomical account of their ebbing and flowing, which Sir Jonas Moore assured him would be well received by his majesty. Sir Jonas received from Mr Flamsteed a pair of barometers, with directions how to use them, which he presented to the king and the duke of York, to whose notice he embraced every opportunity of introducing Mr Flamsteed.

Having taken the degree of M. A. at Cambridge, he formed the resolution of entering into holy orders, when Sir Jonas wrote to him to come to London, where he had an appointment for him very different from that of the church. But as he found that nothing could make him abandon the resolution he had formed, he obtained a situation for him which was perfectly consistent with the character of a clergyman. This was the new office of astronomer to the king, with a salary of 100l. per annum. He received ordination at Ely-house by Bishop Gunning, in Easter 1675; and on the 10th of August in the same year the foundation stone of the royal observatory at Greenwich was laid, which received the designation of Flamsteed house, in honour of the first astronomer royal. Till this edifice was erected, he made his observations in the queen's house at Greenwich, and in 1681 his Doctrine of the Sphere was published by Sir Jonas Moore in his system of the mathematics. Notwithstanding his extraordinary merit, he never rose higher in the church than to the living of Burslow in Surrey, although he was deservedly esteemed by the greatest men in the nation. He corresponded with the great Newton, Dr Halley, Mr W. Molyneux, Dr Wallis, and many others; and M. Cassini and he imparted their discoveries to each other with the utmost confidence and cordiality. But none of his works contributed so much to render his fame immortal as his "Historia Cœlestis Britannica," in three volumes folio. Mr Flamsteed was suddenly carried off by a strangury on the 31st of December 1719; and notwithstanding the extreme delicacy of his constitution and incessant labours, he reached the 73d year of his age.

FLANDERS, a province of the Netherlands, bounded by the German sea and the United Provinces on the north, by the province of Brabant on the east, by Hainault and Artois on the south, and by another part of Artois and the German sea on the west; being about 60 miles long and 50 broad.

Flanders is a perfectly champaign country, with not a rising ground or hill in it, and watered with many fine rivers and canals. Its chief commodities are fine lace, linen, and tapestry.

In this country some important arts were invented and improved. Weaving in general was greatly improved, and that of figures of all sorts in linen was invented; also the art of dyeing cloths and stuffs, and of oil colours; the curing of herrings, &c. The manufactures of this country are not now in the flourishing state they were formerly; yet silk, cotton, and woollen stuffs, brocades, camblets, tapestry, lace, and linen, are still manufactured here in great quantities. This province had counts of its own from the ninth century to the year 1369, when it went by marriage to the dukes of Burgundy; and afterwards from them, by marriage also, to the house of Austria. France, in 1667, seized the southern part; and the states general obtained the northern, partly by the treaty of Munster, and partly by the barrier treaty of 1715.

For a more particular history of Flanders, with a continuation down to the present times, see the article Netherlands.

Flanel.

FLANEL, or Flannel, a kind of slight, loose, woollen stuff, composed of a woof and warp, and wove on a loom with two treddles, after the manner of baize.

Dr Black assigns as a reason why flanel and other substances of the kind keep the body warm, that they compose a rare and spongy mass, the fibres of which touch each other so slightly, that the heat moves slowly through the interstices, which being filled only with air, and that in a stagnant state, give little assistance in conducting the heat. From the experiments of Count Rumford, it appears, that there is a relation betwixt the power which the substances usually worn as clothing have of absorbing moisture, and that of keeping the body warm. Having provided a quantity of each of these substances mentioned below, he exposed them, spread out upon clean China plates, for the space of 24 hours to the warm and dry air of a room which had been heated by a German stove for several months, and during the last six hours had raised the thermometer to 85° of Fahrenheit; after which he weighed equal quantities of the different substances with a very accurate balance. They were then spread out upon a China plate, and removed into a very large uninhabited room upon the second floor, where they were exposed 48 hours upon a table placed in the middle of the room, the air of which was at 45° of Fahrenheit. At the end of this space they were weighed, and then removed into a damp cellar, and placed on a table in the middle of the vault, where the air was at the temperature of 45°, and which by the hygrometer seemed to be fully saturated with moisture. In this situation they were suffered to remain three days and three nights; the vault being all the time hung round with wet linen cloths, to render the air as completely damp as possible. At the end of three days they were weighed, and the weights at the different times were found as in the following table.

		Weight after being dried in the hot room.	Weight after coming out of the cold room.	Weight after remaining 72 h. in the vault.
Sheep's wool		Parts 1000	1084	1163
Beaver's fur			1072	1125
The fur of a Ruffian hare			1065	1115
Eider down			1067	1112
Silk	Raw fingle thread		1057	1107
	Ravellings of white taffety		1054	1103
Linen	Fine lint		1046	1102
	Ravelling of fine linen		1044	1082
Cotton wool			1043	1089
Ravellings of filver lace			1000	1000

On thefe experiments our author obferves, that though linen, from the apparent eafe with which it receives dampnefs from the atmofphere, feems to have a much greater attraction for water than any other; yet it would appear from what is related above, that thofe bodies which receive water in its unelaftic form with the greateft eafe, or are moft eafily wet, are not thofe which in all cafes attract the moifture of the atmofphere with the greateft avidity. "Perhaps (fays he), the apparent dampnefs of linen to the touch, arifes more from the eafe with which that fubftance parts with the water it contains, than from the quantity of water it actually holds: in the fame manner as a body appears hot to the touch, in confequence of its parting freely with its heat; while another body which is really at the fame temperature, but which withholds its heat with great obftinacy, affects the fenfe of feeling much lefs violently. It is well known that woollen clothes, fuch as flanels, &c. worn next the fkin, greatly promote infenfible perfpiration. May not this arife principally from the ftrong attraction which fubfifts between wool and the watery vapour which is continually iffuing from the human body? That it does not depend entirely on the warmth of that covering, is clear; for the fame degree of warmth produced by wearing more clothing of a different kind, does not produce the fame effect. The perfpiration of the human body being abforbed by a covering of flanel, it is immediately diftributed through the whole thicknefs of that fubftance, and by that means expofed, by a very large furface, to be carried off by the atmofphere; and the lofs of this watery vapour which the flanel fuftains on the one fide by evaporation, being immediately reftored from the other, in confequence of the ftrong attraction between the flanel and this vapour, the pores of the fkin are difencumbered, and they are continually furrounded by a dry and falubrious atmofphere."

Our author expreffes his furprife, that the cuftom of wearing flanel next the fkin fhould not have prevailed more univerfally. He is confident it would prevent a number of difeafes; and he thinks there is no greater luxury than the comfortable fenfation which arifes from wearing it, efpecially after one is a little accuftomed to it. "It is a miftaken notion (fays he), that it is too warm a clothing for fummer. I have worn it in the hotteft climates, and at all feafons of the year; and never found the leaft inconvenience from it. It is the warm bath of perfpiration confined by a linen fhirt, wet with fweat, which renders the fummer-heats of fouthern climates fo unfupportable; but flanel promotes perfpiration, and favours its evaporation; and evaporation, as is well known, produces pofitive cold.

It has been obferved that new flanel, after fome time wearing, acquires the property of fhining in the dark, but lofes it on being wafhed. *Philofophical Tranfactions*, N° 483. § 7.

FLANK, or FLANC, in the manege, is applied to the fides of a horfe's buttocks, &c. In a ftrict fenfe, the flanks of a horfe are the extremes of the belly, where the ribs are wanting, and are below the loins.

The flanks of a horfe fhould be full, and at the top of each a feather. The diftance between the laft rib and hauch-bone, which is properly the flank, fhould be fhort, which they term *well coupled*, fuch horfes being moft hardy, and fit to endure labour.

A horfe is faid to have no flank if the laft of the fhort ribs be at a confiderable diftance from the haunch-bone; as alfo when the ribs are too much ftraitened in their compafs.

FLANK, in *War*, is ufed by way of analogy for the fide of a battalion, army, &c. in contradiftinction to the *front* and *rear*.

To attack the enemy in flank, is to difcover and fire upon them on the fide. See FILE.

FLANK, in *Fortification*, is a line drawn from the extremity of the face towards the infide of the work.

Or, flank is that part of a baftion which reaches from the curtain to the face, and defends the oppofite face, the flank, and the curtain. See FORTIFICATION.

Oblique or *Second* FLANK, or FLANK *of the Curtain*, is that part of the curtain from whence the face of the oppofite baftion can be feen, being contained between the lines rafant and fichant, or the greater and lefs lines of defence; or the part of the curtain between the flank and the point where the fichant line of defence terminates.

Covered, *Low*, or *Retired* FLANK, is the platform of the cafement, which lies hid in the baftion; and is otherwife called the Orillon.

Fichant FLANK, is that from whence a cannon playing, fires directly on the face of the oppofite baftion.

Rafant or *Razant* FLANK, is the point from whence the line of defence begins, from the conjunction of which with the curtain, the fhot only rafeth the face of the next baftion, which happens when the face cannot be difcovered but from the flank alone.

FLAT, in fea-language, denotes a level ground lying at a fmall depth under the furface of the fea, and is alfo called a *fhoal* or *fhallow*.

FLAT-bottomed Boats are fuch as are made to fwim in fhallow water, and to carry a great number of troops, artillery, ammunition, &c. They are conftructed with a 12 pounder, bow-chafe, and an 18 pounder, ftern-chafe; their keel is from 90 to 100 feet, and from 12 to 24 feet beam: they have one maft, a large fquare main-fail, and a jib-fail; are rowed by 18 or 20 oars, and can carry 400 men each. The gun takes up one bow, and a bridge the other, over which the troops are to march. Thofe that carry horfes have the fore-part of the boat made to open when the men are to mount and ride over a bridge.

FLATS, in *Mufic*. See INTERVAL.

FLATUS,

FLATUS, FLATULENCE, in *Medicine*; vapours generated in the ſtomach and inteſtines, chiefly occaſioned by a weakneſs of theſe parts. They occaſion diſtenſions, uneaſy ſenſation, and ſickneſs, and often a conſiderable degree of pain. See MEDICINE *Index*.

FLAVEL, JOHN, an eminent non-conformiſt miniſter, was educated at Univerſity-college, in Oxford; and became miniſter firſt of Deptford, and afterwards of Dartmouth in Devonſhire, where he reſided the greateſt part of his life, much reſpected and admired for his preaching; although he was perſecuted on account of his principles, when in 1685, ſeveral of the aldermen of the town, attended by the rabble, carried about a ridiculous effigy of him, to which were affixed the Bill of Excluſion and the Covenant. Upon this occaſion, he thought it prudent to withdraw from the town; not knowing what treatment he might meet with from a riotous mob, headed by magiſtrates who were themſelves among the loweſt of mankind. Part of his Diary, printed with his Remains, muſt give the reader a high idea of his piety. He died in 1691, aged 61; and after his death, his works, which conſiſted of many pieces of practical divinity, were printed in two volumes folio. Among theſe, the moſt famous are his "Navigation Spiritualized, or a New Compaſs for Seamen, conſiſting of 32 points of pleaſant obſervations and ſerious reflections," of which there have been ſeveral editions in 8vo; and his "Huſbandry Spiritualized, &c. with occaſional meditations upon beaſts, birds, trees, flowers, rivers and ſeveral other objects," of which alſo there have been many editions in octavo.

FLAX, in *Botany*. See LINUM, BOTANY *Index*.

The following particulars with regard to the manner of raiſing flax, have been ſome years paſt warmly recommended by the truſtees for fiſheries, manufactures, and improvements in Scotland.

Of the choice of the Soil, and preparing the Ground for FLAX. A ſkilful flax-raiſer always prefers a free open deep loam; and all grounds that produced the preceding year a good crop of turnip, cabbage, potatoes, barley, or broad clover, or have been formerly laid down rich, and kept for ſome years in paſture.

A clay ſoil, the ſecond or third crop after being limed, will anſwer well for flax; provided, if the ground be ſtill ſtiff, that it be brought to a proper mould, by tilling after harveſt to expoſe it to the winter froſts.

All new grounds produce a ſtrong crop of flax, and pretty free of weeds. When a great many mole heaps appear upon new ground, it anſwers the better for flax, after one tilling.

Flax ſeed ought never to be ſown on grounds that are either too wet or dry; but on ſuch as retain a natural moiſture: and ſuch grounds as are inclined to weeds ought to be avoided, unleſs prepared by a careful ſummer fallow.

If the linſeed be ſown early, and the flax not allowed to ſtand for ſeed, a crop of turnip may be got after the flax that very year; the ſecond year a crop of bear or barley may be taken; and the third year, graſs ſeeds are ſometimes ſown along with the linſeed. This is the method moſtly practiſed in and about the counties of Lincoln and Somerſet, where great quantities of flax and hemp are every year raiſed, and where theſe crops have long been capital articles. There, old ploughed grounds are never ſown with linſeed, unleſs the ſoil be very rich and clean. A certain worm, called in Scotland the *coup worm*, abounds in grounds newly broken up, and greatly hurts every crop but flax. In ſmall encloſures ſurrounded with trees or high hedges, the flax, for want of free air, is ſubject to fall before it be ripe; and the droppings of rain and dew from the trees prevent the flax, within the reach of the trees, from growing to any perfection.

Of preceding crops, potatoes and hemp are the beſt preparation for flax. In the fens of Lincoln, upon proper ground of old tillage, they ſow hemp, dunging well the firſt year; the ſecond year, hemp without dung; the third year, flax without dung; and that ſame year, a crop of turnip eaten on the ground by ſheep; the fourth year, hemp with a large coat of dung; and ſo on for ever.

If the ground be free and open, it ſhould be but once ploughed; and that as ſhallow as poſſible, not deeper than $2\frac{1}{2}$ inches. It ſhould be laid flat, reduced to a fine garden mould by much harrowing, and all ſtones and ſods ſhould be carried off.

Except a little pigeons dung for cold or ſour ground, no other dung ſhould be uſed preparatory for flax; becauſe it produces too many weeds, and throws up the flax thin and poor upon the ſtalk.

Before ſowing, the bulky clods ſhould be broken, or carried off the ground; and ſtones, quickenings, and every other thing that may hinder the growth of the flax ſhould be removed.

Of the choice of Linſeed. The brighter in colour, and heavier the ſeed is, ſo much the better; that which when bruiſed appears of a light or yellowiſh green, and freſh in the heart, oily and not dry, and ſmells and taſtes ſweet, and not fuſty, may be depended upon.

Dutch ſeed of the preceding year's growth, for the moſt part, anſwers beſt; but it ſeldom ſucceeds if kept another year. It ripens ſooner than any other foreign ſeed. Philadelphia ſeed produces fine lint and few bolls, becauſe ſown thick, and anſwers beſt in wet cold ſoils. Riga ſeed produces coarſer lint, and the greateſt quantity of ſeed. Scots ſeed, when well winned and kept, and changed from one kind of ſoil to another, ſometimes anſwers pretty well; but ſhould be ſown thick, as many of its grains are bad, and fail. It ſprings well, and its flax is ſooner ripe than any other; but its produce afterwards is generally inferior to that from foreign ſeed.

A kind has been lately imported called *Memmel ſeed*; which looks well, is ſhort and plump, but ſeldom grows above eight inches, and on that account ought not to be ſown.

Of Sowing Linſeed. The quantity of linſeed ſown ſhould be proportioned to the condition of the ſoil; for if the ground be in good heart, and the ſeed ſown thick, the crop will be in danger of falling before it is ready for pulling. From 11 to 12 pecks Linlithgow meaſure of Dutch or Riga ſeed, is generally ſufficient for one Scots acre; and about 10 pecks of Philadelphia ſeed, which, being the ſmalleſt grained, goes fartheſt. Riga linſeed, and the next year's produce of it, is preferred in Lincolnſhire.

The time for ſowing linſeed is from the middle of March to the end of April, as the ground and ſeaſon anſwers;

Flax.

answers; but the earlier the seed is sown, the less the crop interferes with the corn harvest.

Late sown linseed may grow long, but the flax upon the stalk will be thin and poor.

After sowing, the ground ought to be harrowed till the seed is well covered, and then (supposing the soil, as before mentioned, to be free and reduced to a fine mould) it ought to be rolled.

When a farmer sows a large quantity of linseed, he may find it proper to sow a part earlier and part later, that in the future operations of weeding, pulling, watering, and grassing, the work may be the easier and more conveniently gone about.

It ought always to be sown on a dry bed.

Of Weeding Flax. It ought to be weeded when the crop is about four inches long. If longer deferred, the weeders will so much break and crook the stalks, that they will never perhaps recover their straightness again; and when the flax grows crooked, it is more liable to be hurt in the rippling and swingling.

Quicken grass should not be taken up; for, being strongly rooted, the pulling of it always loosens a deal of the lint.

If there is an appearance of a settled drought, it is better to defer the weeding, than by that operation to expose the tender roots of the flax to the drought.

How soon the weeds are got out, they ought to be carried off the field, instead of being laid in the furrows, where they often take root again, and at any rate obstruct the growth of the flax in the furrows.

Of Pulling Flax. When the crop grows so short and branchy, as to appear more valuable for seed than flax, it ought not to be pulled before it be thoroughly ripe; but if it grows long and not branchy, the seed should be disregarded, and all the attention given to the flax. In the last case it ought to be pulled after the bloom has fallen, when the stalk begins to turn yellow, and before the leaves fall, and the bolls turn hard and sharp pointed.

When the stalk is small, and carries few bolls, the flax is fine; but the stalk of coarse flax is gross, rank, branchy, and carries many bolls.

When the flax has fallen, and lies, such as lies ought to be immediately pulled, whether it has grown enough or not, as otherwise it will rot altogether.

When parts of the same field grow unequally, so that some parts are ready for pulling before other parts; only what is ready should be pulled, and the rest should be suffered to stand till ready.

The flax-raiser ought to be at pains to pull and keep by itself, each different kind of lint which he finds in his field; what is both long and fine, by itself; what is both long and coarse, by itself; what is both short and fine, by itself; what is both short and coarse, by itself; and in like manner every other kind by itself that is of the same size and quality. If the different kinds be not thus kept separate, the flax must be much damaged in the watering and the other succeeding operations.

What is commonly called *under-growth* may be neglected as useless.

Few persons that have seen pulled flax, are ignorant of the method of laying it in handfuls across each other; which gives the flax sufficient air, and keeps the handfuls separate and ready for the rippler.

Of Stacking up Flax *during the Winter, and Winning the Seed.* If the flax be more valuable than the seed, it ought by no means to be stacked up; for its own natural juice assists it greatly in the watering; whereas, if kept long unwatered, it loses that juice, and the harle adheres so much to the boon, that it requires longer time to water, and even the quality of the flax becomes thereby harsher and coarser. Besides, the flax stacked up over year, is in great danger from vermine and other accidents; the water in spring is not so soft and warm as in harvest; and near a year is thereby lost of the use of the lint: but if the flax be so short and branchy as to appear most valuable for seed, it ought, after pulling, to be stooked and dried upon the field, as is done with corn; then stacked up for winter, rippled in spring; and after sheeling, the seed should be well cleaned from bad seeds, &c.

Of Rippling Flax. After pulling, if the flax is to be regarded more than the seed, it should be allowed to lie some hours upon the ground to dry a little, and so gain some firmness, to prevent the skin or harle, which is the flax, from rubbing off in the rippling; an operation which ought by no means to be neglected, as the bolls, if put into the water along with the flax, breed vermine there, and otherwise spoil the water. The bolls also prove very inconvenient in the grassing and breaking.

In Lincolnshire and Ireland, they think that rippling hurts the flax; and therefore, in place of rippling, they strike the bolls against a stone.

The handfuls for rippling should not be great, as that endangers the lint in the rippling comb.

After rippling, the flax-raiser will perceive, that he is able to assort each size and quality of the flax by itself more exactly than he could before.

Of Watering Flax. A running stream wastes the lint, makes it white, and frequently carries it away. Lochs, by the great quantity and motion of the water, also waste and whiten the flax, though not so much as running streams. Both rivers and lochs water the flax quicker than canals.

But all flax ought to be watered in canals, which should be digged in clay ground if possible, as that soil retains the water best: but if a firm retentive soil cannot be got, the bottom or sides of the canal, or both the bottom and sides, may be lined with clay; or instead of lining the sides with clay, which might fall down, a ditch may be dug without the canal, and filled with clay, which will prevent both extraneous water from entering, and the water within from running off.

A canal of 40 feet long, six broad, and four deep, will generally water the growth of an acre of flax.

It ought to be filled with fresh soft water from a river or brook, if possible, two or three weeks before the flax is put in, and exposed all that time to the heat of the sun. The greater way the river or brook has run, the softer, and therefore the better, will the water be. Springs, or short runs from hills, are too cold, unless the water is allowed to stand long in the canal. Water from coal or iron is very bad for flax. A little of the powder of galls thrown into a glass of water, will

will immediately discover if it comes from minerals of that kind, by turning it into a dark colour, more or less tinged in proportion to the quantity of vitriol it contains.

The canal ought not to be under shade: which, besides keeping the sun from softening the water, might make part of the canal cooler than other parts, and so water the flax unequally.

The flax-raiser will observe, when the water is brought to a proper heat, that small plants will be rising quickly in it, numbers of small insects and reptiles will be generating there, and bubbles of air rising on the surface. If no such signs appear, the water must not be warm enough, or is otherwise unfit for flax.

Moss holes, when neither too deep nor too shallow, frequently answer well for watering flax, when the water is proper, as before described.

The proper season for watering flax is from the end of July to the end of August.

The advantage of watering flax as soon as possible after pulling, has been already mentioned.

The flax being sorted after rippling, as before mentioned, should next be put in beets, never larger than a man can grasp with both his hands, and tied very slack with a band of a few stalks. Dried rushes answer exceedingly well for binding flax, as they do not rot in the water, and may be dried and kept for use again.

The beets should be put into the canals slopewise, or half standing upon end, the root end uppermost. Upon the crop ends, when uppermost, there frequently breeds a deal of vermine, destructive of the flax, which is effectually prevented by putting the crop end downmost.

The whole flax in the canal ought to be carefully covered from the sun with divots; the grassy side of which should be next the flax, to keep it clean. If it is not thus covered, the sun will discolour the flax, though quite covered with water. If the divots are not weighty enough to keep the flax entirely under water, a few stones may be laid above them. But the flax should not be pressed to the bottom.

When the flax is sufficiently watered, it feels soft to the gripe, and the *harle* parts easily with the *boon* or *show*, which last is then become brittle, and looks whitish. When these signs are found, the flax should be taken out of the water, beet after beet; each gently rinsed in the water, to cleanse it of the nastiness which has gathered about it in the canal; and as the lint is then very tender, and the beet slackly tied, it must be carefully and gently handled.

Great care ought to be taken that no part be overdone; and as the coarsest waters soonest, if different kinds be mixed together, a part will be rotted, when the rest is not sufficiently watered.

When lint taken out of the canal is not found sufficiently watered, it may be laid in a heap for 12, 18, or 24 hours, which will have an effect like more watering; but this operation is nice, and may prove dangerous in unskilful hands.

After the flax is taken out of the canal, fresh lint should not be put a second time into it, until the former water be run off, and the canal cleaned, and supplied with fresh water.

Of Grassing FLAX. Short heath is the best field for grassing flax; as, when wet, it fastens to the heath, and is thereby prevented from being blown away by the wind. The heath also keeps it a little above the earth, and so exposes it the more equally to the weather. When such heath is not to be got, links or clean old lea ground is the next best. Long grass grounds should be avoided, as the grass growing through the lint frequently spots, tenders, or rots it; and grounds exposed to violent winds should also be avoided.

The flax, when taken out of the water, must be spread very thin upon the ground; and being then very tender, it must be gently handled. The thinner it is spread the better, as it is then the more equally exposed to the weather. But it ought never to be spread during a heavy shower, as that would wash and waste the harle too much, which is then excessively tender, but soon after becomes firm enough to bear the rains, which, with the open air and sunshine, cleans, softens, and purifies the harle to the degree wanted, and makes it blister from the boon. In short, after the flax has got a little firmness by being a few hours spread in dry weather, the more rain and sunshine it gets the better.

If there be little danger of high winds carrying off the flax, it will be much the better of being turned about once a week. If it is not to be turned, it ought to be very thin spread. The spreading of flax and hemp requires a deal of ground, and enriches it greatly.

The skilful flax-raiser spreads his first row of flax at the end of the field opposite to the point from whence the most violent wind commonly comes, placing the root-ends foremost; he makes the root-ends of every other row overlap the crop ends of the former row three or four inches, and binds down the last row with a rope; by which means the wind does not easily get below the lint to blow it away; and as the crop ends are seldom so fully watered as the root ends, the aforesaid overlapping has an effect like giving the crop ends more watering. Experience only can fully teach a person the signs of flax being sufficiently grassed: then it is of a clearer colour than formerly; the harle is blistered up, and easily parts with the boon, which is then become very brittle. The whole should be sufficiently grassed before any of it is lifted; for if a part be lifted sooner than the rest, that which remains is in great danger from the winds.

A dry day ought to be chosen for taking up the flax; and if there is no appearance of high wind, it should be loosed from the heath or grass, and left loose for some hours, to make it thoroughly dry.

As a great quantity of flax can scarcely be all equally watered and grassed, and as the different qualities will best appear at lifting the flax off the grass; therefore at that time each different kind should be gathered together, and kept by itself; that is, all of the same colour, length, and quality.

The smaller the beets lint is made up in, the better for drying, and the more convenient for stacking, housing, &c. and in making up these beets, as in every other operation upon flax, it is of great consequence that the lint be laid together as it grew, the root ends together, and the crop ends together.

Follows

Flax. Flax.

Follows an estimate of the Expence, Produce, and Profit of a Scots Acre of FLAX,—*supposing the season favourable, that no accidental losses happen, and that the farmer is neither unskilful nor negligent.*

	A medium crop.	*A great crop.*	*An extra crop.*
Ground rent, labouring the ground, and leading the flax	L. 2 10 0	L. 3 10 0	L. 5 0 0
Linseed from 2l. to 4l. per hogshead, the medium 3s. 4d. per peck — —	1 16 8 for 11 pecks.	1 10 0 for 9 pecks.	1 6 8 for 8 pecks.
Clodding and sowing — —	0 2 0	0 2 0	0 2 0
Weeding — — —	0 12 0	0 8 0	nothing.
Pulling, rippling, putting in, and covering in the water — — —	0 14 0	0 15 0	1 0 0
Taking out of the water, grassing, and stacking	0 8 0	0 12 0	0 18 0
Breaking and scutching, at 2s. per stone —	3 0 0 for 30 stones.	4 0 0 for 40 stones.	6 0 0 for 60 stones.
Total expence	L. 9 2 8	L. 10 17 0	L. 14 6 8
Produce at 10s. per stone. — —	L. 15 0 0 for 30 stones.	L. 20 0 0 for 40 stones.	L. 30 0 0 for 60 stones.
Linseed sold for oil at 1s. per peck — The chaff of the bolls is well worth the expence of drying the seed; as it is good food, when boiled and mixed with bear, for horses.	0 16 0	0 18 0	1 0 0
Total produce	L. 15 16 0	L. 20 18 0	L. 31 0 0
Balance for profit — —	L. 6 14 4	L. 10 1 0	L. 16 13 4

The above estimate being made several years ago, the expence and profit are now different; but the proportions of each are probably the same. There is nothing stated here as expence of the canal in which the flax is watered; because that varies much according to circumstances.

It is a certain fact, that the greater the crop is, the better is the quality of the same kind of flax.

The advantage of having both a crop of flax and a crop of turnip the same year—or of sowing grass seeds along with the linseed—and of reducing the ground to a fine garden mould, free of weeds, ought to be attended to.

For Cambric and fine Lawn. The ground must be a rich light soil, rather sandy, but cannot be too rich.

It ought to be ploughed in September, or the beginning of October, first putting a little hot rotten dung upon it. In January it ought to have a second ploughing, after a hard frost; and when you intend to sow it, plough it a third time, or rather hoe it, reducing the clods very fine; but make no furrows: the land must be made level like a garden; but never work the land when wet.

The seed should be sown the beginning of April, and about double the quantity that is generally sown by our farmers; if the land be very rich, it will require rather more than double.

As soon as sown (if the weather be dry) it will be necessary to roll the ground.

The lint must be weeded very clean when about three inches high; directly after which you must set forked sticks, of about one and a half inch thick (which ought to be prepared before), every four or five feet, according to the length of the poles you are to lay upon them; they should be well fixed in the ground, the forked part to receive the poles about six or seven inches above the lint; each row of poles should be two, three, or four feet asunder, according to the length of the brushwood you are to lay upon them.

The poles ought to be from 10 to 15 feet long, and strong enough to support the brush across the poles; take the longest brushwood you can get, the more branchy the better, very thick, filling up the vacancies with smaller brush, and any of the branches that rise higher than 18 or 20 inches ought to be lopt off to make the brush lie as level as possible: any sort of brush will do except oak, as that tinges the lint.

Your lint must be pulled as soon as the seed is fully formed, which is a few days after it is out of the bloom, before the lint turn yellow.

It must be pulled above the brushwood, and every handful laid upon it as soon as possible: if it is fine weather, leave it four or five hours in that manner: then carry it to a screen near a barn, to put it under cover in case of rain; there it must be spread four or five days, and always put in the barn at night, or when it appears to rain: the bundles must be opened in the barn, or made hollow, to prevent it from heating.

These operations must be performed until the lint is perfectly dry, and out of danger of heating; taking care all the time to keep the roots as even as possible, and if possible keep it from rain or wet: if you cannot prevent it from being wet, it will be better to leave it on the grass till dry; because when once wet, the putting it under cover before dry will make it turn black; a thing which must be prevented at all events.

If any of the lint upon the border, or through the piece of ground, be coarser than another, it must be separated from the rest.

 The

Flax.

The utmoſt care muſt be taken to preſerve the ſint entire or unbroken; for this reaſon they beat off the ſeed with a round mell or bittle.

The moſt proper ground is ſummer fallow, or after potatoes or lea; if poſſible near a wood, to prevent the expence of carrying bruſh.

As ſoon as the ſeed is off, if you intend to water it that ſeaſon, it muſt be tied in bundles about as large as you can graſp with your two hands.

The water proper for it, is a very ſmall rivulet or ſoft ſpring free of any metellic ore; taking care that no flood or foul water enters your pit; which muſt be at leaſt five feet deep, about nine or ten broad at the top, and ſeven or eight at the bottom; the length will depend on the quantity of flax you have to water. A very ſmall ſtripe of water, when clear, ſhould always be running in and off from your pit when the lint is in it.

The pit ought to be made three or four months before it be uſed.

You muſt drive poles about four inches thick, with a hook inclining downwards, in this form 7, all along the ſides of the pit, above five feet aſunder. The hooks muſt be level with, or rather under, the ſurface of the water. A long pole, the whole length of the pit, muſt be fixed into theſe hooks on each ſide; and croſs poles put under that, to keep the lint under water; but the croſs poles are not uſed till the lint is put in. You muſt order it ſo, that all the lint ſhould be three or four inches under water. You next bring your lint to the ſides of the pit; then put your ſheaves head to head, cauſing each to overlap the other about one-third, and take as many of theſe as make a bundle of two or two and a half feet broad, laying the one above the other till it is about four or four and a half feet high; then you tie them together in the middle, and at each root end: after this you wrap your bundle in ſtraw, and lay it in the water, putting the thin or broad ſide undermoſt, taking care that none of your lint touch the earth; after it is fully preſſed under water, put in your croſs poles to keep it under. The bundles ought to lie in the pit a foot ſeparate from each other. This renders it eaſy to take out; for, if the bundles entangle, they will be too heavy to raiſe.

The time of watering depends ſo much upon the weather, and ſoftneſs or hardneſs of the water, that it is impoſſible to fix any certain time. This muſt be left to the ſkill of the farmer. If the flax be intended for ſpinning yarn ſoft and fit for cambric, it ought to be ſpread upon ſhort graſs for four or five days before you put it into the water; but if for lawns, lace, or thread, it is beſt to dry it outright. In either caſe, avoid as much as poſſible to let it get rain; as much rain blanches and waſhes out the oil, which is neceſſary to preſerve the ſtrength.

The great property of this flax is to be fine and long. Thick ſowing raiſes all plants fine and ſlender; and when the ground is very rich, it forces them to a great length. Pulling green prevents that coarſe hardneſs which flax has when let ſtand till it be full ripe, and gives it the fine ſilky property. The bruſhwood, when the flax ſprings up catches it by the middle, and prevents it from lying down and rotting; infallible conſequences of ſowing thick upon rich ground. It likewiſe keeps it ſtraight, moiſt, and ſoft at the roots; and by keeping it warm, and ſhaded from the ſun, greatly promotes its length. The keeping it from rain, heating, taking proper care of your water, preſerves the colour, and prevents thoſe bars in cloth ſo much complained of by bleachers.

Flax-Dreſſing. For many ages it was the practice to ſeparate the boon or core from the flax, which is the bark of the plant, by the following ſimple *hand methods*. Firſt, for breaking the boon, the ſtalks in ſmall parcels were beat with a mallet; or, more dexterouſly, the *break* (Plate CCXVIII. fig. 1. and 2.) was uſed thus: The flax being held in the left hand acroſs the three *under teeth* or *ſwords* of the break (*A*, fig. 1. and *a* fig. 2.), the *upper teeth* (*B*, fig. 1. and *b*. fig. 2.) were with the right hand quickly and often forced down upon the flax, which was artfully ſhifted and turned with the left hand. Next, for clearing the flax of the broken boon: the workman with his left hand held the flax over the *ſtock* (fig. 3. and 4.), while with his right hand he ſtruck or thraſhed the flax with the *ſcutcher* (fig. 5.)

Theſe methods of breaking and ſcutching the flax being ſlow and very laborious, a *water-mill* was invented in Scotland about the year 1750; which, with ſome improvements, makes great deſpatch, and in ſkilful and careful hands gives ſatisfaction. It has been generally conſtructed to break the boon by three dented rollers, placed one above the other. The middle one of which, being forced quickly round, takes the other two along with it, and one end of the handfuls of the flax being by the workmen directed in between the upper and middle rollers, the flax is immediately drawn in by the rollers; a curved board or plate of tin behind the rollers directs the flax to return again between the middle and undermoſt rollers;—and thus the operation is repeated until the boon be ſufficiently broke. Great weights of timber or ſtone at the ends of levers, preſs the upper and under rollers towards the middle one.

The ſcutching is next carried on by the mill in the following manner: Four arms, ſomething like the hand-ſcutchers before deſcribed, project from a perpendicular axle; a box around the axle encloſes theſe projecting ſcutchers; and this box is divided among the workmen, each having ſufficient room to ſtand and handle his flax, which, through ſlits in the upper part and ſides of the box, they hold in to the ſtroke of the ſcutchers; which, moving round horizontally, ſtrike the flax acroſs or at right angles, and ſo thraſh out or clear it of the boon.

The breaking of the flax by *rollers* is ſcarcely ſubject to any objection, but that it is dangerous to workmen not ſufficiently on their guard, who ſometimes allow the rollers to take hold of their fingers, and thereby their whole arm is inſtantly drawn in: thus many have loſt their arms. To avoid this danger, a break, upon the general principles of the hand-break before deſcribed, has been lately adapted to water-machinery, and uſed in place of rollers. The horizontal ſtroke of the ſcutchers was long thought too ſevere, and waſteful of the flax; but very careful experiments have diſcovered that the waſte complained of muſt be charged to the unſkilfulneſs or negligence of the workmen, as in good hands the mill carries away nothing but what, if not ſo ſcutched off, muſt be be taken off in the heckling, with more loſs both of time and flax. But to obviate this objection of the violence of the *horizontal ſcutchers*, an imitation of hand-ſcutching has lately been applied to water. The ſcutchers then project from a horizontal axle, and move like the arms of a check reel, ſtriking the flax neither acroſs nor perpendicularly down, but ſloping in upon the parcel exactly as the flax is ſtruck by the hand-ſcutcher. This ſloping ſtroke is got by raiſing the ſcutching ſtock ſome inches higher than the centre of the axle; and by raiſing or lowering the ſtock over which the flax is held, or ſcrewing it nearer to or farther from the ſcutchers, the workman can temper or humour the ſtroke almoſt as he pleaſes.

A lint mill, with horizontal ſcutchers upon a perpendicular axle, requires a houſe of two ſtories, the rollers or break being placed in the ground ſtory, and the ſcutchers in the loft above; but a mill with vertical ſcutchers on a horizontal axle, requires but one ground ſtory for all the machinery.

Another method of breaking and ſcutching flax, more expeditious than the old hand methods, and more gentle than water mills, has alſo been invented in Scotland. It is much like the break and ſcutcher, giving the ſloping ſtroke laſt deſcribed, moved by the foot. The treddle is remarkably long, and the ſcutchers are fixed upon the rim of a fly wheel. The foot-break is alſo aſſiſted in its motion by a fly. Theſe foot machines are very uſeful where there are no water mills, but they are far inferior to the mills in point of expedition.

The next operation that flax undergoes after ſcutching is heckling. The *heckle* (fig. 6.) is firmly fixed to a bench before the workman, who ſtrikes the flax upon the teeth of the heckle, and draws it through the teeth. To perſons unacquainted with that kind of work this may ſeem a very ſimple operation; but, in fact, it requires as much practice to acquire the ſlight of heckling well, and without waſting the flax, as any other operation in the whole manufacture of linen. They uſe coarſer and wider teethed heckles, or finer, according to the quality of the flax; generally putting the flax through two heckles, a coarſer one firſt, and next a fine one.

Flax for Cambric and fine Lawn, Thread, and Lace, is dreſſed in a manner ſomewhat different. It is not ſcutched ſo thoroughly as common flax; which from the ſcutch proceeds to the heckle, and from that to the ſpinner: whereas, this fine flax, after a rough ſcutching, is ſcraped and cleanſed with a blunt knife upon the workman's knee covered with his leather apron; from the knife it proceeds to the ſpinner, who, with a bruſh made for the purpoſe, ſtraights and dreſſes each parcel juſt before ſhe begins to ſpin it.

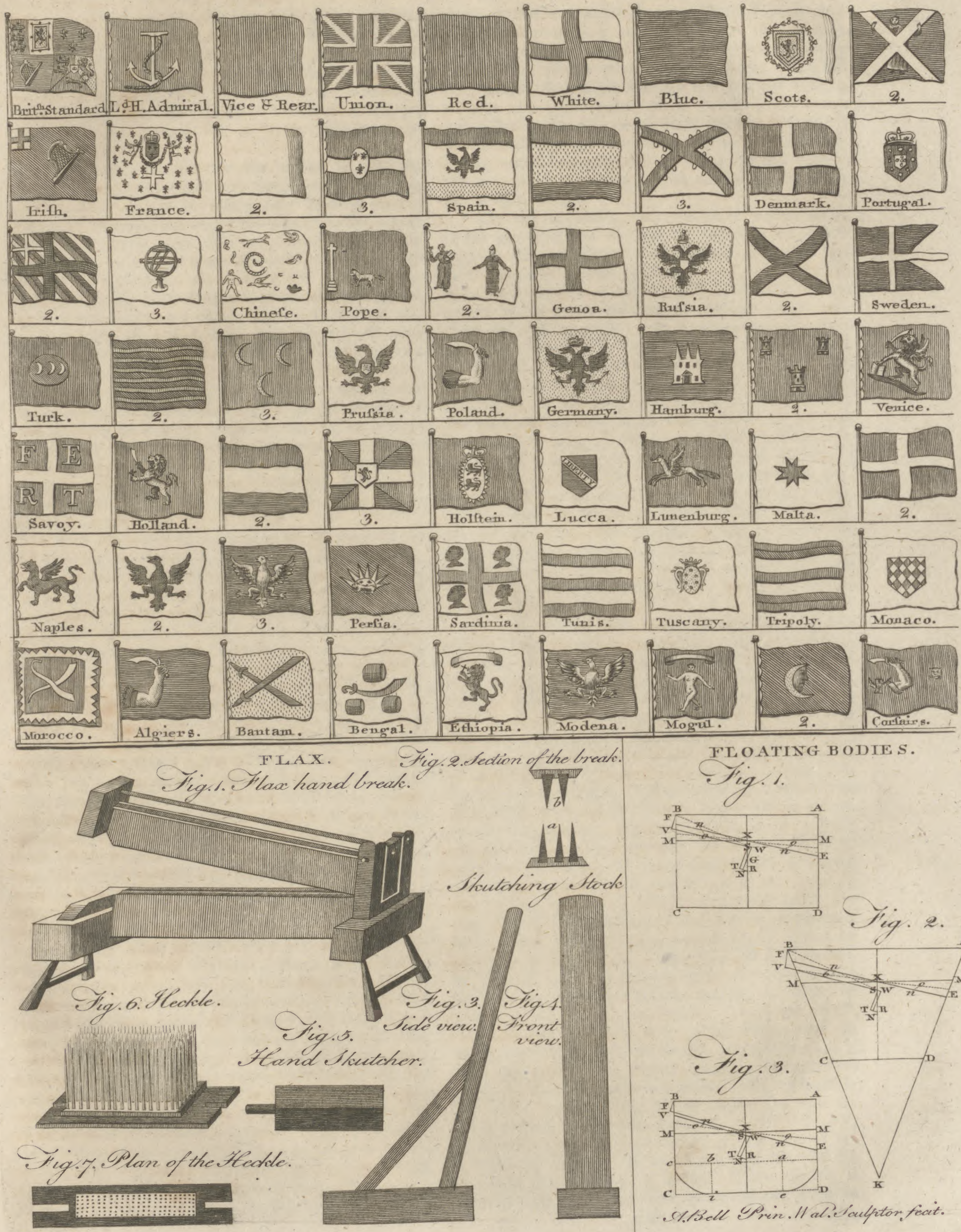
The following obſervations on this ſubject, firſt publiſhed in the Gentleman's Magazine for June 1787, ſeem worthy of particular attention.

Of the watering of Flax by a new method, ſo as to ſhorten labour, to add probably to the ſtrength of the flax, and to give it a much finer colour, which would render the operation of bleaching ſafer and leſs tedious.

"Though the following reflections have for their object an improvement in the very eſſential article of watering of flax, yet I muſt advertiſe the reader, that they are only theory, and muſt depend entirely for their truth and juſtification upon future experiments, ſkilfully and judiciouſly made. Should repeated trials prove the advantage of the new method propoſed, we may venture to affirm, that it would be an improvement that would increaſe the national income in the agricultural branch many thouſand pounds annually, would add greatly to the perfection of the linen manufacture, and over and above would ſuppreſs a very diſagreeable nuiſance, which the preſent method of watering flax occaſions during ſome part of the ſummer in every flax-growing country.

"The intention of watering flax is, in my opinion, to make the boon more brittle or friable, and, by ſoaking, to diſſolve that gluey kind of ſap that makes the bark of plants and trees adhere in a ſmall degree to the woody part. The bark of flax is called the *harle;* and when ſeparated from the uſeleſs woody part, the *boon*, this harle itſelf is called flax. To effect this ſeparation eaſily, the practice has long prevailed, of ſoaking the flax in water to a certain degree of fermentation, and afterwards drying it. For this ſoaking ſome prefer rivulets that have a ſmall current, and others ſtagnant water in ponds and lakes. In both methods the water acts as in all other caſes of infuſion and maceration; after two or three weeks it extracts a great many juices of a very ſtrong quality, which in ponds give the water an inky tinge and offenſive ſmell; and in rivulets mix in the ſtream and kill the fiſh. Nay, if this maceration be too long continued, the extracted and fermented ſap will completely kill the flax itſelf. For if, inſtead of two or three weeks, the new flax were to lie ſoaking in the water four or five months, I preſume it would be good for nothing but to be thrown upon the dunghill; both harle and boon would in time be completely rotted; yet the harle or flax, when entirely freed from this ſap, and manufactured into linen, or into ropes, might lie many months under water without being much damaged; as linen, it may be waſhed and ſteeped in ſcalding water twenty times without loſing much of its ſtrength; and as paper, it acquires a kind of incorruptibility.

"It appears then eſſential to the right management of new flax, to get rid of this pernicious vegetative ſap, and to macerate the boon; but from the complaints made againſt both the methods of watering now in uſe, there is reaſon to think that there is ſtill great room for improvement in that article. In rivulets, the vegetative ſap, as it is diſſolved, is carried off by the current, to the deſtruction of the fiſh. This prevents the flax from being ſtained; but the operation is tedious, and not complete, from the uncertainty of knowing when it is juſt enough, and not too much, or perhaps from neglect. In ponds, the inky tinge of the water often ſerves as a kind of dye to the flax, which imbibes it ſo ſtrongly, that double the labour in bleaching will hardly bring the linen made of ſuch flax to an equality in whiteneſs with linen made of flax untinged. This ſeems to be equally unwiſe as though we were to die cotton black firſt, in order to whiten it afterwards. Theſe ponds, beſides, become a great nuiſance to the neighbourhood; the impregnated water is often of ſuch a pernicious quality, that cattle,


Britth. Standard
Ld. H. Admiral.
Vice & Rear.
Union.
Red.
White.
Blue.
Scots.
2.
Irish.
France.
2.
3.
Spain.
2.
3.
Denmark.
Portugal.
2.
3.
Chinese.
Pope.
2.
Genoa.
Russia.
2.
Sweden.
Turk.
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Prussia.
Poland.
Germany.
Hamburg.
2.
Venice.
Savoy.
Holland.
2.
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Holstein.
Lucca.
Lunenburg.
Malta.
2.
Naples.
2.
3.
Persia.
Sardinia.
Tunis.
Tuscany.
Tripoly.
Monaco.
Morocco.
Algiers.
Bantam.
Bengal.
Ethiopia.
Modena.
Mogul.
2.
Corsairs.
FLAX.
Fig. 1. Flax hand break.
Fig. 2. Section of the break.
Skutching Stock
Fig. 3. Side view.
Fig. 4. Front view.
Fig. 5. Hand Skutcher.
Fig. 6. Heckle.
Fig. 7. Plan of the Heckle.
FLOATING BODIES.
Fig. 1.
Fig. 2.
Fig. 3.
A. Bell Prin. Wal. Sculptor fecit.

Flax.

cattle, however thirfty, will not drink of it; and the effluvia of it may perhaps be nearly as infectious as it is offenfive. If this effluvia is really attended with any contagious effects in our cold climate, a thing worth the inquiring into, how much more pernicious muft its effects have been in the hot climate of Egypt, a country early noted for its great cultivation of flax?

"I have often thought that the procefs of watering might be greatly improved and fhortened by plunging the new flax, after it is rippled, into fcalding water; which, in regard to extracting the vegetative fap, would do in five minutes more than cold water would do in a fortnight, or perhaps more than cold water could do at all, in refpect to the clearing the plant of fap. Rough almonds, when thrown into fcalding water, are blanched in an inftant; but perhaps a fortnight's macerating thofe almonds in cold water would not make them part fo eafily with their fkins, which are the fame to them as the harle is to the flax. Were tea leaves to be infufed in cold water a fortnight, perhaps the tea produced by that infufion would not be fo good to the tafte, or fo ftrongly tinged to the eye, as what is effected by fcalding water in five minutes. By the fame analogy, I think, flax or any fmall twig would be made to part with its bark much eafier and quicker by being dipped in boiling water than by being fteeped in cold water.

"This reflection opens a door for a great variety of new experiments in regard to flax. I would therefore recommend to gentlemen cultivators and farmers, to make repeated trials upon this new fyftem, which would foon afcertain whether it ought to be adopted in practice or rejected. One thing, I think, we may be certain of, that if the Egyptians watered their flax in our common manner, they undoubtedly watered it in *very warm water*, from the great heat of their climate, which would probably make them neglect to think of water heated by any other means than that of the fun. A good general practice can only be eftablifhed upon repeated trials. Though one experiment may fail, another with a little variation may fucceed; and the importance of the object defired to be obtained will juftify a good degree of perfeverance in the profecution of the means. In this view, as the Chinefe thread is faid to be very ftrong, it would be worth while to be acquainted with the practice of that diftant nation, in regard to the rearing and manufacturing of flax, as well as with the methods ufed by the Flemings and the Dutch.

"Boiling water perhaps might at once clear the new flax from many impurities, which when not removed till it be fpun into yarn, are then removed with difficulty, and with lofs of fubftance to the yarn. Why fhould not the longitudinal fibres of the flax, before they be fpun into yarn, be made not only as *fine* but as *clean* as poffible? Upon the new fyftem propofed, the act of bleaching would begin immediately after the rippling of the flax; and a little done then, might perhaps fave much of what is generally done after the fpinning and weaving. To fpin dirty flax with a view of cleaning it afterwards, appears to be the fame impropriety as though we were to referve part of the dreffing given to leather till after it is made into a glove.

"Should the plunging of the flax into the boiling water not fuffice to make the boon brittle enough, as I am inclined to think it would not, then the common watering might be added; but in that cafe probably half the time ufually given to this watering would fuffice, and the flax might then be laid in clear rivulets, without any apprehenfion of its infecting the water and poifoning the fifh, or of being difcoloured itfelf; for the boiling water into which it had been previoufly put, would have extracted all the poifonous vegetative fap, which I prefume is what chiefly difcolours the flax or kills the fifh.

"On the fuppofition, that the ufe of boiling water in the preparation of flax may be found to be advantageous and profitable, I can recollect at prefent but one objection againft its being generally adopted. Every flax-grower, it may be faid, could not be expected to have conveniences for boiling water fufficient for the purpofe; the confumption of water would be great; and fome additional expence would be incurred. In anfwer to this, I fhall obferve, that I prefume any additional expence would be more than reimburfed by the better marketable price of the flax; for otherwife any new improvement, if it will not quit coft muft be dropt, were it even the fearching after gold. In a large caldron a great deal of flax might be dipt in the fame water, and the confumption perhaps would not be more than a quart, to each fheaf. Even a large houfehold pot would be capable of containing one fheaf after another; and I believe the whole objection would be obviated, were the practice to prevail with us, as in Flanders and Holland, that the flax-grower and the flax-dreffer fhould be two diftinct profeffions.

"I fhall conclude with recommending to thofe who are inclined to make experiments, not to be difcouraged by the failure of one or two trials.—Perhaps the flax, inftead of being juft plunged into the fcalding water, ought to be kept in it five minutes, perhaps a quarter of an hour, perhaps a whole hour. Should five minutes or a quarter of an hour, or an hour, not be fufficient to make the boon and harle eafily feparate, it might perhaps be found expedient to boil the flax for more than an hour; and fuch boiling when in this ftate might in return fave feveral hours boiling in the article of bleaching. It is not, I think, at all probable that the boiling of the flax with the boon in it would prejudice the harle; for in the courfe of its future exiftence, it is made to be expofed 20 or 40 times to this boiling trial; and if not detrimental in the one cafe, it is to be prefumed it would not be detrimental in the other. Perhaps after the boiling, it would be proper to pile up the flax in one heap for a whole day, or for half a day, to occafion fome fermentation; or perhaps, immediately after the boiling, it might be proper to wafh it with cold water. The great object, when the flax is pulled, is to get the harle from the boon with as little lofs and damage as poffible; and if this is accomplifhed in a more complete manner than ufual, confiderable labour and expence will be faved in the future manufacturing of the flax. On this account I think much more would be gained than loft, were the two or three laft inches of the roots of the ftems to be chopped off, or clipt off previous to the flax being either watered or boiled. When the flax is watered, care fhould be taken not to fpread it out to dry,

dry, when there is a hazard of its being expoſed in its wet ſtate to froſt."

To what we have now ſaid we ſhall add the following ſhort account of the flax huſbandry of Ireland, in a letter which appeared in the Farmers Magazine, vol. vii. page 35.

"Having for ſeveral years (ſays the writer) been engaged in the culture of flax, I devoted a part of laſt ſummer to a tour through the manufacturing diſtricts of Ireland. Here that branch of huſbandry has long been eſtabliſhed over a large extent of the country, and conducted with very conſiderable ſucceſs. As ſome of the proceſſes in this culture, which are followed with advantage, are either unknown to the Scots farmers, or are performed in a very awkward and inefficient manner, it might, I conceive, prove of no ſmall benefit, were ſome of your intelligent correſpondents induced to lay before them a plain ſketch of the peculiar management obſerved by the Iriſh peaſantry in this important article. I am the more deſirous it ſhould appear in your pages, becauſe a periodical work on huſbandry, conducted by a practical farmer, appears before the public with manifeſt advantage, and is received with that ſort of deference which is due to experience and authority. The diſcuſſions of actual cultivators regarding the objects of their own profeſſion, however new they may as yet be in the annals of agriculture, are far more likely to prove uſeful, than the writings of thoſe volunteers in this favourite ſcience, who are merely ſpeculative and theoretical. I freely confeſs to you, Sir, that I found with pleaſure your work widely circulated in the ſiſter kingdom; and that the cauſe uniformly given for its popularity, was a degree of confidence placed in the practical ſkill of its conductor.

"During my progreſs through Ireland, the ſeveral proceſſes of *ſteeping*, *drying*, and *ſkutching*, were in hand, and I think I found a peculiarity of management in theſe ſufficient to affect the ſucceſs of the whole buſineſs, and to confer a decided ſuperiority on the produce of an acre of flax in Ireland over that in Scotland, both in quantity and value. It is no uncommon thing for a farmer in this country, who wiſhes to make up a ſum for his rent, to ſell a part of his *lint on the foot*, as it is termed; and for this he will commonly receive from 30 to 40 guineas per acre.

"1. *The Method of Steeping.*—As ſoon as the crop has attained the proper degree of ripeneſs, (which is ſomewhat below your ſtandard of maturity), the flax is pulled, and carried to a ſtagnant pool, dug for this purpoſe, moderately deep. It is allowed to remain there only from *five* to *ſeven* days, according to the temperature of the weather. After the fermentation in the ſteeping proceſs has been carried to a degree ſufficient to produce the requiſite laxity of fibre, the flax is taken out of the pool, and ſpread *very thinly* on the ſtubble of the hay meadow. There, inſtead of remaining till it is merely dried, it is continued for three or four weeks, till the grower conceives it ready for ſkutching. This blenching proceſs, if I am allowed to call it ſo, which, in Scotland, is either unknown, or continued merely till the crop is dried, has many advantages; the moſt obvious one is, that it enables the farmer, every time he examines it, to aſcertain exactly (by rubbing on his hand) the preciſe point at which the fermentation has arrived, and thus to perceive the tenacity and ſtrength of his flax; while the adheſion of the fibre has been ſufficiently weakened, to admit of the ſkutcher cleanſing it completely of the woody parts. It is, I am apprehenſive, only the practical flax farmer who is able to judge of the importance and delicacy of this part of the huſbandry. It is ſo remarkable, that of two acres of flax, under preciſely the ſame ſeed and culture, and of equal fertility, it frequently happens that the one ſhall yield a produce thrice the value of the other, merely from ſuperior accuracy in aſcertaining the proper line of continuing the ſteeping and blenching proceſſes. In Scotland, therefore, I ſuſpect the practice is faulty and defective; becauſe there the whole proceſs of fermentation is completed by ſteeping alone; whereas, in Ireland, it is begun only in the ſteep, and completed by blenching on the meadow, to that preciſe point which the ſafety of the produce requires.

"2. *Smoking and Drying.*—The Iriſh peaſant ſeems to poſſeſs another advantage, almoſt equally deciſive, in his mode of drying the flax, before he ſubmits it to the ſkutcher or beater. After the lint has remained a ſufficient length of time on the blenching green, it is gathered up a ſecond time into ſheafs, (beats, provincially), and ſeems tolerably dry. In this ſtate it is deemed by the Scots growers fully prepared for the flax-mill; but far otherwiſe by the Iriſh farmer, who never ſubmits it to the hands of the beaters till it has undergone a thorough ſmoking over a peat fire. For this purpoſe, he raiſes, at the back of a ditch, a ſmall hurdle thinly wrought with oſiers, and places it on four poſts of wood, at the height of four feet above the level of the ground. A pretty ſtrong fire of peats being kindled below, the heat and ſmoke pervade every part of the flax, which is placed perpendicularly above the hurdle. This proceſs is continued, and freſh quantities of flax regularly added, till the whole crop is brought to a ſtate of dryneſs, which, in this moiſt climate, can never be effected by the ſun and the weather alone: by this operation a degree of brittleneſs and friability is produced on the ſtraw, which greatly facilitates the enſuing work, and admits of an eaſy ſeparation of the fibre from the wood. It is evident, that the leſs friction required in ſkutching, the leſs waſte or diminution muſt be occaſioned in clearing the flax; and conſequently, the greater muſt be the grower's produce from the mill. This part of the proceſs is equally delicate with that deſcribed above, and requires, if poſſible, ſtill greater attention on the part of the workmen, ſince it is clear that, by a careleſs management of the fire, the whole crop may be deſtroyed.

"3. *Cleanſing and Dreſſing.*—The flax huſbandry of Ireland derives no ſmall benefit from the application of hand-labour in the beating and ſkutching of lint, thus ſuperſeding the uſe of the mill. The moſt careful and expert workmen are not always able to temper the velocity of machinery ſo exactly, as to preſerve flax that has been overſteeped or blenched to exceſs: while the ſteady and regulated *impetus* of the hand-ſkutch can eaſily be modified, as the circumſtances of each caſe may require; a matter of obvious advantage, becauſe the beſt flax-mills ſeldom produce an equal quantity of lint, nor equally clean, with that which is obtained by the hand. Beſides this, the price of labour, in this part of the united kingdom, ſtill continues ſo moderate, as to preclude any conſiderable degree of ſaving in expence

pence by the uſe of machinery. In proof of this, the flax millers in Scotland, I find, are charging this ſeaſon from three to four ſhillings for dreſſing a ſtone of flax; while, at the place I am now writing, the ſame quantity is dreſſed by the hand for thirteenpence, or one Britiſh ſhilling. In Scotland, where hands are ſcarce, and the price of labour conſequently high, I certainly would not recommend the diſuſe of the flax-mill; on the contrary, I am perſuaded that it is chiefly owing to our ſuperior machinery, and excellent implements of huſbandry, that we are at all enabled to maintain a competition with our neighbours in the preſent ſtate of our ſkill in flax huſbandry, and ſubjected to the diſadvantage of paying double price for our labour.

"4. *Preſervation of Flax-ſeed.*—The laſt peculiarity of management, which I ſhall at preſent notice as advantageous to the flax huſbandry of Ireland, is the invention of a flax barn for the preſervation of ſeed. Enjoying a climate perhaps ſtill more moiſt and unſteady than that of Great Britain, the farmers here were for a long ſeries of years, unable to ſupply themſelves with this article, and were obliged to commiſſion ſeed annually from America and the Baltic, to ſupply the increaſed demands of an extending culture, to the large amount of 200,000l. ſterling. This annual expenditure of caſh long continued to operate as a drain on the ſtock of the laborious farmer, and prevented the accumulation of his capital; an evil of the moſt ſerious magnitude, under which the Iriſh peaſantry ſtill labour, and from which, till very lately, they had not even a proſpect of relief. By the practice in univerſal uſe, if the farmer ſtored up his lint in the barn-yard with the reſt of his crop in harveſt, he might, it is true, preſerve his ſeed; but in doing ſo, he uniformly loſt his flax to a far greater value from overdryneſs, when wrought in the ſpring.

"If, on the other hand, he attempted to ſeparate his ſeed during the lint harveſt by means of the rippling-comb, he had no means of preventing it from being almoſt invariably deſtroyed by the wetneſs of the climate. Various methods had been attempted to overcome this difficulty, but without ſucceſs; till Robert Tennant, Eſq. of Strangmore, linen-inſpector, near Dungannon, contrived the plan of a flax-barn, which ſeems perfectly competent to the preſervation of ſeed. It has already been erected, and has proved ſucceſsful on a ſmall ſcale; the ſeed cured in it remained during the winter perfectly freſh, and nothing ſeems wanting to complete this improvement in our flax huſbandry, but a larger capital in the hands of a few of our farmers. This flax barn is conſtructed on wooden poſts, roofed on the top, but left perfectly open at each ſide; it is ſupplied with various ſtages of floors of baſket-work, placed regularly at two feet diſtance above each other. Thus, the air, having free acceſs to the ſeed on all ſides, preſerves it freſh and well-coloured for any length of time.

"This contrivance was ſuggeſted to Mr Tennant, it is ſaid, almoſt caſually, by noticing the great effect produced on cloth, by drying-houſes in bleachfields. He had in fact been employed by the Linen Board of Ireland, in teaching the new proceſs of bleaching to the manufacturers, by means of the oxymuriate of lime; and, in the courſe of ſeven or eight years, this method of whitening linen has been eſtabliſhed over the whole kingdom, with the exception of hardly a ſingle field. Lord Northland and Mr Foſter, who invited this gentleman from Scotland, and patronized him in this part of the kingdom, have enjoyed the ſatisfaction of beholding a more eſſential improvement effected in the linen manufacture, in the ſhort ſpace already mentioned, than had ever taken place in a century before.

"It was my intention, when I began this letter, to have preſented you a more minute deſcription of a flax farm, and to have laid before your readers, a more detailed account of the flax huſbandry of Ireland in general. I find, however, that I have already exceeded the ordinary bounds preſcribed to the contributors to your uſeful work; therefore conclude, with expreſſing a hope, that the few hints already offered, will incline ſome of your correſpondents to treat of a ſubject certainly of ſufficient importance to merit attention. For a branch of huſbandry cannot be deemed contemptible, which affords ſuſtenance to upwards of two millions of people; and which, at the ſame time, adds to the general reſources of the empire, no leſs a ſum than ſeven millions ſterling annually. Theſe circumſtances, too, I truſt, will plead my excuſe for holding up a portion of Iriſh huſbandry to the imitation of your numerous readers among the cultivators of Scotland, who are at preſent juſtly celebrated for their agricultural knowledge in every part of the world."

Flax made to reſemble Cotton. In the Swediſh Tranſactions for the year 1747, a method is given of preparing flax in ſuch a manner as to reſemble cotton in whiteneſs and ſoftneſs, as well as in coherence. For this purpoſe, a little ſea water is to be put into an iron pot or an untinned copper kettle, and a mixture of equal parts of birch aſhes and quicklime ſtrewed upon it: A ſmall bundle of flax is to be opened and ſpread upon the ſurface, and covered with more of the mixture, and the ſtratification continued till the veſſel is ſufficiently filled. The whole is then to be boiled with ſea water for ten hours, freſh quantities of water being occaſionally ſupplied in proportion to the evaporation, that the water may never become dry. The boiled flax is to be immediately waſhed in the ſea by a little at a time, in a baſket, with a ſmooth ſtick at firſt while hot; and when grown cold enough to be borne by the hands, it muſt be well rubbed, waſhed with ſoap, laid to bleach, and turned and watered every day. Repetitions of the waſhing with ſoap expedite the bleaching; after which the flax is to be beaten, and again well waſhed; when dry it is to be worked and carded in the ſame manner as common cotton, and preſſed betwixt two boards for 48 hours. It is now fully prepared and fit for uſe. It loſes in this proceſs near one half its weight, which is abundantly compenſated by the improvement made in its quality.

The filamentous parts of different vegetables have been employed in different countries for the ſame mechanic uſes as hemp and flax among us. See FILAMENT.

Earth-Flax. See AMIANTHUS, BOTANY *Index.*

New Zealand Flax Plant. See PHORMIUM, BOTANY *Index.*

Toad-Flax. See LINARIA, BOTANY *Index.*

FLEA. See PULEX, ENTOMOLOGY *Index.*

Flea-Bane. See Conyza, Botany *Index*.

Flea-Bitten, that colour of a horse which is white or gray, spotted all over with dark reddish spots.

FLEAM, in *Surgery* and *Farriery*, an instrument for letting blood of a man or horse. A case of fleams, as it is called by farriers, comprehends six sorts of instruments; two hooked ones, called *drawers*, and used for cleansing wounds; a pen knife; a sharp-pointed lancet for making incisions; and two fleams, one sharp and the other broad pointed. These last are somewhat like the point of a lancet, fixed in a flat handle, and no longer than is just necessary to open the vein.

FLECHIER, Esprit, bishop of Nismes, one of the most celebrated preachers of his age, and the publisher of many panegyrics and funeral orations, was born at Perne in Avignon in 1632. He was nominated to the bishopric of Lavaur in 1685, and translated to Nismes in 1687. At this latter place he founded an academy, and took the presidentship upon himself: his own palace was indeed a kind of academy, where he applied himself to train up orators and writers, who might serve the church, and do honour to the nation. He published, besides his panegyrics and funeral orations, 1. A History of the Emperor Theodosius, that of Cardinal Ximenes, and that of Cardinal Commendon. 2. Several Sermons. 3. Miscellaneous Works. 4. Letters, &c. He died in 1710.

FLECKNOE, Richard, an English poet in the reign of Charles II. more remarkable for Mr Dryden's satire on him than for any works of his own. He is said to have been originally a Jesuit, and to have had good English connexions in the Catholic interest. When Dryden lost the place of poet laureat on the Revolution, its being conferred on Flecknoe, for whom he had a settled aversion, gave occasion to his poem entitled *Mac Flecknoe;* one of the best written satires in our language, and from which Pope seems to have taken the hint for his Dunciad. Flecknoe wrote some plays; but could never get more than one of them acted, and that was damned.

FLEECE, the covering of wool shorn off the bodies of sheep. See Wool.

Golden Fleece. See Argonauts, and *Golden Fleece*.

FLEET, commonly implies a company of ships of war, belonging to any prince or state: but sometimes it denotes any number of trading ships employed in a particular branch of commerce.

The admirals of his Britannic majesty's fleet are divided into three squadrons, viz. the red, the white, and the blue. When any of these officers are invested with the command of a squadron or detachment of men of war, the particular ships are distinguished by the colours of their respective squadron: that is to say, the ships of the red squadron wear an ensign whose union is displayed on a red field; the ensigns of the white squadron have a white field; and those of the blue squadron a blue field; the union being common to all three. The ships of war, therefore, are occasionally annexed to any of the three squadrons, or shifted from one to another.

Of whatsoever number a fleet of ships of war is composed, it is usually divided into three squadrons; and these, if numerous, are again separated into divisions. The admiral, or principal officer, commands the centre; the vice admiral, or second in command, superintends the van guard; and the operations of the rear are directed by the rear admiral, or the officer next in rank. See the article Division.

The disposition of a fleet, while proceeding on a voyage, will in some measure depend on particular circumstances; as the difficulty of the navigation, the necessity of dispatch, according to the urgency or importance of the expedition, or the expectation of an enemy in the passage. The most convenient order is probably to range it into three lines or columns, each of which is parallel to a line close hauled according to the tack on which the line of battle is designed to be formed. This arrangement is more useful than any; because it contains the advantages of every other form without their inconveniences. The fleet being thus more enclosed will more readily observe the signals, and with greater facility form itself into the line of battle, a circumstance which should be kept in view in every order of sailing. See *Naval Tactics*.

Fleet, is also a noted prison in London, where persons are committed for contempt of the king and his laws, particularly of his courts of justice; or for debt, where any person will not or is unable to pay his creditors.

There are large rules and a warden belonging to the Fleet prison; which had its name from the float or fleet of the river or ditch, on the side whereof it stands.

FLEETWOOD, William, a very learned English bishop in the beginning of the 18th century, of an ancient family in Lancashire. He distinguished himself during King William's reign, by his *Inscriptionum Antiquarum Sylloge*, by several sermons he preached on public occasions, and by his Essay on Miracles. He was designed by King William to a canonry of Windsor. The grant did not pass the seals before the king's death; but the queen gave it him, and he was installed in 1702. In 1703, he took a resolution to retire; and in 1707, published, without his name, his *Chronicon Pretiosum*. In 1708, he was nominated by the queen to the see of St Asaph. The change of the queen's ministry gave him much regret. In 1715, he published a pamphlet entitled, "The 13th chapter of the Romans vindicated from the abusive senses put upon it." In 1714, he was translated to the bishopric of Ely; and died in 1723, aged 67. He published several other sermons and tracts, and was a man of great learning and exemplary piety.

FLEMINGIANS, or Flandrians, in ecclesiastical history, a sect of rigid Anabaptists, who acquired this name in the 16th century, because most of them were natives of Flanders, by way of distinction from the Waterlandians. In consequence of some dissensions among the Flemingians relating to the treatment of excommunicated persons, they were divided into two sects, distinguished by the appellations of *Flandrians* and *Frieslanders*, who differed from each other in their manners and discipline. Many of these in process of time came over to the moderate community of the Waterlandians, and those who remained separate are still known by the name of the old Flemingians or Flandrians; but they are comparatively few in number. These maintain the opinion of Menno with respect to the incarnation of Christ; alleging, that his body

Flemish || Fletcher.

body was produced by the creating power of the Holy Ghost, and not derived from his mother Mary.

FLEMISH, or the FLEMISH TONGUE, is that which we otherwise call *Low Dutch*, to distinguish it from the *German*, whereof it is a corruption and a kind of dialect. See GERMAN.

It differs from the *Walloon*, which is a corruption of the French language. The Flemish is used through all the provinces of the Netherlands.

FLEMISH Bricks, a neat, strong, yellow kind of bricks, brought from Flanders, and commonly used in paving yards, stables, &c. being preferable for such purposes to the common bricks. See the article BRICKS.

FLESH, in *Anatomy*, a compound substance, consisting of the various softer solids of the animal body, and so denominated in contradistinction to bones. See ANATOMY, *passim*.

FLESH is also used, in *Theology*, in speaking of the mysteries of the incarnation and eucharist. "The word was made *flesh*," *Verbum* caro *factum est*.

The Romanists hold, that the bread in the sacrament of the supper is turned into the real flesh of Jesus Christ. See TRANSUBSTANTIATION.

FLESH is sometimes also used by botanists for the soft pulpy substance of any fruit, enclosed between the outer rind or skin and the seeds or stone; or for that part of a root, fruit, &c. fit to be eaten.

FLESH-Colour. See CARNATION.

FLETA, the name given to an unknown writer who lived about the end of the reign of Edward II. and beginning of Edward III. and who being a prisoner in the Fleet, wrote there an excellent treatise on the common law of England.

FLETCHER. See *BEAUMONT and Fletcher*.

FLETCHER, *Andrew*, of Salton, a celebrated Scots patriot and political writer, was descended from an ancient family who trace their origin to one of the followers of William the Conqueror. He was the son of Sir Robert Fletcher of Salton and Innerpeffer, and born in the year 1650. The tuition of our author was committed by his father, on his deathbed, to Mr (afterwards Bishop) Burnet, then his parish minister; by whose care he received a pious, learned, and polite education. Endowed with uncommon genius, and possessed of virtues and abilities peculiarly suited to the times in which he lived, Mr Fletcher quickly shone forth the ornament of his country, and the champion of its freedom. Having in the course of his classical studies and historical reading been impressed with an enthusiastic admiration both of ancient and modern republics, he had early contracted an ardent love of liberty, and an aversion to arbitrary rule. Hence his spirit the more readily took alarm at certain measures in the reign of Charles II. Being knight of the shire for Lothian to that parliament where the duke of York was commissioner, he openly opposed the designs of that prince and the bill of accession. He had a share with lord viscount Stair in framing the test act, by which the duke of York complained that he lost Scotland. On these accounts he became peculiarly obnoxious to the duke; and was at last obliged to flee to Holland, to avoid the fatal consequences of prosecutions which on various pretences were commenced against him. Being cited before the privy council and justiciary courts, and not appearing, he was declared traitor, and his estate confiscated.

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In Holland, he and Mr Baillie of Jerviswood were the only persons whom the earl of Argyle consulted concerning the designs which were then in agitation. In 1681 they came over to England, in order to concert matters with their party in that country; and were the only two who were intrusted so far as to be admitted to the secrets of Lord Russell's council of six. Mr Fletcher managed his part of the negotiation with so much address, that administration could find no pretext for seizing him; nor could they fix upon him those articles on account of which Mr Baillie was condemned; to whose honour let it be remembered, that although offered a pardon on condition of his accusing his friend, he persisted in rejecting the proposal with indignation.

Mr Fletcher having joined the duke of Monmouth upon his landing, received a principal command under him; but the duke was deprived of his services on the following occasion, as related by Sir John Dalrymple. Being sent upon an expedition, and not esteeming "times of danger to be times of ceremony, he had seized for his own riding the horse of a country gentleman [the mayor of Lynne] which stood ready equipped for its master. The master, hearing this, ran in a passion to Fletcher, gave him opprobrious language, shook his cane, and attempted to strike. Fletcher, though rigid in the duties of morality, having been accustomed to foreign service both by sea and land, in which he had acquired high ideas of the honour of a soldier and a gentleman, and of the affront of a cane, pulled out his pistol, and shot him dead on the spot. The action was unpopular in countries where such refinements were not understood. A clamour was raised against it among the people of the country: in a body they waited upon the duke with their complaints; and he was forced to desire the only soldier, and almost the only man of parts, in his army, to abandon him. With Fletcher all Monmouth's chance of success in war left him." But, in a manuscript memoir belonging to the family, we have the following notice concerning Mr Fletcher's connection with Monmouth, in which his separation from that prince is very differently accounted for: "To Lord Marischal Mr Fletcher explained the motives which first induced him to join, and afterwards abandon, the duke of Monmouth. The former he ascribed to the duke's manifesto in Scotland relating to religion, and in England to liberty. For the latter he accounted by the disgust produced in his own mind and that of his associates, when the duke declared himself king, and broke faith with all who embarked with him on his principles. He complained heavily of the account commonly given of the death of the mayor of Lynne; and mentioned to Lord Marischal, in proof of the contrary, that he did not leave the duke till he came to Taunton, where he was proclaimed king, several weeks after the death of the mayor of Lynne."

Memoirs of Great Britain and Ireland.

Seeing all the efforts of himself and his friends in favour of liberty frustrated at Taunton, he endeavoured to secure his own personal freedom by taking his passage in the first ship bound to a foreign country. It was his misfortune to land in Spain; where he was immediately arrested, cast into prison, and guarded by three

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Memoirs of the family of Salton. MS.

three different bands of ſoldiers, till a veſſel ſhould be prepared to carry him a victim in chains to the court of London. But on the morning before the ſhip could ſail, whilſt he looked penſive through the bars that ſecured the window of his room, he was hailed by a venerable perſonage who made ſigns to ſpeak with him. The priſon doors he found open; and whilſt his friendly conductor waved to him to follow him, he paſſed through three different guards of ſoldiers all faſt aſleep. Without being permitted to offer his thanks to his deliverer, he found himſelf obliged to proſecute with all ſpeed the journey, in which he was directed by a perſon concerning whom he could never collect any information; and in diſguiſe he proceeded in ſafety through Spain. He felt a peculiar pleaſure in relating to his friends inſtances of the care of Providence which he had experienced during his exile; and entertained them often with narratives of this kind, which he always mingled with religious reflections. Of theſe, another may be here mentioned. Happening in the evening to paſs the ſkirt of a wood at a few miles diſtance from a city where he intended to lodge, he came to a place where two roads met. After he had entered upon the road on the right, he was accoſted by a female of a reſpectable figure, who warned him to turn back, and take the road on the left; for that in the other there was danger which he could not eſcape if he continued to proceed. His friendly monitor ſuddenly retired into the wood, out of which ſhe had iſſued no leſs unexpectedly. Having arrived at the city, the inhabitants were ſoon after alarmed by an account of the robbery and murder of ſeveral travellers who that evening had fallen into the hands of a banditti upon the very way in which he had intended to travel. From theſe and other inſtances of preſervation from dangers, the devotion of his mind, habituated from his infancy to an intercourſe with heaven, led him to conclude that he was in a peculiar manner the care of Providence, and that in critical caſes his underſtanding received its direction from a ſupernatural impulſe.

During his exile, he maintained a frequent and extenſive correſpondence with the friends of liberty at home; and he partly employed himſelf in making a curious collection of books, which compoſe the beſt private library in Scotland. But his genius alſo prompted him to engage in more active employments. He repaired to Hungary, and ſerved ſeveral campaigns as a volunteer under the duke of Lorrain with great reputation. At length, underſtanding that the great deſign then projecting in Holland, and upon the iſſue of which he conſidered the liberties of Britain to be ſuſpended, had attained a conſiderable degree of maturity, he haſtened thither; where his councils and addreſs were of eminent ſervice. He came over with King William; and in zeal, activity, penetration, and political ſkill, proved inferior to none of the leaders in the Revolution.

Such, however, was his magnanimity, that from a ſurvey of King William's papers it appears, that while others laboured to turn this grand event to the emolument of themſelves and the aggrandiſement of their family, Mr Fletcher aſked nothing. His eſtate had been forfeited, and his houſe abandoned to military diſcretion; his fortune was greatly ſhattered, and his family reduced to circumſtances of diſtreſs. Nothing was given him in recompenſe of all his ſufferings. On the contrary, he, together with the duke of Hamilton, was diſtinguiſhed by marks of royal and miniſterial diſlike. Still, whatever private reſentment he might entertain, it appeared that his ruling principle was the good of his country; and that to this grand object of his heart he was willing to ſacrifice all perſonal conſiderations. For when, in 1692, the abdicated king meditated an invaſion, Mr Fletcher addreſſed a letter (preſerved in Sir John Dalrymple's collection) to the duke of Hamilton, in which every argument is employed with ſkill and energy to engage his grace to forget his injuries, and in the preſent criſis to employ the extenſive influence and authority he then poſſeſſed in the cauſe of freedom and of his country. This letter produced its full effect; and the duke returned to his duty, from which he had in part begun to deviate.

To follow our author through all the mazes of his political life ſubſequent to the Revolution, is beyond our purpoſe, and would exceed our limits. One or two circumſtances more ſhall therefore ſuffice. Being elected a member for the parliament 1683, he ſhowed an uniform zeal for the intereſt of his country. The thought of England's domineering over Scotland was what his generous ſoul could not endure. The indignities and oppreſſion which Scotland lay under galled him to the heart; ſo that in his learned and elaborate diſcourſes, he expoſed them with undaunted courage and pathetical eloquence. In that great event, the Union, he performed eſſential ſervice. He got the act of ſecurity paſſed, which declared that the two crowns ſhould not paſs to the ſame head till Scotland was ſecured in her liberties civil and religious. Therefore Lord Godolphin was forced into the Union, to avoid a civil war after the queen's demiſe. Although Mr Fletcher diſapproved of ſome of the articles, and indeed of the whole frame of the Union; yet, as the act of ſecurity was his own work, he had all the merit of that important tranſaction.

We muſt not omit mentioning, that in the ardour of his political career Mr Fletcher forgot not the intereſts of the place that gave him birth. He eſteemed the education of youth one of the nobleſt objects of government. On this ſubject he wrote a treatiſe, ſtill extant, moſt characteriſtic of himſelf; and he eſtabliſhed at Salton a foundation for the ſame purpoſe, of great utility while it laſted.

This great man died at London 1716, aged 66. His remains were conveyed to Scotland, and depoſited in the family vault at Salton.

That Mr Fletcher received neither honours nor emoluments from King William, may perhaps be in part attributed to himſelf; a circumſtance, however, which muſt add greatly to the luſtre of his character. His uncomplying virtue, and the ſternneſs of his principles, were ill calculated to conciliate courtly favour. He was ſo zealous an aſſertor of the liberties of the people, that he was too jealous of the growing power of all princes; in whom he thought ambition ſo natural, that he was not for truſting the beſt of kings with the power which ill ones might make uſe of againſt their ſubjects; he was of opinion that all princes were made by, and for the benefit of, the people; and that they ſhould have no power but that of doing good. This, which

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which made him oppose King Charles and invade King James, led him also to oppose the giving so much power to King William, whom he would never serve after his establishment. So we are told by the author of Short Political Characters, a MS. in the library of the late T. Rawlinson, Esq.—Mr Lockhart, in his Memoirs, p. 72. expresses a belief that his aversion to the English and to the Union was so great, that, in revenge to them, he was inclined to side with the abdicated family: "But (adds he) as that was a subject not fit to be entered upon with him, this is only a conjecture from some inuendos I have heard him make; but so far is certain, he liked, commended, and conversed with high-flying Tories, more than any other set of men; acknowledging them to be the best countrymen, and of most honour, integrity, and ingenuity." It seems difficult to reconcile this with Mr Fletcher's avowed principles and the general tenor of his conduct. May we suppose, that, chagrin, if not at the neglect or the ill treatment which he had himself received from government since the Revolution, yet at the public measures relating to his native country, might have occasioned him to relent in his sentiments with regard to the exiled family?—In the family memoirs already quoted, we are informed, That "Lord Marischal held Mr Fletcher's character in high admiration;" and that, "when governor of Neufchatel, where Rousseau resided about the year 1766, he prevailed with this very extraordinary genius to write the life of a man whose character and actions he wished to have transmitted to posterity with advantage. For this purpose, his lordship applied to an honourable relation of Mr Fletcher's for materials; which by him were transmitted to Lord Marischal; but the design failed through Rousseau's desultory and capricious disposition." This anecdote must appear incompatible with the known loyalty and attachments of the Earl Marischal, unless we suppose him to have been privy to some such sentiments of Mr Fletcher as those alluded to by Mr Lockhart; for how could we suppose him anxious to promote a composition, in which the task would be to celebrate principles diametrically opposite to his own, and to applaud actions subversive of that royal family in whose cause he had ventured his life, and forfeited his fortune, and foregone his country!—But however these circumstances may be reconciled, as the integrity, disinterestedness, and public spirit of Mr Fletcher, have been universally acknowledged, there is reason to believe, that all his sentiments and actions were founded in honour, and that he never once pursued a measure further than he judged it to be for the interest of his country.

Mr Fletcher was master of the English, Latin, Greek, French, and Italian languages; and well versed in history, the civil law, and all kinds of learning. In his travels, he had not only acquired considerable knowledge in the art of war, but also became versant in the respective interests of the several princes and states of Europe. In private life, he was affable to his friends, and free from all manner of vice. He had a penetrating, clear, and lively apprehension; but is said to have been too much wedded to opinions, and impatient of contradiction.—He possessed an uncommon elevation of mind, accompanied with a warmth of temper, which would suffer him to brook from no rank among men, nor in any place, an indignity. Of this he exhibited a singular proof in the Scots parliament. The earl of Stair, secretary of state and minister for Scotland, having in the heat of debate used an improper expression against Mr Fletcher, he seized him by his robe, and insisted upon public and immediate satisfaction. His lordship was obliged instantly to beg his pardon in presence of parliament.

Fletewood || Flight.

Mr Fletcher was by far the finest speaker in the parliament of Scotland; the earl of Stair alone rivalled him. The latter was famed for a splendid, the former for a close and nervous, eloquence. He formed his style on the models of antiquity; and the small volume of his works, Sir John Dalrymple observes, though imperfectly collected, is one of the very few classical compositions in the English language.

FLETEWOOD, William, an eminent English lawyer and recorder of London, in the reign of Queen Elizabeth. He was very zealous in suppressing mass-houses, and committing Popish priests; but once rushing in upon mass at the Portuguese ambassador's house, he was committed to the Fleet for breach of privilege, but soon released. Mr Wood says, "He was a learned man, and a good antiquary, but of a marvellous merry and pleasant conceit." He was a good popular speaker, and wrote well upon subjects of government. His principal works are, 1. *Annalium tam regum Edwardi V. Richardi III. et Henrici VII. quam Henrici VIII.* 2. A Table of the Reports of Edmund Plowden. 3. The Office of a Justice of Peace. He died about the year 1593.

FLEVILLEA, a genus of plants belonging to the diœcia class. See Botany *Index*.

FLEURI, Claude, an able French critic and historian, was born at Paris in 1640. He applied himself to the law, was made advocate for the parliament of Paris, and attended the bar nine years; he then entered into orders, and was made preceptor to the princes of Conti. In 1689, the king made him sub-preceptor to the dukes of Burgundy, Anjou, and Berry; and in 1706, when the education of these young princes was completed, the king gave him the priory of Argenteville belonging to the Benedictines in the diocese of Paris. In 1716, he was chosen counsellor to Louis XV. and died in 1723. He was the author of a great number of esteemed French works; the principal of which are, 1. An ecclesiastical history, in 20 volumes, the last of which ends with the year 1414. 2. The manners of the Israelites and Christians. 3. Institutions of ecclesiastical law. 4. An historical catechism. 5. On the choice and method of study. 6. The duties of masters and servants, &c.

FLEXIBLE, in *Physics*, a term applied to bodies capable of being bent or diverted from their natural figure or direction.

FLEXOR, in *Anatomy*, a name applied to several muscles, which are so called from their office, which is to bend the parts to which they belong; in opposition to the *extensors*, which open or stretch them. See Anatomy, *Table of the Muscles*.

FLIGHT, the act of a bird in flying; or the manner, duration, &c. thereof.

Almost every kind of bird has its particular flight; the eagle's flight is the highest; the flight of the sparrow-hawk and vulture is noble, and fit for high enterprise

prise and combat. The flight of some birds is low, weak, and transient; the flight of the partridge and pheasant is but of short continuance; that of the dove is laboured; that of the sparrow undulatory, &c.

The augurs pretended to foretel future events from the flight of birds. See AUGURY.

FLIGHT. In melting the lead ore in the works at Mendip, there is a substance which flies away in the smoke which is called the flight. The workmen find it sweetish upon their lips, if their faces happen to be in the way of the smoke, which they avoid as much as possible. This, falling on the grass, kills cattle that feed thereon; and, being gathered, and carried home, kills rats and mice in their houses; that which falls on the sand, they gather, and melt upon a flag hearth into shot and sheet lead.

FLINT, a species of simple stones, chiefly composed of siliceous earth. See MINERALOGY *Index*.

Breaking of FLINTS. The art of cutting, or rather breaking, flint stones into uniform figures, is by some supposed to be one of the arts now lost. That it was known formerly, appears from the ancient Bridewell at Norwich, from the gate of the Augustin friars at Canterbury, that of St John's Abbey at Colchester, and the gate near Whitehall, Westminster. But that the art is not lost, and that the French know it, appears from the platform on the top of the royal observatory at Paris; which, instead of being leaded, is paved with flint cut or broken into regular figures.

Gun FLINTS. For the method of manufacturing, see MINERALOGY *Index*.

FLINTS, in the glass trade. The way of preparing flints for the nicest operations in the glass trade is this. Choose the hardest flints, such as are black and will resist the file, and will grow white when calcined in the fire. Cleanse these of the white crust that adheres to them, then calcine them in a strong fire, and throw them while red-hot into cold water; wash off the ashes that may adhere to them, and powder them in an iron mortar, and sift them through a very fine sieve; pour upon this powder some weak aquafortis, or the phlegm of aquafortis, to dissolve and take up any particles of iron it may have got from the mortar; stir this mixture several times, then let it rest, and in the morning pour off the liquor, and wash the powder several times with hot water and afterwards dry it for use. You will thus have a powder for making the purest glass as perfectly fine and faultless as if you had used rock-crystal itself.

The washing off the ferruginous particles with aquafortis is not necessary when the glass intended to be made is to be tinged with iron afterwards; but when meant to be a pure white, this is the method that will secure success.

FLINT, the chief town of Flintshire, in North Wales. It is commodiously seated on the river Dee; and is but a small place, though it sends one member to parliament. It was formerly noted for its castle, where Richard II. took shelter on his arrival from Ireland; but having quitted it, he was taken prisoner by the duke of Lancaster. The castle now is in a ruinous condition. This castle stands close to the sea on a rock, which in various parts forms several feet of its foundation. It covers about three quarters of an acre. The assizes are still held in the town. It is 195 miles north-west of London.

FLINTSHIRE, a county of Wales, bounded on the north-east and east by an arm of the sea, which is properly the mouth of the river Dee; on the north-west by the Irish sea; and on the south-south-west and west by Denbighshire. It is the least of all the counties in Wales, being but 33 miles in length and 9 in breadth. It is divided into five hundreds; in which are two market towns and 28 parishes, with 32,400 inhabitants. The greatest part of this county lies in the diocese of St Asaph, and the rest belongs to that of Chester. It sends two members to parliament, one for the county and one for Flint; and pays one part of the land tax. The air is cold, but healthful. It is full of hills, intermixed with a few valleys, which are very fruitful, producing some wheat and plenty of rye. The cows, though small, yield a great quantity of milk in proportion to their size, and are excellent beef. The mountains are well stored with lead, coal, and mill-stones. This county also produces good butter, cheese, and honey; of which last the natives make metheglin, a wholesome liquor much used in these parts.

FLIP, a sort of sailors drink, made of malt liquor, brandy, and sugar mixed.

FLOAT, a certain quantity of timber bound together with rafters athwart, and put into a river to be conveyed down the stream; and even sometimes to carry burdens down a river with the stream.

FLOAT-Boards, those boards fixed to water wheels of under-shot mills, serving to receive the impulse of the stream, whereby the wheel is carried round. See the articles WHEEL and MILL.

It is no advantage to have too great a number of float-boards; because, when they are all struck by the water in the best manner that it can be brought to come against them, the sum of all the impulses will be but equal to the impulse made against one float-board at right angles, by all the water coming out of the penstock through the opening, so as to take place on the float-board. The best rule in this case is to have just so many, that each of them may come out of the water as soon as possible, after it has received and acted with its full impulse. As to the length of the float-board, it may be regulated according to the breadth of the mill. See MILL.

FLOATS for Fishing. See *FISHING Floats*.

FLOATAGES, all things floating on the surface of the sea or any water; a word much used in the commissions of water bailiffs.

FLOATING BODIES are those which swim on the surface of a fluid, the most interesting of which are ships and vessels employed in war and commerce. It is known to every seaman, of what vast moment it is to ascertain the stability of such vessels, and the positions they assume when they float freely on the surface of the water. To be able to accomplish this, it is necessary to understand the principles on which that stability and these positions depend. This has been done with great ingenuity by Mr Atwood, of whose reasoning the following is a summary account, taken from the Philosophical Transactions for 1796.

A floating body is pressed downwards by its own weight in a vertical line passing through its centre of gravity; and it is supported by the upward pressure of a fluid, which acts in a vertical line that passes through the centre of gravity of the part which is under the water;

Floating Bodies.

water; and without a coincidence between theſe two lines, in ſuch a manner as that both centres of gravity may be in the ſame vertical line, the ſolid will turn on an axis, till it gains a poſition in which the equilibrium of floating will be permanent. From this it is obviouſly neceſſary to find what proportion the part immerſed bears to the whole, to do which the ſpecific gravity of the floating body muſt be known, after which it muſt be found by geometrical methods, in what poſitions the ſolid can be placed on the ſurface of the fluid, ſo that both centres of gravity may be in the ſame vertical line, when any given part of the ſolid is immerſed under the ſurface. Theſe things being determined, ſomething is ſtill wanting, for poſitions may be aſſumed in which the circumſtances now mentioned concur, and yet the ſolid will aſſume ſome other poſition wherein it will permanently float. If the ſpecific gravity of a cylinder be to that of the fluid on which it floats as 3 to 4, and its axis to the diameter of the baſe as 2 to 1: if it be placed on the fluid with its axis vertical, it will ſink to a depth equal to a diameter and a half of the baſe; and while its axis is preſerved in a vertical poſition by outward force, the centres of gravity of the whole ſolid and immerſed part will remain in the ſame vertical line; but when the external force is removed, it will deviate from its upright poſition, and will permanently float with its axis horizontal. If we ſuppoſe the axis to be half the diameter of the baſe, and placed vertically, the ſolid will ſink to the depth of three-eighths of its diameter, and in that poſition it will float permanently. If the axis be made to incline to the vertical line, the ſolid will change its poſition till it permanently ſettles with its axis perpendicular to the horizon.

Whether a ſolid floats permanently, or overſets when placed on the ſurface of a fluid, provided the centre of gravity of the ſolid and that of the immerſed part be in the ſame vertical line, it is ſaid to be in a poſition of equilibrium, of which there are three kinds; the equilibrium of ſtability, in which the ſolid permanently floats in a given poſition; the equilibrium of inſtability, in which the ſolid ſpontaneouſly overſets, if not ſupported by external force; and the equilibrium of indifference, or the inſenſible equilibrium, in which the ſolid reſts on the fluid indifferent to motion, without tendency to right itſelf when inclined, or to incline farther.

If a ſolid body floats permanently on the ſurface of a fluid, and external force be applied to turn it from its poſition, the reſiſtance oppoſed to this inclination is termed the *ſtability of floating*. Some ſhips at ſea yield to a given impulſe of the wind, and ſuffer a greater inclination from the perpendicular than others. As this reſiſtance to heeling, duly regulated, has been conſidered of importance in the conſtruction of veſſels, many eminent mathematicians have laid down rules for aſcertaining the ſtability of ſhips from their known dimenſions and weight, without recurring to actual experiment. Bouguer, Euler, Chapman, and others, have laid down theorems for this purpoſe, founded on the ſuppoſition that the inclinations of ſhips from their quieſcent poſitions are evaneſcent, or very ſmall in a practical point of view. But ſhips at ſea have been found to heel 10°, 20°, or 30°, and therefore it may be doubted how far ſuch rules are applicable in practice. If ſtatics can be applied to naval architecture, it ſeems neceſſary that the rules ſhould be extended to thoſe caſes in which the angles of inclination are of any magnitude, likely to occur in the practice of navigation. A ſolid body placed on the ſurface of a lighter fluid, at ſuch a depth as correſponds to the relative gravities, cannot alter its poſition by the joint action of its own weight and the preſſure of the fluid, except by turning on ſome horizontal axis paſſing through the centre of gravity; but, as many axes may be drawn through this point of the floating body, in a direction parallel to the horizon, and the motion of the ſolid regards only one axis, this muſt be determined by the figure of the body and the particular nature of the caſe. When this axis of motion is aſcertained, and the ſpecific gravity of the ſolid found, the poſitions of permanent floating will be determined, by finding the ſeveral poſitions of equilibrium through which the ſolid may be conceived to paſs, while it turns round the axis of motion; and by determining in which of theſe poſitions the equilibrium is permanent, and in which of them it is momentary.

The whole of Mr Atwood's valuable paper relates to the theory of naval architecture, in ſo far as it is dependent on the laws of pure mechanics. If the proportions and dimenſions adopted in the conſtruction of individual veſſels are obtained by exact geometrical meaſurement, and obſervations are made on the performance of theſe veſſels at ſea; a ſufficient number of experiments of this nature judiciouſly varied, are the proper grounds on which theory may be effectually applied, in reducing to ſyſtem thoſe hitherto unperceived cauſes, which contribute to give the greateſt degree of excellence to veſſels of every deſcription. Naval architecture being reckoned among the practical branches of ſcience, every voyage may be viewed in the light of an experiment, from which uſeful truths are to be deduced. But inferences of this nature cannot well be obtained, except by acquiring a thorough knowledge of all the proportions and dimenſions of each part of the ſhip, and by making a ſufficient number of obſervations on the qualities of the veſſel, in all the varieties of ſituation to which a ſhip is commonly ſubject in the practice of navigation.

The following is an ingenious inveſtigation of the ſame ſubject by Mr Engliſh, which we give in his own words.

"However operoſe and difficult (ſays he) the calculations neceſſary to determine the ſtability of nautical veſſels may, in ſome caſes, be, yet they all depend, ſays this author, upon the four following ſimple and obvious theorems, accompanied with other well known ſtereometrical and ſtatical principles.

"*Theorem* 1. Every floating body diſplaces a quantity of the fluid in which it floats, equal to its own weight; and conſequently, the ſpecific gravity of the fluid will be to that of the floating body, as the magnitude of the whole is to that of the part immerſed.

"*Theorem* 2. Every floating body is impelled downward by its own eſſential power, acting in the direction of a vertical line paſſing through the centre of gravity of the whole; and is impelled upward by the re-action of the fluid which ſupports it, acting in the direction of a vertical line paſſing through the centre of gravity of the part immerſed; therefore, unleſs theſe two lines are coincident, the floating body thus impelled muſt revolve round an axis, either in motion or at reſt, until the equilibrium is reſtored.

"*Theorem* 3. If by any power whatever a veſſel be deflected

deflected from an upright position, the perpendicular distance between two vertical lines passing through the centres of gravity of the whole, and of the part immersed respectively, will be as the stability of the vessel, and which will be positive, nothing, or negative, according as the metacentre is above, coincident with, or below, the centre of gravity of the vessel.

" *Theorem* 4. The common centre of gravity of any system of bodies being given in position, if any one of these bodies be moved from one part of the system to another, the corresponding motion of the common centre of gravity, estimated in any given direction, will be to that of the aforesaid body, estimated in the same direction, as the weight of the body moved is to that of the whole system.

" From whence it is evident, that in order to ascertain the stability of any vessel, the position of the centres of gravity of the whole, and of that part immersed, must be determined; with which, and the dimensions of the vessel, the line of floatation, and angle of deflection, the stability or power either to right itself or overturn, may be found.

" In ships of war and merchandise, the calculations necessary for the purpose become unavoidably very operose and troublesome; but they may be much facilitated by the experimental method pointed out in the New Transactions of the Swedish Academy of Sciences, first quarter of the year 1787, page 48.

" In river and canal boats, the regularity and simplicity of the form of the vessel itself, together with the compact disposition and homogeneal quality of the burden, render that method for them unnecessary, and make the requisite calculations become very easy. Vessels of this kind are generally of the same transverse section throughout their whole length, except a small part in prow and stern, formed by segments of circles or other simple curves; therefore a length may easily be assigned such, that any of the transverse sections being multiplied thereby, the product will be equal to the whole solidity of the vessel. The form of the section ABCD is for the most part either rectangular, as in fig. 1. Plate CCXVIII. trapezoidal as in fig. 2. or mixtilineal as in fig. 3. in all which MM represents the line of floatation when upright, and EF that when inclined at any angle MXE; also G represents the centre of gravity of the whole vessel, and R that of the part immersed.

" If the vessel be loaded quite up to the line AB, and the specific gravity of the boat and burden be the same, then the point G is simply the centre of gravity of the section ABCD; but if not, the centres of gravity of the boat and burden must be found separately, and reduced to one by the common method, namely, by dividing the sum of the momenta by the sum of weights, or areas, which in this case are as the weights. The point R is always the centre of gravity of the section MMCD, which, if consisting of different figures, must also be found by dividing the sum of the momenta by the sum of the weights as common. These two points being found, the next thing necessary is to determine the area of the two equal triangles MXE, MXF, their centres of gravity *o*, *o*, and the perpendicular projected distance *n n* of these points on the water line EF. This being done, through R and parallel to EF draw RT = a fourth proportional to the whole area MMCD, either triangle MXE or MXF, and the distance *n n*; through T, and at right angles to RT or EF, draw TS meeting the vertical axis of the vessel in S the metacentre; also through the points G, B, and parallel to ST, draw NGW and BV; moreover through S, and parallel to EF, draw WSV, meeting the two former in V and W; then SW is as the stability of the vessel, which will be positive, nothing, or negative, according as the point S is above, coincident with, or below, the point G. If now we suppose W to represent the weight of the whole vessel and burden (which will be equal to the section MMCD multiplied by the length of the vessel), and P to represent the required weight applied at the gunwale B to sustain the vessel at the given angle of inclination; we shall always have this proportion: as VS : SW :: W : P; which proportion is general, whether SW be positive or negative; it must only in the latter case be supposed to act upward to prevent an overturn.

" In the rectangular vessel, of given weight and dimensions, the whole process is so evident, that any farther explanation would be unnecessary. In the trapezoidal vessel, after having found the points G and R, let AD, BC be produced until they meet in K. Then, since the two sections MMCD, EFDC are equal; the two triangles MMK, EFK are also equal; and therefore the rectangle $EK \times KF = KM \times KM = \overline{KM}^2$; and since the angle of inclination is supposed to be known, the angles at E and F are given. Consequently, if a mean proportional be found between the sines of the angle at E and F, we shall have the following proportions:

" As the mean proportional thus found : sine $\angle E$ :: KM : KF, and in the said mean proportional : sine $\angle F$ :: KM : KE; therefore ME, MF become known; from whence the area of either triangle MXE or MXF, the distance *n n*, and all the other requisites, may be found.

" In the mixtilineal section, let AB = 9 feet = 108 inches, the whole depth = 6 feet = 72 inches, and the altitude of MM the line of floatation 4 feet or 48 inches; also let the two curvilinear parts be circular quadrants of two feet, or 24 inches radius each. Then the area of the two quadrants = 904·7808 square inches, and the distance of their centres of gravity from the bottom = 13·8177 inches very nearly; also the area of the included rectangle *a b i e* = 1440 square inches, and the altitude of its centre of gravity 12 inches; in like manner, the area of the rectangle AB *c d* will be found = 5184 square inches, and the altitude of its centre of gravity 48 inches: therefore we shall have

Momentum of the two quad.	= 904·7807	× 13·8177	= 12501·98966016
Moment. of the rectan. *a b i e*	= 1440·	× 12	= 17280·
Moment. of the rectan. AB *cd*.	= 5184·	× 48	= 248832·
	7528·7808		278613·98960016

" Now the sum of the momenta, divided by the sum of the areas, will give $\frac{278613 \cdot 98966016}{7528 \cdot 7808} = 37 \cdot 006$ inches, the altitude of G, the centre of gravity of the section

Floating Bodies || Flooking.

section ABCD above the bottom. In like manner, the altitude of R, the centre of gravity of the section MMCD, will be found to be equal $\frac{123093\cdot98966016}{4936\cdot7808}$ $= 24\cdot934$ inches; and consequently their difference, or the value of GR $= 12\cdot072$ inches, will be found.

Suppose the vessel to heel 15°, and we shall have the following proportion; namely, As radius : tangent of 15° : : MX = 54 inches : 14·469 inches = ME or MF; and consequently the area of either triangle MXE or MXF = 390·663 square inches. Therefore, by theorem 4th, as 4936·7808 : 390·663 : : 72 = nn = $\frac{2}{3}$ AB : 5·6975 inches = RT; and, again, as radius : sine of 15° : : 12·072 = GR : 3·1245 inches = RN; consequently RT—RN = 5·6975—3·1245 = 2·573 inches = SW, the stability required.

"Moreover, as the sine of 15° : radius : : 5·6975 = RT : 22·013 = RS, to which, if we add 24·934, the altitude of the point R, we shall have 46·947 for the height of the metacentre, which taken from 72, the whole altitude, there remains 25·053; from which, and the half width = 54 inches, the distance BS is found = 59·529 inches very nearly, and the angle SBV = 80°—06′—42″; from whence SV = 58·645 inches.

Again: Let us suppose the mean length of the vessel to be 40 feet, or 480 inches, and we shall have the weight of the whole vessel equal to the area of the section MMCD = 4936·7808 multiplied by 480 = 2369654·784 cubic inches of water, which weighs exactly 85708 pounds avoirdupoise, allowing the cubic foot to weigh 62.5 pounds.

"And, finally, as SV : SW (*i. e.*) as 58·645 : 2·573 :: 85708 : 3760 +, the weight on the gunwale which will sustain the vessel at the given inclination. Therefore a vessel of the above dimensions, and weighing 38 tons 5 cwts. 28 lbs. will require a weight of 1 ton 13 cwts. 64 lbs. to make her incline 15°.

"In this example the deflecting power has been supposed to act perpendicularly on the gunwale at B; but if the vessel is navigated by sails, the centre velique must be found; with which and the angle of deflection, the projected distance thereof on the line SV may be obtained; and then the power calculated as above, necessary to be applied at the projected point, will be that part of the wind's force which causes the vessel to heel. And conversely, if the weight and dimensions of the vessel, the area and altitude of the sails, the direction and velocity of the wind be given, the angle of deflection may be found."*

* Phil. Mag. i. 393.

Floating Bridge. See Bridge.

Flock Paper. See Paper.

FLOOD, a deluge or inundation of waters. See Deluge.

Flood is also used in speaking of the tide. When the water is at lowest, it is called *ebb;* when rising, *young flood;* when at highest, *high flood;* when beginning to fall, *ebb water.*

Flood-mark, the mark which the sea makes on the shore at flowing water and the highest tide; it is also called *high-water mark.*

FLOOK of an anchor. See Anchor.

FLOOKING, among miners, a term used to express a peculiarity in the load of a mine. The load or quantity of ore is frequently intercepted in its course by the crossing of a vein of earth or stone, or some different metallic substance; in which case the load is moved to one side, and this transient part of the land is called a *flooking.*

Floor.

FLOOR, in building, the underside of a room, or that part we walk on.

Floors are of several sorts; some of earth, some of brick, others of stone, others of boards, &c.

For brick and stone Floors, see Pavement.

For boarded Floors, it is observable that the carpenters never floor their rooms with boards till the carcass is set up, and also enclosed with walls, lest the weather should injure the flooring. Yet they generally rough-plane their boards for the flooring before they begin any thing else about the building, that they may set them by to dry and season, which is done in the most careful manner. The best wood for flooring is the fine yellow deal well seasoned, which when well laid, will keep its colour for a long while; whereas the white sort becomes black by often washing, and looks very bad. The joints of the boards are commonly made plain, so as to touch each other only; but, when the stuff is not quite dry, and the boards shrink, the water runs through them whenever the floor is washed, and injures the ceiling underneath. For this reason they are made with feather edges, so as to cover each other about half an inch, and sometimes they are made with grooves and tenons: and sometimes the joints are made with dove tails; in which case the lower edge is nailed down, and the next drove into it, so that the nails are concealed. The manner of measuring floors is by squares of 10 feet on each side, so that taking the length and breadth, and multiplying them together and cutting off two decimals, the content of a floor in square will be given. Thus 18 by 16 gives 288 or 2 squares and 88 decimal parts.

Earthen Floors, are commonly made of loam, and sometimes, especially to make malt on, of lime, and brook sand, and gun dust, or anvil dust from the forge.

Ox blood and fine clay, tempered together, Sir Hugh Plat says, make the finest floor in the world.

The manner of making earthen floors for plain country habitations is as follows: Take two-thirds of lime, and one of coal ashes well sifted, with a small quantity of loam clay; mix the whole together, and temper it well with water, making it up into a heap: let it lie a week or ten days, and then temper it over again. After this, heap it up for three or four days, and repeat the tempering very high, till it become smooth, yielding, tough, and gluey. The ground being then levelled, lay the floor therewith about $2\frac{1}{2}$ or 3 inches thick, making it smooth with a trowel: the hotter the season is, the better; and when it is thoroughly dried, it will make the best floor for houses, especially malt houses.

If any one would have their floors look better, let them take lime made of rag stones, well tempered with whites of eggs, covering the floor about half an inch thick with it, before the under-flooring is too dry. If this be well done, and thoroughly dried, it will look when rubbed with a little oil as transparent as metal or glass. In elegant houses, floors of this nature are made of stucco, or of plaster of Paris beaten and sifted, and mixed with other ingredients.

Floor

Flora, Florales.

Floor of a Ship, ſtrictly taken, is only ſo much of her bottom as ſhe reſts on when aground.

Such ſhips as have long, and withal broad floors, lie on the ground with moſt ſecurity, and are not apt to heel, or tilt on one ſide; whereas others, which are narrow in the floor, or in the ſea phraſe, *cranked by the ground*, cannot be grounded without danger of being overturned.

Floor Timbers, in a ſhip, are thoſe parts of a ſhip's timbers which are placed immediately acroſs the keel, and upon which the bottom of the ſhip is framed; to theſe the upper parts of the timbers are united, being only a continuation of floor timbers upwards.

FLORA, the reputed goddeſs of flowers, was, according to Lactantius, only a lady of pleaſure, who having gained large ſums of money by proſtituting herſelf, made the Roman people her heir, on condition that certain games called *Floralia* might be annually celebrated on her birth day. Some time afterwards, however, ſuch a foundation appearing unworthy the majeſty of the Roman people, the ſenate, to ennoble the ceremony, converted Flora into a goddeſs, whom they ſuppoſed to preſide over flowers; and ſo made it a part of religion to render her propitious, that it might be well with their gardens, vineyards, &c. But Voſſius (*de Idol.* lib. i. c. 12.) can by no means allow the goddeſs Flora to have been the courtezan above mentioned: he will rather have her a Sabine deity, and thinks her worſhip might have commenced under Romulus. His reaſon is, that Varro, in his fourth book of the Latin tongue, ranks Flora among the deities to whom Tatius king of the Sabines offered up vows before he joined battle with the Romans. Add, that from another paſſage in Varro it appears, that there were prieſts of Flora, with ſacrifices, &c. as early as the times of Romulus and Numa.

The goddeſs Flora was, according to the poets, the wife of Zephyrus. Her image in the temple of Caſtor and Pollux was dreſſed in a cloſe habit, and ſhe held in her hands the flowers of peaſe and beans: but the modern poets and painters have been more laviſh in ſetting off her charms, conſidering that no parts of nature offered ſuch innocent and exquiſite entertainment to the ſight and ſmell, as the beautiful variety which adorns, and the odour which embalms, the floral creation.

FLORALES ludi, or Floral Games, in antiquity, were games held in honour of Flora, the goddeſs of flowers.—They were celebrated with ſhameful debaucheries. The moſt licentious diſcourſes were not enough, but the courtezans were called together by the ſound of a trumpet, made their appearance naked, and entertained the people with indecent ſhows and poſtures: the comedians appeared after the ſame manner on the ſtage. Val. Maximus relates, that Cato being once preſent in the theatre on this occaſion, the people were aſhamed to aſk for ſuch immodeſt repreſentations in his preſence; till Cato, appriſed of the reſervedneſs and reſpect with which he inſpired them, withdrew, that the people might not be diſappointed of their accuſtomed diverſion. There were ſeveral other ſorts of ſhows exhibited on this occaſion; and, if we may believe Suetonius in *Galba*, c. 6. and Vopiſcus in *Carinus*, theſe princes preſented elephants dancing on ropes on theſe occaſions.

Floralia, Florence.

The ludi florales, according to Pliny, lib. xviii. c. 29. were inſtituted by order of an oracle of the Sibyls, on the 28th of April; not in the year of Rome IↃXVI. as we commonly read it in the ancient editions of that author; nor in IↃXIV. as F. Hardouin has corrected it, but, as Voſſius reads it, in 513: though they were not regularly held every year till after 580. They were chiefly held in the night time, in the Patrician ſtreet: ſome will have it there was a circus for the purpoſe on the hill called Hortulorum.

FLORALIA, in antiquity, a general name for the feaſts, games, and other ceremonies, held in honour of the goddeſs Flora. See Flora and Florales *Ludi*.

FLORENCE, the capital of the duchy of Tuſcany, and one of the fineſt cities in Italy. It is ſurrounded on all ſides but one with high hills, which riſe inſenſibly, and at laſt join with the lofty mountains called the *Apennines*. Towards Piſa, there is a vaſt plain of 40 miles in length; which is ſo filled with villages and pleaſure houſes, that they ſeem to be a continuation of the ſuburbs of the city. Independent of the churches and palaces of Florence, moſt of which are very magnificent, the architecture of the houſes in general is in a good taſte; and the ſtreets are remarkably clean, and paved with large broad ſtones chiſeled ſo as to prevent the horſes from ſliding. The city is divided into two unequal parts by the river Arno, over which there are no leſs than four bridges in ſight of each other. That called the *Ponte della Trinità*, which is uncommonly elegant, is built entirely of white marble, and ornamented with four beautiful ſtatues repreſenting the Seaſons. The quays, the buildings on each ſide, and the bridges, render that part of Florence through which the river runs by far the fineſt. Every corner of this beautiful city is full of wonders in the arts of painting, ſtatuary, and architecture. The ſtreets, ſquares, and fronts of the palaces, are adorned with a great number of ſtatues; ſome of them by the beſt modern maſters, Michael Angelo, Bandinelli, Donatello, Giovanni di Bologna, Benvenuto Cellini, and others. Some of the Florentine merchants formerly were men of vaſt wealth, and lived in a moſt magnificent manner. One of them, about the middle of the fifteenth century, built that noble fabric, which, from the name of its founder, is ſtill called the *Palazzo Pitti*. The man was ruined by the prodigious expence of this building, which was immediately purchaſed by the Medici family, and has continued ever ſince to be the reſidence of the ſovereigns. The gardens belonging to this palace are on the declivity of an eminence. On the ſummit there is a kind of fort, called *Belvedere*. From this, and from ſome of the higher walks, you have a complete view of the city of Florence, and the beauteous vale of Arno, in the middle of which it ſtands. This palace has been enlarged ſince it was purchaſed from the ruined family of Pitti. The furniture is rich and curious, particularly ſome tables of Florentine work, which are much admired. The moſt precious ornaments, however, are the paintings. The walls of what is called the *Imperial Chamber*, are painted in freſco, by various painters; the ſubjects are allegorical, and in honour of Lorenzo of Medicis diſtinguiſhed ftinguifhed by the name of the *Magnificent*. The famous gallery attracts every ftranger. One of the moft interefting parts of it, in the eyes of many, is the feries of Roman emperors, from Julius Cæfar to Gallienus, with a confiderable number of their empreffes, arranged oppofite to them. This feries is almoft complete; but wherever the buft of an emperor is wanting, the place is filled up by that of fome other diftinguifhed Roman. The celebrated Venus of Medici, which has been removed to Paris, is thought to be the ftandard of tafte in female beauty and proportion, and ftood formerly in a room called the *Tribunal*. The infcription on its bafe mentions its being made by Cleomenes an Athenian, the fon of Apollodorus. It is of white marble, and furrounded by other mafterpieces of fculpture, fome of which are faid to be the works of Praxiteles and other Greek mafters. In the fame room are many valuable curiofities, befides a collection of admirable pictures by the beft mafters. There are various other rooms, whofe contents are indicated by the names they bear; as, the Cabinet of Arts, of Aftronomy, of Natural Hiftory, of Medals, of Porcelain, of Antiquities; the Saloon of the Hermaphrodite, fo called from a ftatue which divides the admiration of the amateurs with that in the Borghefe villa at Rome, though the excellence of the execution is difgraced by the vilenefs of the fubject; and the Gallery of Portraits, which contains the portraits of the moft eminent painters (all executed by themfelves) who have flourifhed in Europe during the three laft centuries. Our limits will not admit of a detail of the hundredth part of the curiofities and buildings of Florence. We muft not however omit mentioning the chapel of St Lorenzo, as being perhaps the fineft and moft expenfive habitation that ever was reared for the dead; it is incrufted with precious ftones, and adorned by the workmanfhip of the beft modern fculptors. Mr Addifon remarked, that this chapel advanced fo very flowly, that it is not impoffible that the family of Medicis may be extinct before their burial place is finifhed. This has actually taken place: the Medici family is extinct, and the chapel remains ftill unfinifhed.

Florence is a place of fome ftrength, and contains an archbifhop's fee and an univerfity. The number of inhabitants is calculated at 80,000. They boaft of the improvements they have made in the Italian tongue, by means of their Academia della Crufca; and feveral other academies are now eftablifhed at Florence. Though the Florentines affect great ftate, yet their nobility and gentry drive a retail trade in wine, which they fell from their cellar windows, and fometimes they even hang out a broken flafk, as a fign where it may be bought. They deal, befides wine and fruits, in gold and filver ftuffs. The Jews are not held in that degree of odium, or fubjected to the fame humiliating diftinctions here, as in moft other cities of Europe; and it is faid that fome of the richeft merchants are of that religion.

As to the manners and amufements of the inhabitants, Dr Moore informs us, that "befides the *converfazionis* which they have here, as in other towns of Italy, a number of the nobility meet every day at a houfe called the *Cafino*. This fociety is pretty much on the fame footing with the clubs in London. The members are elected by ballot. They meet at no particular hour, but go at any time that is convenient. They play at billiards, cards, and other games, or continue converfing the whole evening, as they think proper. They are ferved with tea, coffee, lemonade, ices, or what other refrefhments they choofe; and each perfon pays for what he calls for. There is one material difference between this and the Englifh clubs, that women as well as men are members. The company of both fexes behave with more franknefs and familiarity to ftrangers as well as to each other, than is cuftomary in public affemblies in other parts of Italy. The opera is a place where the people of quality pay and receive vifits, and converfe as freely as at the Cafino above mentioned. This occafions a continual paffing and repaffing to and from the boxes, except in thofe where there is a party of cards formed; it is then looked on as a piece of ill manners to difturb the players. From this it may be gueffed, that here, as in fome other towns in Italy, little attention is paid to the mufic by the company in the boxes, except at a new opera, or during fome favourite air. But the dancers command a general attention: as foon as they begin, converfation ceafes; even the card-players lay down their cards, and fix their eyes on the *ballette*. Yet the excellence of Italian dancing feems to confift in feats of ftrength, and a kind of jerking agility, more than in graceful movement. There is a continual conteft among the performers, who fhall fpring higheft. You fee here none of the fprightly alluring gaiety of the French comic dancers, or of the graceful attitudes and fmooth flowing motions of the performers in the ferious opera at Paris. It is furprifing that a people of fuch tafte and fenfibility as the Italians, fhould prefer a parcel of athletic jumpers to elegant dancers. On the evenings on which there is no opera, it is ufual for the genteel company to drive to a public walk immediately without the city, where they remain till it begins to grow dufkifh." E. Long. 12. 24. N. Lat. 43. 34.

FLORENCE, an ancient piece of Englifh gold coin. Every pound weight of ftandard gold was to be coined into 50 Florences to be current at fix fhillings each; all which made in tale 15 pounds; or into a proportionate number of half Florences, or quarter pieces, by indenture of the mint: 18 Edw. III.

FLORENTIA, in *Ancient Geography*, a town of Etruria, on the Arnus; of great note in Sylla's wars. Now called *Florenza* or *Firenza* by the Italians; *Florence* in Englifh. E. Long. 11. Lat. 43. 30.

FLORENTINE MARBLE. See CITADANESCA.

FLORESCENTIA (from *florefco*, "to flourifh or bloom"); the act of flowering, which Linnæus and the fexualifts compare to the act of generation in animals; as the ripening of the fruit in their opinion refembles the birth. See FLOWER.

FLORID STYLE, is that too much enriched with figures and flowers of rhetoric.

FLORIDA, the moft foutherly province of the Britifh empire in America before the laft war, bounded on the fouth by the gulf of Mexico, on the north by the Apalachian mountains, on the eaft by the province of Georgia, and on the weft by the river Miffiffippi. It was firft difcovered, in 1497, by Sebaftian Cabot, a Venetian, then in the Englifh fervice; whence a right to the country was claimed by the kings of England; and this province, as well as Georgia, was included in the charter granted by Charles II. to Carolina.

rolina. In 1512, however, Florida was more fully discovered by Ponce de Leon, an able Spanish navigator, but who undertook his voyage from the most absurd motives that can be well imagined.—The Indians of the Caribbee islands had among them a tradition, that somewhere on the continent there was a fountain whose waters had the property of restoring youth to all old men who tasted them. The romantic imaginations of the Spaniards were delighted with this idea. Many embarked in voyages to find out this imaginary fountain, who were never afterwards heard of. Their superstitious countrymen never imagined that these people had perished. They concluded that they did not return, only because they had drunk of the immortalizing liquor, and had discovered a spot so delightful, that they did not choose to leave it. Ponce de Leon set out with this extravagant view as well as others, and fully persuaded of the existence of a third world, the conquest of which was to immortalize his name. In the attempt to discover this country, he rediscovered Florida; but returned to the place from whence he came, visibly more advanced in years than when he set out. For some time this country was neglected by the Spaniards, and some Frenchmen settled in it: But the new colony being neglected by the ministry, and Philip II. of Spain having accustomed himself to think that he was the sole proprietor of America, fitted out a fleet at Cadiz to destroy them. His orders were executed with barbarity. The French intrenchments were forced, and most of the people killed. The prisoners were hanged on trees; with this inscription, "Not as Frenchmen, but as Heretics."

This cruelty was soon after revenged by Dominic de Gourgues, a skilful and intrepid seaman of Gascony, an enemy to the Spaniards, and passionately fond of hazardous expeditions and of glory. He sold his estate; built some ships; and with a select band of adventurers like himself embarked for Florida. He drove the Spaniards from all their posts with incredible valour and activity; defeated them in every rencounter: and by way of retaliation, hung the prisoners on trees. with this inscription, "Not as Spaniards, but as Assassins." This expedition was attended with no other consequences; Gourgues blew up the forts he had taken, and returned home, where no notice was taken of him. It was conquered in 1539 by the Spaniards under Ferdinand de Soto, not without a great deal of bloodshed; as the natives were very warlike and made a vigorous resistance. The settlement, however, was not fully established till the year 1565; when the town of St Augustine, the capital of the colony while it remained in the hands of the Spaniards, was founded. In 1586, this place was taken and pillaged by Sir Francis Drake. It met with the same fate in 1665, being taken and plundered by Captain Davis and a body of bucaniers. In 1702, an attempt was made upon it by Colonel More, governor of Carolina. He set out with 500 English and 700 Indians: and having reached St Augustine, he besieged it for three months; at the expiration of which, the Spaniards having sent some ships to the relief of the place, he was obliged to retire. In 1740 another attempt was made by General Oglethorpe; but he being outwitted by the Spanish governor, was forced to raise the siege with loss; and Florida continued in the hands of the Spaniards till the year 1763, when it was ceded by treaty to Great Britain.—During the American war, which terminated in 1783, it was again reduced by his Catholic majesty, and was guaranteed to the crown of Spain at the peace.

FLORILEGIUM, Florilege, a name the Latins have given to what the Greeks call ανθολογιον, *anthology*; viz. a collection of choice pieces, containing the finest and brightest things in their kind.

Florilege, is also particularly used for a kind of breviary, in the Eastern church, compiled by Arcadius, for the conveniency of the Greek priests and monks, who cannot carry with them, in their travels and pilgrimages, all the volumes wherein their office is dispersed. The florilegium contains the general rubrics, psalter, canticles, the horologium, and the office of the feriæ, &c.

FLORIN, is sometimes used for a coin, and sometimes for a money of account.

Florin, as a coin, is of different values, according to the different metals and different countries where it is struck. The gold florins are most of them of a very coarse alloy, some of them not exceeding thirteen or fourteen carats, and none of them seventeen and a half. See *Money Table*.

Florin, as a money of account, is used by the Italian, Dutch, and German merchants and bankers, but admits of divisions in different places. Ibid.

FLORINIANI, or Floriani, a sect of heretics, of the second century, denominated from its author Florinus, or Florianus, a priest of the Roman church, deposed along with Blastus for his errors. Florinus had been a disciple of St Polycarp, along with Irenæus. He made God the author of evil; or rather asserted, that the things forbidden by God are not evil, but of his own appointing. In which he followed the errors of Valentinus, and joined himself with the Carpocratians. They had also other names given them. Philastrius says, they were the same with the *Carpophorians*. He adds that they were also called *soldiers*, *milites*, *quia de militaribus fuerunt*. St Irenæus calls them *Gnostics*; St Epiphanius *Phibionites*; and Theodoret, *Barborites*, on account of the impurities of their lives. Others call them *Zaccheans*; others *Coddians*, &c. though for what particular reasons, it is not easy to say, nor perhaps would be worth while to inquire.

FLORIS, Francis, an eminent historical painter, was born at Antwerp in 1520. He followed the profession of a statuary till he was twenty years of age; when preferring painting, he entered the school of Lambert Lombard, whose manner he imitated very perfectly. He afterwards went to Italy, and completed his studies from the most eminent masters. The great progress he made in historical painting, at his return procured him much employment; and his countrymen complimented him with the flattering appellation of *the Flemish Raphael*. He got much money, and might have rendered his acquaintance more worthy of the attention of the great, had he not debased himself by frequent drunkenness. He died 1570, aged 50.

FLORIST, a person curious or skilled in flowers; their kinds, names, characters, culture, &c. It is also applied to an author who writes what is called the flora,

flora of any particular place, that is, a catalogue of the plants and trees which are found ſpontaneouſly growing there.

FLORUS, Lucius Annæus, a Latin hiſtorian, of the ſame family with Seneca and Lucan. He flouriſhed in the reigns of Trajan and Adrian; and wrote an abridgment of the Roman hiſtory, of which there have been many editions. It is compoſed in a florid and poetical ſtyle; and is rather a panegyric on many of the great actions of the Romans, than a faithful and correct recital of their hiſtory. He alſo wrote poetry, and entered the liſts againſt the emperor Adrian, who ſatirically reproached him with frequenting taverns and places of diſſipation.

FLORY, Flowery, or *Fleury*, in *Heraldry*, a croſs that has flowers at the end circumflex and turning down; different from the *potence*, in as much as the latter ſtretches out more like that which is called *patee*.

FLOS, Flower. See Flower, Botany *Index*.

Fœmineus Flos, a flower which is furniſhed with the pointal or female organs of generation, but wants the ſtamina or male organ. Female flowers may be produced apart from the male, either on the ſame root or on diſtinct plants. Birch and mulberry are examples of the firſt caſe, willow and poplar of the ſecond.

Maſculus Flos, a male flower. By this name Linnæus and the ſexualiſts diſtinguiſh a flower which contains the ſtamen, reckoned by the ſexualiſts the male organ of generation; but not the ſtigma or female organ. All the plants of the claſs diœcia of Linnæus have male and female flowers upon different roots; thoſe of the claſs monœcia bear flowers of different ſexes on the ſame root. The plants, therefore of the former are only male and female: thoſe of the latter are androgynous; that is, contain a mixture of both male and female flowers.

Flos, in *Chemiſtry*, the moſt ſubtile part of bodies ſeparated from the more groſs parts by ſublimation in a dry form.

FLOTA, or Flotta, *fleet;* a name the Spaniards give particularly to the ſhips which they ſend annually from Cadiz to the port of Vera Cruz, to fetch thence the merchandiſes gathered in Mexico for Spain. It conſiſts of the captains, admiral, and patach, or pinnace, which go on the king's account; and about 16 ſhips, from 400 to 1000 tons, belonging to particular perſons. They ſet out from Cadiz about the month of Auguſt, and are 18 or 20 months before they return. Thoſe ſent to fetch the commodities prepared in Peru are called *galleons*.

The name *flotilla* is given to a number of ſhips, which get before the reſt in their return, and give information of the departure and cargo of the flota and galleons.

FLOTSON, or Flotsom, goods that by ſhipwreck are loſt, and floating upon the ſea; which, with jetſon and lagan, are generally given to the lord admiral: but this is the caſe only where the owners of ſuch goods are not known. And here it is to be obſerved, that *jetſon* ſignifies any thing that is caſt out of a ſhip when in danger, and afterwards is beat on the ſhore by the water, notwithſtanding which the ſhip periſhes. *Logan* is where heavy goods are thrown overboard, before the wreck of the ſhip, and ſink to the bottom of the ſea.

FLOUNDER, Fluke, or *But*. See Pleuronectes, Ichthyology *Index*.

Flounders may be fiſhed for all day long, either in a ſwift ſtream, or in the ſtill deep water; but beſt in the ſtream in the months of April, May, June, and July: the moſt proper baits are all ſorts of worms, waſps, and gentles.

FLOUR, the meal of wheat-corn, finely ground and ſifted. See Meal.

The grain itſelf is not only ſubject to be eaten by inſects in that ſtate; but, when ground into flour, it gives birth to another race of deſtroyers, who eat it unmercifully, and increaſe ſo faſt in it, that it is not long before they wholly deſtroy the ſubſtance. The fineſt flour is moſt liable to breed theſe, eſpecially when ſtale or ill prepared. In this caſe, if it be examined in a good light, it will be obſerved to be in continual motion, and on a nicer inſpection there will be found in it a great number of little animals of the colour of the flour, and very nimble. If a little of this flour is laid on the plate of the double microſcope, the inſects are very diſtinctly ſeen in great numbers, very briſk and lively, continually crawling over one another's backs, and playing a thouſand antic tricks together; whether in diverſion, or in ſearch of food, is not eaſy to be determined. Theſe animals are of an oblong and ſlender form; their heads are furniſhed with a kind of trunk or hollow tube, by means of which they take in their food, and their body is compoſed of ſeveral rings. They do vaſt miſchief among magazines of flour laid up for armies and other public uſes. When they have once taken poſſeſſion of a parcel of this valuable commodity, it is impoſſible to drive them out; and they increaſe ſo faſt, that the only method of preventing the total loſs of the parcel is to make it up into bread as ſoon as can be done. The way to prevent their breeding in the flour is to preſerve it from damp: nothing gets more injury by being put up damp than flour; and yet nothing is more frequently put up ſo. It ſhould be always carefully and thoroughly dried before it is put up, and the barrels alſo dried into which it is to be put; then, if they are placed in a room tolerably warm and dry, they will keep it well. Too dry a place never does flour any hurt, though one too moiſt almoſt always ſpoils it.

Flour when carefully analyzed, is found to be compoſed of three very different ſubſtances. The firſt and moſt abundant is pure *ſtarch*, or white fecule, inſoluble in cold, but ſoluble in hot water, and of the nature of mucous ſubſtances; which, when diſſolved, form water-glues. The ſecond is the *gluten*, moſt of whoſe properties have been deſcribed under the article Bread. The third is of a mild nature, perfectly ſoluble in cold water, of the nature of *ſaccharine* extractive mucous matters. It is ſuſceptible of the ſpirituous fermentation, and is found but in ſmall quantity in the flour of wheat. See Bread, Gluten, Starch, and Sugar, Chemistry *Index*.

FLOWER, Flos, among botaniſts and gardeners, the moſt beautiful part of trees and plants, containing the organs or parts of fructification. See Botany *Index*.

Flowers.

Flowers, deſigned for medical uſe, ſhould be plucked when they are moderately blown, and on a clear day before noon: for conſerves, roſes muſt taken in the bud.

FLOWERS, in antiquity. We find flowers in great requeſt at the entertainments of the ancients, being provided by the maſter of the feaſt, and brought in before the ſecond courſe; or, as ſome are of opinion, at the beginning of the entertainment. They not only adorned their heads, necks, and breaſts, with flowers, but often beſtrewed the beds whereon they lay, and all parts of the room with them. But the head was chiefly regarded. See GARLAND.

Flowers were likewiſe uſed in the bedecking of tombs. See BURIAL.

Eternal FLOWER. See XERANTHEMUM,
Everlaſting FLOWER. See GNAPHALIUM,
FLOWER-*Fence*. See POINCIANA,
Sun-FLOWER. See HELIANTHUS,
Sultan-FLOWER. See CYANUS,
Trumpet-FLOWER. See BIGNONIA,
Wind-FLOWER. See ANEMONE,
} BOTANY *Index*.

FLOWER-*de-lis*, or *Flower-de-luce*, in *Heraldry*, a bearing repreſenting the lily called the *queen of flowers*, and the true hieroglyphic of royal majeſty; but of late it is become more common, being borne in ſome coats one, in others three, in others five, and in ſome *ſemee* or ſpread all over the eſcutcheon in great numbers.

The arms of France are, three flowers-de-lis or, in a field azure.

FLOWER-*de-Luce*. See IRIS, BOTANY *Index*.

FLOWERS, in *Heraldry*. They are much uſed in coats of arms; and in general ſignify hope, or denote human frailty and momentary proſperity.

FLOWERS, in *Chemiſtry*. By this name are generally underſtood bodies reduced into very fine parts, either ſpontaneouſly, or by ſome operation of art; but the term is chiefly applied to volatile ſolid ſubſtances, reduced into very fine parts, or into a kind of meal by ſublimation.—Some flowers are nothing elſe than the bodies themſelves, which are ſublimed entire, without ſuffering any alteration or decompoſition; and other flowers are ſome of the conſtituent parts of the body ſubjected to ſublimation.

Colours of FLOWERS. See the article *Colour* (*of Plants*).

Colours extracted from FLOWERS. See *Colour-Making*.

Preſerving of FLOWERS. The method of preſerving flowers in their natural beauty through the whole year has been much ſought after by many people. Some have attempted it by gathering them when dry and not too much opened, and burying them in dry ſand; but this, though it preſerves their figure well, takes off from the livelineſs of their colour. Muntingius prefers the following method to all others. Gather roſes, or other flowers, when they are not yet thoroughly open, in the middle of a dry day; fill the veſſel up to the top with them; and when full ſprinkle them over with ſome good French wine, with a little ſalt in it; then ſet them by in a cellar, tying down the mouth of the pot. After this they may be taken out at pleaſure; and, on ſetting them in the ſun, or within reach of the fire, they will open as if growing naturally; and not only the colour, but the ſmell alſo will be preſerved.

Flowers.

The flowers of plants are by much the moſt difficult parts of them to preſerve in any tolerable degree of perfection; of which we have inſtances in all the collections of dried plants, or *horti ſicci*. In theſe the leaves, ſtalks, roots, and ſeeds of the plants, appear very well preſerved; the ſtrong texture of theſe parts making them always retain their natural form, and the colours in many ſpecies naturally remaining. But where theſe fade, the plant is little the worſe for uſe as to the knowing the ſpecies by it. But it is very much otherwiſe in regard to flowers; theſe are naturally by much the moſt beautiful parts of the plants to which they belong; but they are ſo much injured in the common way of drying, that they not only loſe, but change their colours one into another, by which means they give a handle to many errors; and they uſually alſo wither up, ſo as to loſe their very form and natural ſhape. The primroſe and cowſlip kinds are very eminent inſtances of the change of colours in the flowers of dried ſpecimens; for thoſe of this claſs of plants eaſily dry in their natural ſhape; but they loſe their yellow, and, inſtead of it, acquire a fine green colour, much ſuperior to that of the leaves in their moſt perfect ſtate. The flowers of all the violet kind loſe their beautiful blue, and become of a dead white: ſo that in dried ſpecimens there is no difference between the blue-flowered violet and the white-flowered kinds.

Sir Robert Southwell has communicated to the world a method of drying plants, by which this defect is propoſed to be in a great meaſure remedied, and all flowers preſerved in their natural ſhape, and many in their natural colours.—For this purpoſe two plates of iron are to be prepared of the ſize of a large half ſheet of paper, or larger, for particular occaſions; theſe plates muſt be made ſo thick as not to be apt to bend; and there muſt be a hole made near every corner for the receiving a ſcrew to faſten them cloſe together. When theſe plates are prepared, lay in readineſs ſeveral ſheets of paper, and then gather the plants with their flowers when they are quite perfect. Let this be always done in the middle of a dry day; and then lay the plant and its flower on one of the ſheets of paper doubled in half, ſpreading out all the leaves and petals as nicely as poſſible. If the ſtalk is thick, it muſt be pared or cut in half, ſo that it may lie flat; and if it is woody, it may be peeled, and only the bark left. When the plant is thus expanded, lay round about it ſome looſe leaves and petals of the flower, which may ſerve to complete any part that is deficient. When all is thus prepared, lay ſeveral ſheets of paper over the plant, and as many under it; then put the whole between the iron plates, laying the papers ſmoothly on one, and laying the other evenly over them; ſcrew them cloſe, and put them into an oven after the bread is drawn, and let them lie there two hours. After that, make a mixture of equal parts of aquafortis and common brandy; ſhake theſe well together, and when the flowers are taken out of the preſſure of the plates, rub them lightly over with a camel's hair pencil dipped in this liquor; then lay them upon freſh brown paper, and covering them with ſome other ſheets, preſs them between this and other papers with a handkerchief till the

the wet of theſe liquors is dried wholly away. When the plant is thus far prepared, take the bulk of a nutmeg of gum dragon; put this into a pint of fair water cold, and let it ſtand 24 hours; it will in this time be wholly diſſolved: then dip a fine hair pencil in this liquor, and with it daub over the back ſides of the leaves, and lay them carefully down on half a ſheet of white paper fairly expanded, and preſs them down with ſome more papers over theſe. When the gum-water is fixed, let the preſſer and papers be removed, and the whole work is finiſhed. The leaves retain their verdure in this caſe, and the flowers uſually keep their natural colours. Some care, however, muſt be taken, that the heat of the oven be not too great. When the flowers are thick and bulky, ſome art may be uſed to pare off their backs, and diſpoſe the petals in a due order; and after this, if any of them are wanting, their places may be ſupplied with ſome of the ſupernumerary ones dried on purpoſe; and if any of them are only faded, it will be prudent to take them away, and lay down others in their ſtead: the leaves may be alſo diſpoſed and mended in the ſame manner.

Another method of preſerving both flowers and fruit ſound throughout the whole year is alſo given by the ſame author. Take ſaltpetre, one pound; Armenian bole, two pounds; clean common ſand, three pounds: mix all well together. Then gather fruit of any kind that is not fully ripe, with the ſtalk to each; put theſe in, one by one, into a wide-mouthed glaſs, laying them in good order. Tie over the top with an oil-cloth, and carry them into a dry cellar, and ſet the whole upon a bed of the prepared matter of four inches thick in a box. Fill up the remainder of the box with the ſame preparation; and let it be four inches thick all over the top of the glaſs, and all round its ſides. Flowers are to be preſerved in the ſame ſort of glaſſes, and in the ſame manner; and they may be taken up after a whole year as plump and fair as when they were buried.

Artificial Flowers of the Chineſe. See Tong-tsao.

Flowers, in the animal economy, denote women's monthly purgations or menſes.—Nicod derives the word in this ſenſe, from *fluere*, q. d. *fluors*. Others will have the name occaſioned hence, that women do not conceive till they have had their flowers; ſo that theſe are a ſort of forerunners of their fruit.

Flowers, in *Rhetoric*, are figures or ornaments of diſcourſe, by the Latins called *floſculi*.

FLOWERING *of Bulbous* Plants. Theſe plants will grow and flower in water alone, without any earth, and make a very elegant appearance. We daily ſee this practiſed in ſingle roots; but there is a method of doing it with ſeveral roots in the ſame veſſel. Take a common ſmall garden pot; ſtop the hole at the bottom with a cork, and lute in the cork with putty, that no water can get through; then fit a board to the top of the pot, and bore ſix or ſeven holes in it at equal diſtances, to place the bulbs in; and as many ſmaller ones near them to receive ſticks, which will ſerve to tie up the flowers. Then fill up the pot with water to the board; and place tulips, jonquils, narciſſuſes, and the like plants in the root upon the holes, ſo that the bottom of the roots may touch the water: thus will they all flower early in the ſeaſon, and be much more beautiful than any pot of gathered flowers, and will laſt many weeks in their full perfection. After the ſeaſon of flowering is over, the roots will gradually ſhrink through the holes of the board, and get looſe into the water: but, inſtead, of being ſpoiled there, they will ſoon increaſe in ſize; ſo that they cannot return through the holes, and will produce ſeveral offſets. It is natural to try from this the conſequence of keeping the roots under water during the whole time of their blowing; and in this way they have been found to ſucceed very well, and flower even ſtronger and more beautifully than when in the ground. They may thus, alſo, with proper care in the degree of heat in the room, be kept flowering from before Chriſtmas till March or April. It is not eaſy, in this laſt manner, to manage the keeping the boards under water, for which reaſon, it is better to procure ſome ſheet-lead of about four pounds to the foot, and cut this to the ſize of the mouth of the pot. In this there ſhould be bored holes for the bulbs, and other holes for the ſticks: and, in order to keep the ſticks quite firm, it is proper to have another plate of lead ſhaped to the bottom of the pot, with holes in it, anſwering to thoſe of the upper plate made for the ſticks. The ſticks will by this means be always kept perfectly ſteady; and the roots, being kept under water by the upper plate of lead, will flower in the moſt vigorous and beautiful manner imaginable. Some have thought of adding to the virtues of the water by putting in nitre in ſmall quantities, and others have added earth and ſand at the bottom; but it has always been found to ſucceed better without any addition.

It may be more agreeable to ſome to uſe glaſs jars in this laſt method with the leads, inſtead of earthen pots. The bulbs ſucceed full as well in theſe; and there is this advantage, that the progreſs of the roots is ſeen all the while, and they are managed better as to the ſupply of water.

By repeated experiments in this way on dried bulbs, and on thoſe taken freſh out of the ground, the former have been found to ſucceed the beſt. For thoſe taken freſh out of the ground being full of moiſture, will not ſo ſoon, upon changing their element, be nouriſhed fully by a new one; and the fibres which they had ſtruck in the ground, always rot when put into the water, and new ones muſt be formed in their places; ſo that it requires more time for them to come to flowering. The bulbs themſelves will not rot in this manner; but they will never be ſo ſtrong as thoſe which were put into the water dry, which gradually fill themſelves with moiſture from it, and regularly plump up. The beſt method of managing the whole proceſs is this: Place the bulbs at firſt only on the ſurface of the water; for thus they will ſtrike out their fibres moſt ſtrongly. When they have ſtood thus ſix weeks, pour in the water ſo high as to cover them entirely, and keep them thus till they have done flowering.

Sometimes the roots will become mouldy in ſeveral parts while they ſtand above the water, and the cleaning them of it is to no purpoſe; for it will eat and ſpread the farther, and frequently eat through two or three of their coats. In this caſe they muſt be immediately covered with water; when the mould will be

 ſtopped,

Flowering stopped, and the roots become found, and flower as well as those which never had any such distemper. If the roots are suffered to remain in water all the year, they will not decay: but will flower again at their proper season, and that as vigorously as those which have been taken out and dried. The old fibres of those roots never rot till they are ready to push forth new ones. It is found by experience, that the hyacinth, and many other plants, grow to a greater degree of perfection when thus in water than when in the ground. There is a peculiar species of hyacinth called *Keyser's jewel;* this never, or very rarely, produces seed-vessels in the common way of flowering in the ground; but it will often produce some pods when blown in water.

Mr Millar has intimated, in the Philosophical Transactions, that bulbs set in glasses grow weaker, and should be renewed every other year: but it is found, that, when managed in this manner, and kept under water, at the time of taking them up, they are as large, and some of them larger, than when planted; and if these be dried at a proper season, they will flower, year after year, as well as fresh ones.

Ranunculus and anemone roots have been found to shoot up their stalks very well in this way; but the flowers are usually blasted, which seems to arise from want of free air. Pinks will flower very well in this manner; auriculas also may, with care, be brought to flower, but not strongly. Roses, jessamines, and honeysuckles, may also be made to flower this way, and will thrive and send out suckers; the best pieces to plant, are suckers cut off about three inches under ground, without any fibres. The succulent plants may also be raised this way; for instance, the opuntia or Indian fig. If a fragment of a leaf of this plant be cut, and laid by to dry for a month till it is an absolute skin, as soon as it is put in this manner into water, it begins to plump up, and soon sends out fibrous roots, and produces new leaves as quickly as it would do in the ground.

This is the more singular in these sorts of plants, because in their natural state in the ground, they cannot bear much water. This method of growing in water is not peculiar to the bulbous-rooted ones, but others may even be raised from seed by it. A bean or pea, set in this manner, will grow up to its proper standard, and will flower and produce pods which will ripen their seed. The smaller seeds may be also raised in this manner, by the help of wool to support them.

No vegetable transplanted out of the earth into water will thrive kindly; but any plant, whether raised from the root or seed in water, may be transplanted to the earth, and will succeed very well. It may be possible, therefore, from this method of raising plants in water, to come at a better way than is usually practised of raising some roots in the earth which are subject to rot there; such as anemonies, ranunculuses, and hyacinths. A bulb dropped by chance upon the ground, will strike out both stronger and more numerous fibres than those which are planted in the usual way in the ground. On this principle, it may be proper to take out the earth of the bed where the bulbs are to stand at the time of planting them, to such a depth as they are to be placed under it when set for flowering. The bulbs are then to be set in their places, on the surface of this low ground; and to stand there till they have shot out their fibres and their head: then the earth is to be added over them by degrees, till they are covered as high above the head as they are in the usual manner of planting them; thus they would be preserved from the danger of rotting; and their fibres would be much stronger, and consequently they would draw more nourishment, and flower better, than in the common way. The common method of planting these roots renders them liable to be destroyed by either extreme of a wet or a dry season. In the first case, they immediately rot by the abundant moisture they receive; and, in the second, they become dry as a stick and mouldy, so that they are infallibly rotted by the first rain that falls afterwards.

The directions necessary to the success of the bulbs planted in water are these. When the leaden false bottoms are fixed down tight within two or three inches of the bottom of the vessel (which is only designed to hold the sticks steady which are to support the leaves and stalks), then lay on the lead upon which the bulbs are to rest, placing the notched part opposite to that in the false bottom, as near as the sticks, when placed, will suffer it; then place the bulbs one in each hole, and fill up with water to the upper lead. The bottom of the bulb will then touch the water; and as the water diminishes in quantity, keep it supplied with more up to the same height for a month or six weeks; in which time the bulbs will have shot strong fibres. Then fill up the water about half an inch above the surface of the lead; and, by degrees, as the fibres strengthen, and the plume shoots from the head, keep the water higher and higher, till at length the whole bulb is covered. The water is to be kept at this standard till the season for drying them returns.—At the time of planting the bulbs, they must be carefully cleaned from any foulnesses at the bottom, by scraping them with the point of a knife till the sound part of the bulb appears; clear them likewise from any loose skins, and even take off their brown skin till they appear white; otherwise this brown skin will tinge the water, and the growth will not succeed so well.

The notches in the side of each lead are intended to give easy passage to the water, that, if there should be any foulness or sediment in it, on shaking it a little it may all run through, and fresh water be put in its place. But this shifting the water need not be done more than once or twice in a winter, as there may be occasion from the foulness; and when this is done, the sides of the vessel should be cleaned with a painter's brush, and rinsed out again, and the bulbs themselves washed, by pouring water on them at a little distance.

At any time when the outer skins of the bulbs dry, they are to be peeled off, that they may not occasion foulness in the water; and if any dust or foul matter be at any time observed swimming on the surface, the method is to fill up the pot or vessel to the rim, and let it run over: this will carry off that light foulness, and the water may afterwards be poured away to the proper standard.

Bulbs of equal bigness should be planted together in the

the ſame pot, that they may all have the ſame benefit of the water. Narciſſuſes and hyacinths do well together; as alſo tulips and jonquils, and crocuſes and ſnowdrops.

FLUDD, Robert, a philoſopher and phyſician of ſome celebrity in his time, was the ſon of Sir Thomas Fludd, treaſurer of war to Queen Elizabeth; and was born at Milgate in Kent, in the year 1574. He received his education at St John's college, Oxford, and afterwards ſpent ſix years in travelling through Europe. He acquired a ſtrong attachment to the Roſycruſian philoſophy, which chiefly conſiſted of myſticiſm and jargon, and ſuch as were admitted among them had certain ſecrets analogous to thoſe of free maſonry. On his return home, he took the degree of M. D. ſettled in the city of London, and was choſen a fellow of the college of phyſicians. His piety was of an enthuſiaſtic nature, and the ſeeming depth of his knowledge procured him much admiration, and gave him a temporary fame. It is ſaid that he employed a kind of unintelligible cant when ſpeaking to his patients, which ſometimes contributed to their recovery, as it operated on their faith. He is chiefly known as a ſectary in philoſophy, and not as a phyſician. He bleuded the incomprehenſible reveries of the Cabaliſts and Paracelſians, forming a new phyſical ſyſtem replete with myſtery and abſurdity. He believed in two univerſal principles, the northern or condenſing, and the ſouthern or rarefying power. Innumerable geniuſes he conceived to preſide over theſe, and committed the charge of diſeaſes to legions of ſpirits collected from the four winds of heaven. In his eſtimation, a harmony ſubſiſted between the macrocoſm and the microcoſm, or the world of nature and of man. All his fancies and whims it is impoſſible to enumerate, yet they attracted the notice of the philoſophers of that age, being ſupported by myſterious gravity and the ſhadow of erudition. Even Kepler himſelf thought his extravagant jargon worthy of refutation, and Gaſſendi for this purpoſe wrote his *Examen Philoſophiæ Fluddianæ*. One of Fludd's performances, entitled *Nexus utriuſque Coſmi*, is illuſtrated by ſome prints of a very ſingular and extraordinary nature.

FLUENT, or Flowing Quantity, in the doctrine of fluxions, is the variable quantity which is conſidered as increaſing and decreaſing: or the fluent of a given fluxion, is that quantity whoſe fluxion being taken, according to the rules of that doctrine, ſhall be the ſame with the given fluxion. See Fluxions.

FLUID, an appellation given to all bodies whoſe particles eaſily yield to the leaſt partial preſſure, or force impreſſed. For the

Laws and Properties of Fluids, ſee Hydrostatics.

There are various kinds of animalcules to be diſcerned in different fluids by the microſcope. Of many remarkable kinds of theſe, a deſcription is given under the article Animalcule. All of theſe little creatures are eaſily deſtroyed by ſeparating them from their natural element. Naturaliſts have even fallen upon ſhorter methods. A needle point, dipped in ſpirit of vitriol, and then immerſed into a drop of pepper water, readily kills all the animalcules: which, though before friſking about with great livelineſs and activity, no ſooner come within the influence of the acid particles, than they ſpread themſelves, and tumble down to all appearance dead. The like may be done by a ſolution of ſalt; only with this difference, that, by the latter application, they ſeem to grow vertiginous, turning round and round till they fall down. Tincture of ſalt of tartar, uſed in the ſame manner, kills them ſtill more readily; yet not ſo, but there will be apparent marks of their firſt being ſick and convulſed. Inks deſtroy them as faſt as ſpirit of vitriol, and human blood produces the ſame effect. Urine, ſack, and ſugar, all deſtroy them, though not ſo faſt; beſides, that there is ſome diverſity in their figures and appearances, as they receive their deaths from this poiſon or that. The point of a pin dipped in ſpittle, preſently killed all the kinds of animalcules in puddle water, as Mr Harris ſuppoſes it will other animalcules of this kind.

All who are acquainted with microſcopic obſervations, know very well, that in water, in which the beſt glaſſes can diſcover no particle of animated matter, after a few grains of pepper, or a fragment of a plant of almoſt any kind, has been ſome time in it, animals full of life and motion are produced; and thoſe in ſuch numbers, as to equal the fluid itſelf in quantity.—When we ſee a numerous brood of young fiſhes in a pond, we make no doubt of their having owed their origin to the ſpawn, that is, to the eggs of the parents of the ſame ſpecies. What are we then to think of theſe? If we will conſider the progreſs of nature in the inſect tribes in general, and eſpecially in ſuch of them as are moſt analogous to theſe, we ſhall find it leſs difficult to give an account of their origin than might have been imagined.

A ſmall quantity of water taken from any ditch in the ſummer months, is found to be full of little worms, ſeeming in nothing ſo much as in ſize to differ from the microſcopic animalcules. Nay, water, without theſe, expoſed in open veſſels to the heat of the weather, will be always found to abound with multitudes of them, viſible to the naked eye, and full of life and motion. Theſe we know, by their future changes, are the fly worms of the different ſpecies of gnats, and multitudes of other fly ſpecies; and we can eaſily determine, that they have owed their origin only to the eggs of the parent fly there depoſited. Nay, a cloſer obſervation will at any time give ocular proof of this; as the flies may be ſeen laying their eggs there, and the eggs may be followed through all their changes to the fly again. Why then are we to doubt but that the air abounds with other flies and animalcules as minute as the worms in thoſe fluids; and that theſe laſt are only the fly worms of the former, which after a proper time ſpent in that ſtate, will ſuffer changes like thoſe of the larger kinds, and become flies like thoſe to whoſe eggs they owed their origin? *Vid. Reaumur, Hiſt. Inſect.* vol. iv. p. 431.

The differently medicated liquors made by infuſions of different plants, afford a proper matter for the worms of different ſpecies of theſe ſmall flies: and there is no reaſon to doubt, but that among theſe ſome are viviparous, others oviparous; and to this may be, in a great meaſure owing the different time taken up for the production of theſe inſects in different fluids. Thoſe which are a proper matter for the worms of the viviparous fly, may be ſooneſt found full of them; as, probably the liquor is no ſooner in a ſtate to afford them

them proper nouriſhment, than their parents place them there: whereas thoſe produced from the eggs of the little oviparous flies, muſt, after the liquor is in a proper ſtate, and they are depoſited in it in the form of eggs, have a proper time to be hatched, before they can appear alive.

It is eaſy to prove, that the animals we find in theſe vegetable infuſions were brought thither from elſewhere. It is not leſs eaſy to prove, that they could not be in the matter infuſed any more than in the water in which it is infuſed.

Notwithſtanding the fabulous accounts of ſalamanders, it is now well known, that no animal, large or ſmall, can bear the force of fire for any conſiderable time; and, by parity of reaſon, we are not to believe, that any inſect, or embryo inſect, in any ſtate, can bear the heat of boiling water for many minutes. To proceed to inquiries on this foundation: If ſeveral tubes filled with water, with a ſmall quantity of vegetable matter, ſuch as pepper, oak bark, truffles, &c. in which, after a time, inſects will be diſcovered by the microſcope; and other like tubes be filled with ſimple water boiled, with water and pepper boiled together, and with water with the two other ingredients all ſeparately boiled in it; when all theſe liquors come to a proper time for the obſervation of the microſcope, all, as well thoſe which have been boiled as thoſe which have not, will be found equally to abound with inſects, and thoſe of the ſame kind, in infuſions of the ſame kind, whether boiled or not boiled. Thoſe in the infuſions which had ſuſtained a heat capable of deſtroying animal life, muſt therefore not have ſubſiſted either in the water or in the matters put into it, but muſt have been brought thither after the boiling; and it ſeems by no way ſo probably, as by means of ſome little winged inhabitants of the air depoſiting their eggs or worms in theſe fluids.

On this it is natural to aſk, how it comes to paſs, that while we ſee myriads of the progeny of theſe winged inſects in water, we never ſee themſelves? The anſwer is equally eaſy, viz. becauſe we can always place a drop of this water immediately before the focus of the microſcope, and keep it there while we are at leiſure to examine its contents; but that is not the caſe with regard to the air inhabited by the parent flies of theſe worms, which is an immenſe extent in proportion to the water proper for nouriſhing theſe worms; and conſequently, while the latter are cluſtered together in heaps, the former may be diſperſed and ſcattered. Nor do we want inſtances of this, even in inſects of a larger kind. In many of our gardens, we frequently find veſſels of water filled with worms of the gnat kind, as plentifully, in proportion to their ſize, as thoſe of other fluids are with animalcules. Every cubic inch of water in theſe veſſels contains many hundreds of animals: yet we ſee many cubic inches of air in the garden not affording one of the parent flies.

But neither are we poſitively to declare that the parent flies of theſe animalcules are in all ſtates wholly inviſible to us; if not ſingly to be ſeen, there are ſome ſtrong reaſons to imagine that they may in great cluſters. Every one has ſeen in a clear day, when looking ſtedfaſtly at the ſky, that the air is in many places diſturbed by motions and convolutions in certain ſpots. Theſe cannot be the effects of imagination, or of faults in our eyes, becauſe they appear the ſame to all; and if we conſider what would be the caſe to an eye formed in ſuch a manner as to ſee nothing ſmaller than an ox, on viewing the air on a marſh fully peopled with gnats, we muſt be ſenſible that the clouds of theſe inſects, though to us diſtinctly enough viſible, would appear to ſuch an eye merely as the moving parcels of air in the former inſtance do to us: and ſurely it is thence no raſh concluſion to infer, that the caſe may be the ſame, and that myriads of flying inſects, too ſmall to be ſingly the objects of our view, yet are to us what the clouds of gnats would be in the former caſe.

Nervous Fluid. See Anatomy *Index*.

Elaſtic Fluids. See Chemistry *Index*.

FLUIDITY, is by Sir Iſaac Newton defined to be, that property of bodies by which they yield to any force impreſſed, and which have their parts very eaſily moved among one another.

To this definition ſome have added, that the parts of a fluid are in a continual motion. This opinion is ſupported by the ſolution of ſalts, and the formation of tinctures. If a ſmall bit of ſaffron is thrown into a phial full of water, a yellow tincture will ſoon be communicated to the water to a conſiderable height, though the phial is allowed to remain at reſt; which indicates a motion in thoſe parts of the fluid which touch the ſaffron, by which its colouring matter is carried up.

With regard to water, this can ſcarce be denied; the conſtant exhalations from its ſurface ſhow, that there muſt be a perpetual motion in its parts from the aſcent of the ſteam through it. In mercury, where inſenſible evaporation does not take place, it might be doubted; and accordingly the Newtonian philoſophers in general have been of opinion, that there are ſome ſubſtances eſſentially fluid, from the ſpherical figure of their conſtituent particles. The congelation of mercury, however, by an extreme degree of cold, demonſtrates that fluidity is not eſſentially inherent in mercury more than in other bodies.

That fluids have vacuities in their ſubſtance is evident, becauſe they may be made to diſſolve certain bodies without ſenſibly increaſing their bulk. For example, water will diſſolve a certain quantity of ſalt; after which it will receive a little ſugar, and after that a little alum, without increaſing its firſt dimenſions. Here we can ſcarce ſuppoſe any thing elſe than that the ſaline particles were interpoſed between thoſe of the fluid; and as, by the mixture of ſalt and water, a conſiderable degree of cold is produced, we may thence eaſily ſee why the fluid receives theſe ſubſtances without any increaſe of bulk. All ſubſtances are expanded by heat, and reduced into leſs dimenſions by cold; therefore, if any ſubſtance is added to a fluid, which tends to make it cold, the expanſion by the bulk of the ſubſtance added will not be ſo much perceived as if this effect had not happened; and if the quantity added be ſmall, the fluid will contract as much, perhaps more, from the cold produced by the mixture, than it will be expanded from the bulk of the ſalt. This alſo may let us know with what theſe interſtices between the particles of the fluid were filled up; namely, the element of fire or heat. The ſaline particles, upon on their solution in the fluid, have occupied these spaces; and now the liquor being deprived of a quantity of this element equal in bulk to the salt added, feels sensibly colder.

As, therefore, there is scarce any body to be found, but what may become solid by a sufficient degree of cold, and none but what a certain degree of heat will render fluid; the opinion naturally arises, that fire is the cause of fluidity in all bodies, and that this element is the only essentially fluid substance in nature. Hence we may conclude, that those substances which we call *fluids* are not essentially so, but only assume that appearance in consequence of an intimate union with the element of fire; just as gums assume a fluid appearance on being dissolved in spirit of wine, or salts in water.

Upon these principles Dr Black mentions fluidity as an effect of heat. The different degrees of heat which are required to bring different bodies into a state of fluidity, he supposes to depend on some particulars in the mixture and composition of the bodies themselves: which becomes extremely probable, from considering that we change the natural state of bodies in this respect, by certain mixtures; thus, if two metals are compounded, the mixture is usually more fusible than either of them separately. See CHEMISTRY *Index*.

It is certain, however, that water becomes warmer by being converted into ice; which may seem contradictory to this opinion. To this, however, the doctor replies, that fluidity does not consist in the degree of sensible heat contained in bodies, which will affect the hand or a thermometer; but in a certain quantity which remains in a latent state. This opinion he supports from the great length of time required to melt ice; and to ascertain the degree of heat requisite to keep water in a fluid state, he put five ounces of water into a Florence flask, and converted it into ice by means of a freezing mixture put round the flask. Into another flask of the same kind he put an equal quantity of water cooled down nearly to the freezing point, by mixing it with snow, and then pouring it off. In this he placed a very delicate thermometer; and found that it acquired heat from the air of the room in which it was placed: seven degrees of heat were gained the first half hour. The ice being exposed to the same degree of heat, namely, the air of a large room without fire, it cannot be doubted that it received heat from the air as fast as the water which was not frozen; but, to prevent all possibility of deception, he put his hand under the flask containing the ice, and found a stream of cold air very sensibly descending from it, even at a considerable distance from the flask; which undeniably proved, that the ice was all that time absorbing heat from the air. Nevertheless, it was not till 11 hours that the ice was half melted, though in that time it had absorbed so much heat as ought to have raised the thermometer to 140°; and even after it was melted, the temperature of the water was found scarce above the freezing point: so that, as the heat which entered could not be found in the melted ice, he concluded that it remained concealed in the water, as an essential ingredient of its composition.

FLUKE, or FLOUNDER. See PLEURONECTES, ICHTHYOLOGY *Index*.

FLUKE *Worm*. See FASCIOLA, HELMINTHOLOGY *Index*.

FLUKE *of an Anchor*, that part of it which fastens in the ground. See ANCHOR.

FLUMMERY, a wholesome sort of jelly made of oatmeal.

The manner of preparing it is as follows. Put three large handfuls of finely ground oatmeal to steep, for 24 hours, in two quarts of fair water: then pour off the clear water, and put two quarts of fresh water to it; strain it through a fine hair sieve, putting in two spoonfuls of orange flower water, and a spoonful of sugar: boil it till it is as thick as a hasty pudding, stirring it continually while it is boiling, that it may be very smooth.

FLUOR, in *Physics*, a fluid; or, more properly, the state of a body that was before hard or solid, but is now reduced by fusion or fire into a state of fluidity.

FLUOR *Acid*. See FLUORIC *Acid*, CHEMISTRY *Index*.

FLUOR *Albus*, a flux incident to women, commonly known by the name of *whites*. See MEDICINE *Index*.

FLUOR *Spar*, or *Blue John*, called also fluxing spars, vitrescent or glass spars, are minerals composed of calcareous earth united with fluoric acid. See MINERALOGY *Index*.

FLUSHING, a handsome, strong, and considerable town of the United Provinces, in Zealand, and in the island of Walcheren, with a very good harbour, and a great foreign trade. It was put into the hands of Queen Elizabeth for a pledge of their fidelity, and as a security for the money she advanced. It is one of the three places which Charles V. advised Philip II. to preserve with care. E. Long. 3. 32. N. Lat. 51. 26.

FLUTE, an instrument of music, the simplest of all those of the wind kind. It is played on by blowing it with the mouth; and the tones or notes are changed by stopping and opening the holes disposed for that purpose along its side.

This is a very ancient instrument. It was at first called the flute *à bec*, from *bec* an old Gaulish word signifying the beak of a bird or fowl, but more especially of a cock; the term *flute à bec* must therefore signify the *beaked flute*; which appears very proper, on comparing it with the traverse or German flute. The word *flute* is derived from *fluta*, the Latin for a lamprey or small eel taken in the Sicilian seas, having seven holes immediately below the gills on each side, the precise number of those in the front of the flute.

By Mersennus this instrument is called the *fistula dulcis, seu Anglica*; the lowest note, according to him, for the treble flute, is *C fa ut*, and the compass of the instrument 15 notes. There is, however, a flute known by the name of the *concert flute*, the lowest note of which is F. Indeed, ever since the introduction of the flute into concerts, the lowest note of the instrument, of what size soever it is, has been called F; when in truth its pitch is determinable only by its correspondence in respect of acuteness or gravity with one or other of the chords in the *scala maxima* or great system.

Besides the true concert flute, others of a less size were soon introduced into concerts of violins; in which case the method was to write the flute part in a key correspondent

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correspondent to its pitch. This practice was introduced in 1710 by one Woodcock, a celebrated performer on this instrument, and William Babell organist of the church of All-hallows, Bread Street, London. They failed, however, in procuring for the flute a reception into concerts of various instruments; for which reason, one Thomas Stanesby, a very curious maker of flutes and other instruments of the like kind, about the year 1732, adverting to the scalc of Mersennus, in which the lowest note was C, invented what he called the *new system;* in which, by making the flute of such a size as to be a fifth above concert pitch, the lowest note became *C sol fa ut.* By this contrivance the necessity of transposing the flute part was taken away; for a flute of this size, adjusted to the system above mentioned, became an octave to the violin. To further this invention of Stanesby's, one Lewis Merci, an excellent performer on the flute, published, about the year 1735, six solos for this instrument, three of which are said to be accommodated to Mr Stanesby's new system; but the German flute was now become a favourite instrument, and Stanesby's ingenuity failed of its effect.—One great objection indeed lies against this instrument, which, however, equally affects all perforated pipes; namely, that they are never perfectly in tune, or cannot be made to play all their notes with equal cxactness. The utmost that the makers of them can do is to tune them to some one key; as the hautboy to C, the German flute to D, and the English flute to F; and to effect this truly, is a matter of no small difficulty. The English flutes made by the younger Stanesby came the nearest of any to perfection; but those of Bressan, though excellent in their tone, are all too flat in the upper octave. For these reasons some are induced to think, that the utmost degree of proficiency on any of those instruments is not worth the labour of attaining it.

German FLUTE, is an instrument entirely different from the common flute. It is not, like that, put into the mouth to be played; but the end is stopt with a tompion or plug, and the lower lip is applied to a hole about two inches and a half or three inches distant from the end. This instrument is usually about a foot and a half long; rather bigger at the upper end than the lower; and perforated with holes, besides that for the mouth, the lowest of which is stopped and opened by the little finger's pressing on a brass or sometimes a silver key, like those in hautboys, bassoons, &c. Its sound is exceeding sweet and agreeable; and serves as a treble in a concert.

FLUTE, or FLUYT, is a kind of long vessel, with flat ribs or floor timbers, round behind, and swelled in the middle; serving chiefly for the carrying of provisions in fleets or squadrons of ships; though it is often used in merchandise. The word *flute* taken for a sort of boat or vessel, is derived, according to Borel, from the ancient *flotte*, a little boat. In the verbal process of the miracles of St Catharine of Sweden, in the 12th century, we read *Unus equum suum una cum mercibus magni ponderis introduxit super instrumentum de lignis fabricatum, vulgariter dictum fluta.* Upon which the Bollandists observe, that in some copies it is read *flotta*, an instrument called by the Latins *ratis;* and that the word *flutta* or *flotta* arose from *flotten* or *vlotten*, "to float."

I

Flux.

FLUTES, or FLUTINGS, in *Architecture*, are perpendicular channels or cavities cut along the shaft of a column or pilaster. They are supposed to have been first introduced in imitation of the plaits of women's robes; and are therefore called by the Latins *striges* and *rugæ.* The French call them *cannelures*, as being excavations; and we, *flutes* or *flutings*, as bearing some resemblance to the musical instrument so called. They are chiefly affected in the Ionic order, in which they had their first rise; though they are also used in all the richer orders, as the Corinthian and Composite; but rarely in the Doric, and scarce ever in the Tuscan.

FLUX, in *Medicine*, an extraordinary issue or evacuation of some humour. Fluxes are various, and variously denominated, according to their seats or the humours thus voided; as a flux of the belly, uterine flux, hepatic flux, salival flux, &c. The flux of the belly is of four kinds, which have each their respective denominations, viz. the *lientery*, or *fluxus lientericus;* the *cæliac*, or *fluxus chylosus;* the *diarrhœa;* and the *dysentery*, or *bloody flux.* See MEDICINE *Index.*

FLUX, in *Hydrography*, a regular periodical motion of the sea, happening twice in 24 hours; wherein the water is raised and driven violently against the shores. The flux or flow is one of the motions of the tide; the other, whereby the water sinks and retires, is called the reflux or ebb. There is also a kind of rest or cessation of about half an hour between the flux and reflux; during which time the water is at its greatest height, called *high-water.* The flux is made by the motion of the water of the sea from the equator towards the poles; which, in its progress, striking against the coasts in its way, and meeting with opposition from them, swells, and where it can find passage, as in flats, rivers, &c. rises up and runs into the land. This motion follows, in some measure, the course of the moon; as it loses or comes later every day by about three quarters of an hour, or more precisely by 48 minutes; and by so much is the motion of the moon slower than that of the sun. It is always highest and greatest in full moons, particularly those of the equinoxes. In some parts, as at Mount St Michael, it rises 80 or 90 feet, though in the open sea it never rises above a foot or two; and in some places, as about the Morea, there is no flux at all. It runs up some rivers above 120 miles. Up the river Thames it only goes 80, viz. near to Kingston in Surry. Above London bridge the water flows four hours and ebbs eight; and below the bridge, flows five hours and ebbs seven.

FLUX, in *Metallurgy*, is sometimes used synonymously with *fusion.* For instance, an ore, or other matter, is said to be in a liquid flux, when it is completely fused.

But the word *flux* is generally used to signify certain saline matters, which facilitate the fusion of ores, and other matters which are difficultly fusible in essays and reductions of ores; such are alkalies, nitre, borax, tartar, and common salt. But the word *flux* is more particularly applied to mixtures of different proportions of only nitre and tartar; and these fluxes are called by particular names, according to the proportions of these ingredients, as in the following articles.

White FLUX, is made with equal parts of nitre and of tartar detonated together, by which they are alkalized.

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lized. The residuum of this detonation is an alkali composed of the alkalies of the nitre and of the tartar, both which are absolutely of the same nature. As the proportion of nitre in this mixture is more than is sufficient to consume entirely all the inflammable matter of the tartar, the alkali remaining after the detonation is perfectly white, and is therefore called *white flux;* and as this alkali is made very quickly, it is also called *extemporaneous alkali.* When a small quantity only of white flux is made, as a few ounces for instance, some nitre always remains undecomposed, and a little of the inflammable principle of the tartar, which gives a red or even a black colour to some part of the flux; but this does not happen when a large quantity of white flux is made; because then the heat is much greater. This small quantity of undecomposed nitre and tartar which remains in white flux is not hurtful in most of the metallic fusions in which this flux is employed: but if the flux be required perfectly pure, it might easily be disengaged from those extraneous matters by a long and strong calcination, without fusion.

Crude Flux. By crude flux is meant the mixture of nitre and tartar in any proportions, without detonation. Thus the mixture of equal parts of the two salts used in the preparation of the white flux, or the mixture of one part of nitre and two parts of tartar for the preparation of the black flux, are each of them a crude flux before detonation. It has also been called *white flux*, from its colour; but this might occasion it to be confounded with the white flux above described. The name, therefore, of crude flux is more convenient.

Crude flux is detonated and alkalized during the reductions and fusions in which it is employed; and is then changed into white or black flux, according to the proportions of which it is composed. This detonation produces good effects in these fusions and reductions, if the swelling and extravasation of the detonating matters be guarded against. Accordingly, crude flux may be employed successfully in many operations; as, for instance, in the ordinary operation for procuring the regulus of antimony.

Black Flux. Black flux is produced from the mixture of two parts of tartar and one part of nitre detonated together. As the quantity of nitre which enters into the composition of this flux is not sufficient to consume all the inflammable matters of the tartar, the alkali which remains after the detonation contains much black matter, of the nature of coal, and is therefore called *black flux.*

FLUXIONS.

INTRODUCTION.

Introduction.

THE branch of mathematical analysis which is called in this country the *Method of Fluxions*, but on the continent the *Differential* and *Integral Calculi*, was invented near the end of the 17th century; and *Sir Isaac Newton*, and *Mr Leibnitz*, two of the greatest philosophers of that age, have both claimed the discovery.

It will appear very possible that two such men should both fall upon this method of calculation nearly about the same time, if it be considered, that from the beginning of the 17th century its principles were gradually coming into view, in consequence of the united labours and discoveries of a number of mathematicians, such as *Napier*, *Cavallerius*, *Roberval*, *Fermat*, *Barrow*, *Wallis*, and others. And considering the number of men of the first abilities engaged at that time in the study of mathematics, we may reasonably suppose, that the fluxional, or differential calculus would very soon have been found according to the ordinary progress of human knowledge, even although a *Newton*, or a *Leibnitz*, had not by the force of superior genus anticipated perhaps by a few years that event. The first intimation that was given of the discovery of the calculus was in the year 1669, when, through the intervention of *Dr Barrow*, a correspondence was begun between *Sir Isaac Newton* (then *Mr Newton*), and *Mr Collins*, one of the secretaries to the Royal Society. *Dr Barrow* communicated to the latter a paper by *Newton*, which had for its title, *De analysi per æquationes numero terminorum infinitas.* In this paper, besides shewing how to resolve equations by approximation, *Newton* teaches how to square curves, not only when the expression for the ordinate in terms of the abscissa is a rational quantity, but also when it involves radical quantities, by first resolving these into an infinite series of rational terms by means of the binomial theorem, a thing which had never before been done. *Newton* in this paper gives some rather obscure indications of the nature of his calculus, which however serve to shew, beyond all doubt, that he was then in possession of it; and indeed there is good reason to believe that he knew it as early as the year 1665, or even sooner.

These analytical discoveries of *Newton* were immediately circulated among mathematicians both in this country and abroad, by *Dr Barrow*, and by *Collins* and *Oldenburg*, the two secretaries to the Royal Society.

About the end of the year 1672, *Newton* communicated to *Collins*, by letter, a method of drawing tangents to curve lines, illustrated by an example, from which it again plainly appears, that he now possessed his method of fluxions.

In the course of the following year, *Leibnitz* came to London, and communicated to several members of the Royal Society, some researches relating to the theory of differences. It was however shewn to him, that this subject had been previously treated by *Mouton*, an astronomer of Lyons; upon this *Leibnitz* directed his attention to the doctrine of series, which was now considerably advanced, in consequence of the discoveries of the English mathematicians.

The first direct communication that passed between *Newton* and *Leibnitz*, was by a letter, which the former addressed to *Oldenburg*, about the middle of the year 1676. In the beginning of this letter, which was intended to be shewn to *Leibnitz*, *Newton* speaks of him with much respect. The letter itself chiefly refers to the

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the theory of infinite series. In a second letter, written also with a view to its being communicated to *Leibnitz*, *Newton*, after bestowing deserved commendation on him, proceeds to explain the steps by which he was led to the discovery of the binomial theorem. He afterwards, among other things, delivers several theorems which have the method of fluxions for their basis; but he does not give their demonstrations, and only observes, that they depend on the solution of a general problem, the enunciation of which he conceals under an anagram of transposed letters, but the meaning of it is this: *An equation being given containing any number of flowing quantities, to find their fluxions; and the contrary*. This letter affords another proof that *Newton* was now in full possession of his calculus.

In the end of June 1677, *Leibnitz* sent to *Oldenburg*, for the purpose of being communicated to *Newton*, a letter containing the first essays of his *Differential Calculus*. The death of *Oldenburg*, which happened soon after, put an end to the correspondence, and in the year 1684, *Leibnitz* published his method, in the *Leipsic Acts* for the month of October 1684. The title of the memoir which contained it was, *Nova methodus pro* maximis et minimis, *itemque tangentibus, quæ nec fractas, nec irrationales quantitates moratur, et singulare pro illis calculi genus*. Thus, in whatever way *Leibnitz* came by his calculus, whether he discovered it solely by the force of his own genius, or founded it on the method of fluxions, previously invented by *Newton*, both of which hypotheses are possible, his method was certainly published before *Newton's*, which, except what transpired in consequence of the circulation of his letters and manuscripts, became only known to the world in general for the first time, by the publication of the *Principia* in the end of the year 1686.

It seems at first to have been allowed, that *Leibnitz* had invented his calculus, without having any previous knowledge of what had been done by *Newton*; for in the first edition of the *Principia*, *Newton* says, "In the course of a correspondence which ten years ago I carried on with the very learned geometrician *Mr Leibnitz*, having intimated to him that I possessed a method of determining *maxima* and *minima*, of drawing tangents, and resolving such problems, not only when the equations were rational, but also when they were irrational; and having concealed this method, by transposing the letters of the following sentence—*An equation being given, containing any number of flowing quantities, to find their fluxions; and the contrary*; this celebrated man answered that he had found a similar method, which he communicated to me, and which differs from mine, only in the enunciation, and in the notation." To this, in the edition of 1714 is added, "and in the manner of conceiving the quantities to be generated." *

* Principia, lib. ii. lem. 2. schol.

There is reason to suppose that *Leibnitz* might have continued to enjoy undisturbed the honour of being considered as one of the inventors of the fluxional, or differential calculus, if he had not manifested a disposition to attribute the invention too exclusively to himself. This called forth some remarks respecting the priority of *Newton's* claim to the discovery. In particular *M. Facio* asserted, in a treatise *on the Line of swiftest descent*, published in 1699, "that he was obliged to own *Newton* as the *first inventor* of the differential calculus, and the first by many years; and that he left the world to judge whether *Leibnitz*, the *second inventor* had taken any thing from him."

On the other hand, when *Newton's* treatise on the quadrature of curves, and on the enumeration of lines of the third order was published, which was in 1704, the Leipsic journalists insinuated, in a very illiberal account which they gave of the work, that *Leibnitz* was the first inventor, and that *Newton* had taken his method from *Leibnitz's*, substituting fluxions for differences.

In consequence of this attack on *Newton*, *Dr John Keill* asserted, in the Philosophical Transactions for 1708, that *Newton* was beyond a doubt the first inventor of the arithmetic of fluxions, and that the same arithmetic, having its name and notation changed, was afterwards published by *Mr Leibnitz* in the Leipsic Acts. In answer to this, *Leibnitz* replied, in a letter to *Hans Sloane*, secretary to the Royal Society, that no one knew better than *Newton* himself, that the charge against him implied in *Keill's* assertion was false; and he required *Keill* to retract what he had said. To this request however *Keill* would by no means accede; but on the contrary, he wrote a long letter to the secretary of the Royal Society, in which he endeavoured to prove, not only that *Newton* had preceded *Leibnitz* in the invention, but that he had given to the latter such indications of the nature of his calculus, as made it easy for him to fall upon the same. This letter was sent to *Leibnitz*, who replied, that *Keill*, although learned, was too young a man to be fit to judge of what had passed between him and *Newton*, and he requested the Royal Society to put a stop to *Keill's* clamours.

The Royal Society being thus appealed to as a judge, appointed a committee to examine all the old letters, papers, and documents, which had passed among the several mathematicians, relating to the question. The judgment of the committee was to the following effect. "That *Mr Leibnitz* was in London in 1673, and went thence to Paris, where he kept a correspondence with *Mr Collins*, by meams of *Mr Oldenburg*, till about September 1676, and then returned by London and Amsterdam, to Hanover; and that *Mr Collins* was very free in communicating to able mathematicians what he had received from *Newton*. That it did not appear, that *Mr Leibnitz* knew any thing of the differential calculus before his letter of the 21st of June 1677, which was a year after a copy of *Newton's* letter of the 10th of December 1672 had been sent to Paris, to be communicated to him, and above four years after *Mr Collins* began to communicate that letter to his correspondents; in which letter, the method of fluxions was sufficiently described to any intelligent person. That *Newton* was in possession of his calculus before the year 1669, and that those who had reputed *Leibnitz* the first inventor, knew little or nothing of his correspondence with *Mr Collins*, and *Mr Oldenburg*, long before, nor of *Newton's* having that method above 15 years before *Mr Leibnitz* began to publish it in the Leipsic Acts. That for these reasons, they reckoned *Newton* the first inventor, and were of opinion, that *Mr Keill* in asserting the same had been in no ways injurious to *Mr Leibnitz*."

It is deserving of remark, that the committee delivered no opinion upon the advantage which *Leibnitz* was accused of having taken of the hints furnished to him, in

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The *Commercium Epistolicum* having appeared, *Leibnitz* expressed great dissatisfaction, and threatened to reply in such a manner as to confound his adversaries. There seems no reason however to suppose, that any thing he could have said, would have affected *Newton's* claim to the honour of being the first inventor; for on this point there cannot be any doubt. With respect, however, to the other question, whether *Leibnitz* took his calculus from *Newton*, or found it himself, it is impossible to decide with such certainty. *Mr Montucla*, in his History of Mathematics,* says, "There are only three places of the *Commercium Epistolicum*, which treat of the principles of fluxions in so clear a way, as to prove that *Newton* had found it before *Leibnitz*, but too obscurely, it seems, to take from the latter the merit of the discovery. One of these is in a letter from *Newton* to *Oldenburg*, who had signified to him, that *Slusius* and *Gregory* had each found a very simple method of drawing tangents. *Newton* replied, that he conjectured what the nature of that method was; and he gave an example of it, which shews it to be in effect the same thing as those geometricians had found. He adds, that it is only a particular case, or rather a corollary to a method much more general, which, without a laborious calculation, applies to the finding of tangents to all sorts of curves, geometrical or mechanical, and that without being obliged to free the equation from radicals. He repeats the same thing without explaining himself farther, in another letter, and he conceals the principle of the method under transposed letters. The only place where *Newton* has allowed any thing of his method to transpire, is in his *Analysis per æquationes numero terminas infinitas*. He here discloses, in a very concise and obscure manner, his principle of fluxions, but there is no certainty of *Leibnitz's* having seen this essay. His opponents have never asserted that it was communicated to him by letter, and they have gone no farther than to suspect, that he had obtained a knowledge of it in the interview which he had with *Collins*, upon his second journey to London. Indeed, this suspicion is not entirely destitute of probability, for *Leibnitz* admitted, that in this interview, he saw a part of the *Epistolary Correspondence* of *Collins*. However I think it would be rash to pronounce upon this circumstance. If *Leibnitz* had confined himself to a few essays of his new calculus, there might have been some foundation for that suspicion; but the numerous pieces he inserted in the Leipsic Acts, prove the calculus to have received such improvements from him, that probably he owed the invention of it to his genius, and to the efforts he made to discover a method, which put *Newton* in possession of so many beautiful truths. This is so much the more likely, as, from the method of tangents discovered by *Dr Barrow*, the transition to the differential calculus was easy, nor was the step too great for such a genius as that with which *Leibnitz* appears to have been endowed." Such is the opinion of *Montucla*, who being a foreigner, cannot be supposed have been too partial towards *Newton*, an Englishman. The British mathematicians have hitherto, with few exceptions, entertained an opinion still more decidedly in favour of the claims of their celebrated countryman.

* Vol. ii. p. 381.

It has been said that *Newton* took no share in the controversy; this however seems not to have been exactly the case, for besides suppressing in the third edition of his *Principia* (printed in 1726) the passage we have already quoted, which seems to admit that *Leibnitz* invented his calculus for himself, he is known to have written the notes which accompany the edition of the *Commercium Epistolicum*, printed in 1722. *Leibnitz* had also begun to prepare a *Commercium Epistolicum*, but he died before it was completed.

Besides the disputes that have happened respecting the inventor of the method of fluxions, the accuracy of the method itself has been the subject of controversy, both in Britain and on the continent. The differential calculus was attacked abroad by *Nieuwentiit*, a writer of little or no reputation as a mathematician, and by *Rolle*, who was an expert algebraist, and an indefatigable calculator, but rash, and too confident of the justness of his own opinions, and jealous of the inventions of others. To the first of these writers *Leibnitz* himself replied, and afterwards *Bernoulli* and *Herman;* the attack from *Rolle* was successfully repelled by *Varignon*, who was as zealous and intelligent, as his adversary was warm and impetuous.

The very concise manner in which the great inventor of the method of fluxions thought proper to explain its principles, gave occasion to the celebrated *Dr Berkley* bishop of Cloyne to call in question, not only the logical accuracy of the reasoning employed to establish the theory of fluxions, but also the faith of mathematicians in general, in regard to the truths of religion. The bishop commenced the controversy first in a small work entitled *The Minute Philosopher;* but his principal attack made its appearance in 1734, under the title of "*The Analyst*, or *A Discourse addressed to an Infidel Mathematician*," (understood to be Dr Halley) "*wherein it is examined whether the object, principles, and inferences of the modern Analysis are more distinctly conceived than religious mysteries and points of faith.*" One of the best answers which was made to this work came from the pen of *Benjamin Robins*, and is entitled, "*A discourse concerning the nature and certainty of Sir Isaac Newton's methods of fluxions, and of prime and ultimate ratios.*" Other mathematicians likewise attempted to defend *Newton*, and the method of fluxions, against the very cogent and well-directed arguments of the bishop; but the most satisfactory way of removing all objections to the method, was to abandon those obscure and inaccurate modes of expression, of which *Berkley* had, not without some reason, complained, and to substitute in their place, others more intelligible, and more consonant to the common methods of mathematical reasoning. This was accordingly done by the celebrated *Maclaurin*, who, in the year 1742, published his *Treatise of Fluxions*, a work which, although in some respects rather diffuse, placed the principles of the method beyond controversy, by establishing them on the firm basis of geometrical demonstration.

It would extend this introduction to too great a length were we to enter into a detailed account of the various improvements which the calculus has received

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from its first invention to the present time. We shall just briefly observe, that among those who contributed the first and the most effectually to its improvement, we may reckon *Newton* and *Leibnitz* themselves, the two illustrious rivals for the honour of its discovery; these were followed by the two brothers *James* and *John Bernoulli*, by the *Marquis de L'Hopital*, and many other foreign mathematicians; and in this country we may reckon *Craig*, *Cheyne*, *Cotes*, *Taylor*, and *De Moivre*, as among the earliest of its improvers. It is to *Cotes* in particular that we are indebted for the discovery of the method of finding the fluents of certain rational fractions, a discovery which was extended by *De Moivre*, so as to form one of the most beautiful and complete branches of the theory of fluxions.

Besides innumerable memoirs on particular branches of the fluxional calculus, which are to be found in academical collections, many distinct treatises have been written on the subject. Some of the most valuable of these are as follow. *The Method of Fluxions and Infinite Series*, by *Sir Isaac Newton*. This work was written in Latin, but was not published till the year 1736, when it was translated into English, and given to the world, along with a comment, by *Mr Colson*. *Harmonia Mensurarum*, by *Cotes*, a most valuable and original work, published in 1716. *A Treatise on Fluxions, in two books*, by *Mauclaurin*, published in 1742. Many parts of the writings of the celebrated *Euler* have a reference to the theory of fluxions, or the differential and integral calculi. He has, however, three works in particular that relate to that subject; the first is his *Introductio in Analysin Infinitorum*, the second his *Institutiones Calculi Differentialis*, and the third his *Institutiones Calculi Integralis*.

There is a work on this subject which deserves to be particularly mentioned, both on account of its excellence, and the singular circumstance of its being composed by a lady. Its title is, *Analytical Institutions, in four books, originally written in Italian, by Donna Maria Gaetana Agnesi*. This lady was Professor of Mathematics and Philosophy in the University of Bologna; her work was originally published in 1748, and has been styled by her countryman *Frisi*, *Opus nitidissimum, ingeniosissimum, et certe maximum quod adhuc ex fœminæ alicujus calamo prodierit*. A part of this work has been published in the French language by Bossut. An English translation was prepared for the press many years ago by the late *Professor Colson*; it remained, however, unpublished, and might still have continued so, but for the liberality of *Baron Maseres*, who, after satisfying some pecuniary claims upon the manuscript, caused it, in 1801, to be published (we believe at his own expence), in two volumes quarto. *The Doctrine and Application of Fluxions, by Thomas Simpson*, is a work deservedly in high estimation. *The Doctrine of Fluxions, by Emerson*, is also very generally read by the British mathematicians. We are sorry, however, to observe, that there is no work in the English language that exhibits a complete view of the theory of fluxions, with all the improvements that have been made upon it to the present time. We cannot at present acquire any tolerable acquaintance with the subject, without consulting the writings of the foreign mathematicians. There are several excellent works in the French language; we may mention in particular a *Traité de Calcul Differentiel et de Calcul Integral*, by *Cousin*, in 2 vols. 4to.; another by *Bossut*, in 2 vols. 8vo.; and another by *La Croix*, in 3 vols. 4to. This last deserves particular notice, as the author intended it to comprehend the substance of the various valuable treatises by *Euler*, as well as of the most important academical memoirs that relate to this subject. The author has also published an abridgment of his work, in one volume octavo. *Principiorum Calculi Differentialis et Integralis*, by *L'Huilier*, published in 1795, contains a very clear exposition of the principles of the calculus. The writings of our countrymen *Landen* and *Waring*, and of these foreign mathematicians *La Grange*, *Le Gendre*, *La Place*, and many others, abound with improvements in the calculus. Having given this sketch of the history of this very important branch of mathematical science, we proceed to explain its principles.

PART I. THE DIRECT METHOD OF FLUXIONS.

SECT. I. *Principles and Definitions.*

1. In the application of algebra to the theory of curve lines, we find that some of the quantities which are the subject of consideration, may be conceived as having always the same magnitude, as the parameter of a parabola, and the axes of an ellipse or hyperbola; while others again are indefinite in respect of magnitude, and may have any number of particular values, such are the co-ordinates at any point in a curve line. This difference in the nature of the quantities which are compared together, has equally place in various other theories, both in pure and mixed mathematics, and it naturally suggests the division of all quantities whatever into two kinds, namely, such as are constant, and such as are variable.

2. A *constant* quantity is that which retains always the same magnitude, however other quantities with which it is connected may be supposed to change; and a *variable* quantity is that which is indefinite in respect of magnitude, or which may be supposed to change its value. Thus, in the arithmetic of sines, the radius is a constant quantity, while the co-sine, sine, tangent, &c. of an arch, also the arch itself, are variable quantities; and in the conic sections the axes and the parameters of the axes are constant quantities, and any abscissa and its corresponding ordinate are variable quantities.

Constant quantities are usually denoted by the first letters of the alphabet a, b, c, &c. and variable quantities by the last letters z, y, x, &c.

3. Any expression of calculation, containing a variable quantity, along with other constant quantities, is called a *Function* of that variable quantity. Thus, supposing x to be variable, and the other quantities constant,

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any one of these expressions $a x^n$, $\frac{a+b x^m}{c x^n + d x^p}$, a^x, $log. x$, $cos. x$, $sin. x$, &c. is a function of x; and in any such equation as $y=a x+b x+b x^2+c x^3$, the quantity y is called a function of x. Even although the variable quantities x and y, should not be separated as in the last example, but should be related to each other as in the following

$$a x^2 y+b x y^2+y^3=0,$$

as, setting aside the consideration of the constant quantities, the value of y depends on that of x, and on the contrary the value of x depends upon that of y, the quantity y is said to be a function of x, and on the other hand x is said to be a function of y.

4. If a variable quantity be supposed to change its value, then a corresponding change will take place in the value of any function of that quantity. Let us examine the nature of this change in the magnitude of a function.

First, let us suppose that, x denoting any variable quantity, the function to be considered is any integer power of that quantity, as x^2, or x^3, or x^4, &c.; then, x being supposed to be increased by an indefinite quantity h, and thus to become $x+h$, the function will change its value; if it be x^2 it will become $(x+h)^2$, or

$$x^2+2 x h+h^2;$$

and if it be x^3 it will become $(x+h)^3$ or

$$x^3+3x^2h+3 x h^2+h^3;$$

and if it be x^4 it will become $(x+h)^4$, or

$$x^4+4 x^3 h+6 x^2 h^2+4 x h^3+h^4;$$

and so on, for other integer powers.

If we compare the new value of the function in each of these cases with its former value, it will immediately appear, that the new value may be resolved into two parts, one of which is the original value of the function, and, therefore, the other is the increment which the function has received, in consequence of the change in the value of the variable quantity x. Thus, the function being x^2, we have found its new value to be $x^2+2x h+h^2$, of which expression, the first term x^2 is the original value of the function; therefore the other part of the expression viz. $2 x h+h^2$ is its increment. In like manner the expression $x^3+3 x^2 h+3 x h^2+h^3$, which is the new value of the function x^3, may be resolved into x^3, the original value of the function, and $3 x^2 h+3 x h^2+h^3$ its increment; and $x^4+4 x^3 h+6 x^2 h^2+4 x h^3+h^4$, the new value of the function x^4, may be resolved into x^4, the function itself, and $4 x^3 h+6 x^2 h^2+4 x h^3+h^4$ its increment.

5. Having seen that, by conceiving the variable quantity x to receive the indefinite increment h, the functions x^2, x^3, x^4 receive the increments

$$2 x h+h^2,$$
$$3 x^2 h+3 x h^2+h^3,$$
$$4 x^3 h+6 x^2 h^2+4 x h^3+h^4,$$

respectively, we next observe that each increment is expressed by a series, the first term of which is the first power of the indefinite quantity h multiplied by some function of the variable quantity x as a co-efficient. The second term of the series consists of the second power of h, multiplied also by a function of x as a coefficient; and, in like manner, the third and following terms are composed of the third and higher powers of h (the exponents forming the arithmetical series 1, 2, 3, 4, &c.) each multiplied by a function of x, as a coefficient; and it appears, that the particular form of the function which constitutes the coefficient of any assigned term of the series depends entirely upon the particular form of the original function. Thus, when the original function is x^2, the function which is the coefficient of the first term is $2 x$; when the original function is x^3, the co-efficient of the first term is $3 x^2$; when the original function is x^4, the coefficient of the first term is $4 x^3$, and so on. It also appears that the functions of x, which are the coefficients of the powers of h, are composed only of the variable quantity x and given quantities, so that they are entirely independent of the indefinite increment h.

6. These observations may be extended to a function that is any power whatever of a variable quantity, by the application of the binomial theorem. Let x be supposed to become $x+h$, then x^n will become $(x+h)^n$; but by the binomial theorem, (see ALGEBRA, Sect. xvii.) $(x+h)^n$ when expanded into a series, is

$$x^n+\frac{n}{1}x^{n-1}h+\frac{n(n-1)}{1 \cdot 2}x^{n-2} h^2$$
$$+\frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3} x^{n-3} h^3+\&c.$$

where it appears, that the first term of the series is the original value of the function, and the following terms are the first, second, and following powers of the increment h, each multiplied by a new function of x, that is independent of the increment. Let us denote the functions $n x^{n-1}$, $\frac{n(n-1)}{1 \cdot 2}x^{n-2}$, and $\frac{n(n-1)(n-2)}{1 \cdot 2 \cdot 3} x^{n-3}$, &c. by p, q, r, &c. respectively, and it is to be observed that, in the present case, as well as in the case of any other function of x we may hereafter consider, by the letters p, q, r, &c. or the same letters with accents over them, or lastly the capital letters P, Q, R, &c. we do not mean to denote functions of x of any particular form, but functions of x in general, that consist only of x and given quantities. This being kept in view, it appears that the variable quantity x being supposed to change its value, and to become $x+h$, the function x^n changes its value, so as to become

$$x^n+p h+q h^2+r h^3+s h^4+, \&c.$$

a series, the terms of which have the properties already explained in the two preceding sections.

7. Every rational and integer function of a variable quantity x is necessarily of this form

$$Ax^\alpha+Bx^\beta+C x^\gamma+\&c.$$

where A, B, C, &c, and α, β, γ, are supposed to denote constant quantities.

Let us examine what is the form which the function assumes when the variable quantity x changes its value to to $x+h$; and to avoid complicated expressions, let us suppose the function to consist of these two terms $A x^\alpha + B x^\beta$. We have already found in last section that x being supposed to become $x+h$, x^α will become

$$x^\alpha + p h + q h^2 + r h^3 + \&c.$$

where p, q, r, &c. denote functions of x independent of h, as explained in the last section, and consequently $A x^\alpha$ will become

$$A x^\alpha + A p h + A q h^2 + A r h^3 + \&c.$$

In like manner $B x^\beta$ will become

$$B x^\beta + B p' h + B q' h^2 + B r' h^3 + \&c.$$

p', q', r', &c. denoting also functions of x independent of h; therefore, taking the sum of the two series, it appears that, supposing x to change its value, and to become $x+h$, the function $A x^\alpha + B x^\beta$ becomes

$$A x^\alpha + B x^\beta + (A p + B p') h + (A q + B q') h^2 + (A r + B r') h^3 + \&c.$$

now p and p' being functions of x, $A p + B p'$ will also be a function of x, and may be denoted more simply by P, and for the same reason $A q + B q'$, $A r + B r'$, &c. which are functions of x, may be denoted by Q, R, &c.

thus the expression for the new value of $A x^\alpha + B x^\beta$ is

$$A x^\alpha + B x^\beta + P h + Q h^2 + R h^3 + \&c.$$

a series, the form and properties of which are in all respects analogous to those of the series that expresses the new value of the function x^n; and although we have supposed the function to consist of but two terms, yet it is obvious, that whatever be the number of terms, still the form of the series and its properties will be the same; that is, it will consist of two parts, one of which is independent of h, and is the original value of the function, and the other is a series, the terms of which are the successive powers of the increment h, each multiplied by a function of the variable quantity x as a co-efficient This conclusion may be expressed in symbols concisely thus. Let u denote any rational and integer function of a variable quantity x, let x be conceived to change its magnitude, and to become $x+h$, and let u' denote the new value which the function acquires in consequence of the change in the value of x, then

$$u' = u + p h + q h^2 + r h^3 +, \&c.$$

where p, q, r, &c. denote functions of x as already stated.

8. Suppose next the function of x to be of this form:

$$(A x^\alpha + B x^\beta + C x^\gamma + \&c.)^n,$$

that is, suppose it to be the nth power of a polynomial, consisting of any number of terms whatever. Let the expression between the parenthesis be denoted by v, then we are to consider the function v^n. Now when x becomes $x+h$, we have already found that v becomes

$$v + p h + q h^2 + r h^3 + \&c.$$

therefore v^n will become

$$(v + p h + q h^2 + r h^3 + \&c.)^n,$$

or, putting $p h + q h^2 + r h^3 + \&c. = M$,

v^n will become $(v+M)^n$,

and this expression when expanded into a series by the binomial theorem is

$$v^n + a v^{n-1} M + b v^{n-2} M^2 + c v^{n-3} M^3 + \&c.$$

where a, b, c, &c. express numbers.

Now from the form of the series denoted by M, it is manifest that its square, cube, or any power of it whatever, will be a series proceeding by the powers of h, and having for the coefficients of its terms certain combinations of the quantities p, q, r, &c. which being functions of x, any combinations of them will also be functions of x. Therefore, each of the terms of the above series, expressing the developement of $(v+M)^n$, excepting the first term v^n, will itself be a series proceeding by the powers of h, and having its terms multiplied by functions of x, and consequently their sum will be a series of the same nature. Let us as before denote the functions of x, which are the coefficients of the successive powers of h by P, Q, R, &c. and we shall have upon the whole

$$(v + p h + q h^2 + r h^3 + \&c.)^n$$

expressed by a series of this form

$$v^n + P h + Q h^2 + R h^3 + \&c.$$

therefore, putting the single letter u for the function u^n, or for

$$(A x^\alpha + B x^\beta + C x^\gamma + \&c.)^n$$

and u' for the new value which u acquires by x changing its value to $x+h$,

$$u' = u + P h + Q h^2 + R h^3 + \&c.$$

a series of the same nature as before.

9. Let us now consider a fractional function of x, and let us suppose it to be

$$\frac{A' x^{\alpha'} + B' x^{\beta'} + C' x^{\gamma'} + \&c.}{A x^\alpha + B x^\beta + C x^\gamma + \&c.}$$

Where A′, A, B′, B, &c. also α', α, β', β, &c. denote constant quantities. Let v denote the numerator of the fraction, and w its denominator, then the function is

$$\frac{v}{w}, \text{ or } v\, w^{-1},$$

now when x becomes $x+h$, v becomes

$$v + p h + q h^2 + r h^3 + \&c.$$

and w^{-1} becomes

$$w^{-1} + p' h + q' h^2 + r' h^3 + \&c.$$

and consequently $v\,w^{-1}$ becomes

$$(v + p h + q h^2 + \&c.)(w^{-1} + p' h + q' h^2 + \&c.)$$

and

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and the product of these two factors, by actual multiplication is

$$\left.\begin{matrix} v\,w^{-1} + v\,p' \\ + w^{-1}\,p \end{matrix}\right\} h \quad \left.\begin{matrix} + v\,q' \\ + p\,p' \\ + w^{-1}\,q \end{matrix}\right\} h^2 + \text{\&c.}$$

Now, here as before, it appears that the coefficients of the powers of h are functions of x, therefore, denoting these functions by P, Q, R, &c. and observing that $v\,w^{-1}$ is $\frac{v}{w}$, we have the new value of $\frac{v}{w}$ expressed by by the series

$$\frac{v}{w} + \mathrm{P}\,h + \mathrm{Q}\,h^2 + \mathrm{R}\,h^3 + \text{\&c.}$$

or, substituting the single letter u for $\frac{v}{w}$, that is, for

$$\frac{\mathrm{A}'\,x^{\alpha'} + \mathrm{B}'\,x^{\beta'} + \mathrm{C}'\,x^{\gamma'} + \text{\&c.}}{\mathrm{A}\,x^{\alpha} + \mathrm{B}\,x^{\beta} + \mathrm{C}\,x^{\gamma} + \text{\&c.}}$$

and putting u' for the value that u acquires when x becomes $x+h$,

$$u' = u + \mathrm{P}\,h + \mathrm{Q}\,h^2 + \mathrm{R}\,h^3 + \text{\&c.}$$

a series in all respects analogous to those already found for the other functions of x.

10. In the functions which we have hitherto considered, the exponents of the powers of x were constant quantities. Let us now consider a function in which the exponent is the variable quantity x itself.

Suppose then the function to be a^x, where a denotes a given number; then, by supposing x to become $x+h$, the function will become

$$a^{x+h} = a^x\,a^h.$$

Now it has been shown in the article ALGEBRA, § 295, that if A be put to denote the quotient arising from the division of a logarithm of a by the logarithm of $2{\cdot}7182818\cdots$ the exponential quantity a^h is expressed by the series

$$1 + \frac{\mathrm{A}}{1}h + \frac{\mathrm{A}^2}{1\cdot 2}h^2 + \frac{\mathrm{A}^3}{1\cdot 2\cdot 3}h^3 + \text{\&c.}$$

therefore, a^{x+h}, the new value of the function is

$$a^x\left(1 + \frac{\mathrm{A}}{1}h + \frac{\mathrm{A}^2}{1\cdot 2}h^2 + \frac{\mathrm{A}^3}{1\cdot 2\cdot 3}h^3 + \text{\&c.}\right),$$

this series, by multiplying all its terms by a^x, and putting p, q, r, &c. for that part of each term which is independent of h, becomes

$$a^x + p\,h + q\,h^2 + r\,h^3 + \text{\&c.}$$

so that denoting the function a^x by u, and its new value by u',

$$u' = u + p\,h + q\,h^2 + r\,h^3 + \text{\&c.}$$

a series of the same form as the others.

11. From a due consideration of what has been shewn relating to the change that takes place in the magnitude of a variable function, corresponding to the change that takes place in the magnitude of the variable quantity from which the function is formed, we may conclude the truth of the following general proposition to be sufficiently established.

Let x *denote a variable quantity, and* u *any function whatever of that quantity, let* x *be supposed to receive any increment* h, *and thus to become* x+h, *and let* u′ *be the new value which the function acquires by the change in the value of* x, *then, the new value of* u *may in every case be expressed thus:*

$$u' = u + p\,h + q\,h^2 + r\,h^3 + \text{\&c.}$$

where p, q, r, &c. *denote quantities that are quite independent of* h, *and consequently can only involve the variable quantity* x, *and given quantities.*

12. Having examined what is the general form that any function of a variable quantity acquires by a change in the value of that quantity, and found it to be a series, the first term of which is always the function itself, it is evident that the remaining terms will express the increment that the function receives, in consequence of the change in the magnitude of the variable quantity from which the function is formed. Let us now compare the simultaneous increments of a variable quantity and its function with each other, and that we may at first avoid general reasoning, and fix the mind more completely, let us suppose the functions to have a determinate form, as x^2, x^3, x^4, &c.

Putting u and u' as before to denote the two succeeding values of the function, first let it be supposed that $u=x^2$, then x being supposed to receive the indefinite increment h, and thus to become $x+h$, and u to change its value to $u'=(x+h)^2$, we have

$$u' = x^2 + 2\,x\,h + h^2;$$

$$\text{or, } u' = u + 2\,x\,h + h^2,$$

and consequently

$$u' - u = 2\,x\,h + h^2.$$

Thus it appears, that the simultaneous increments of x and x^2 (or u) are h and $2x\,h+h^2$, respectively. Let us now compare these increments, not in respect of their absolute magnitudes, but in respect of their ratio to each other, thus we shall have the increment of u to the increment of x, as $2x\,h+h^2$ to h, that is, (dividing the two last terms of the proportion by h) as $2x+h$ to 1. Or, instead of employing an analogy, let us, for the sake of brevity, and in conformity to the algebraic notation, rather express each of these ratios by the quotient arising from the divifion of the antecedents of the ratio by its consequents, and put the results equal to each other. Then, observing that the symbol $u'-u$, which expresses the difference between the succeeding values of the function, may be employed to denote its increment, we have

$$\frac{u'-u}{h} = \frac{2\,x\,h + h^2}{h} = 2\,x + h.$$

Hence it appears that the expression for the ratio of the increment of the function u to the increment of the variable quantity x is made up of two parts, one of these, viz. $2\,a\,x$, is quite independent of h, the increment of x, and the other is in the present case that increment itself. In consequence of this peculiarity in the form

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form of the expreſſion for the ratio, it is evident that if the increment h be conceived to be continually diminiſhed, the part of the expreſſion which conſiſts of h will continually diminiſh, ſo that the whole expreſſion, viz. $2x+h$, may become more nearly equal to its firſt term $2x$ than by any aſſignable difference; therefore $2x$ may be conſidered as the *limit* of the ratio $\frac{u'-u}{h}$, that is, a quantity to which the ratio may approach nearer than by any aſſignable difference, but to which it cannot be conſidered as becoming abſolutely equal.

Let us next ſuppoſe that $u=x^3$, then x being ſuppoſed to become $x+h$, we have $u'=(x+h)^3$, $=x^3+3x^2h+3xh^2+h^3$, or

$$u'=u+3x^2h+3xh^2+h^3,$$

and conſequently

$$u'-u=3x^2h+3xh^2+h^3,$$

$$\text{and } \frac{u'-u}{h}=3x^2+3xh+h^2.$$

Here it is evident, as in the former caſe, that the expreſſion for the ratio $\frac{u'-u}{h}$ is compoſed of two parts, one of theſe, viz. the firſt term $3x^2$, is a function of x that is independent of the increment h, but the other, viz. $3xh+h^2$, or $h(3x+h)$, is the product of two factors, one of which is the increment itſelf. From the particular form of this latter part of the expreſſion for the ratio, it is plain, that h being ſuppoſed to be continually diminiſhed, that part will alſo diminiſh, and may become leſs than any aſſignable quantity. Therefore in this caſe, as well as in the former, the ratio $\frac{u'-u}{h}$ has a *limit*, and that limit is the firſt term of the general expreſſion for the ratio, namely the quantity $3x^2$.

Suppoſe, next, that $u=x^4$, and conſequently

$$u'=(x+h)^4=x^4+4x^3h+6x^2h^2+4xh^3+h^4,$$

or,

$$u'=u+4x^3h+6x^2h^2+4xh^3+h^4,$$

$$\text{and } \frac{u'-u}{h}=4x^3+h(6x^2+4xh+h^2).$$

Here, as in the two former caſes, we have only to inſpect the general expreſſion for the ratio $\frac{u'-u}{h}$ to diſcover, that by ſuppoſing h to be continually diminiſhed, the latter part of the expreſſion, viz. $h(6x^2+4xh+h^2)$, and which comprizes all the terms except the firſt, will become ſmaller than any aſſignable quantity; and conſequently, that the firſt term $4x^3$ is the limit of the ratio.

13. It is eaſy to ſee that the property which we have found to belong to the ratio of the ſimultaneous increments of a variable quantity, and its function in theſe three particular caſes, is an immediate conſequence of the form of the expreſſion for the increment of the function, ſo that it is not peculiar to the functions x^2, x^3, and x^4, but belongs equally to all functions whatever.

For we have found, § 11, that u being ſuppoſed to

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denote any function of a variable quantity x, as for example, ax^n, or ax^m+bx^n+ &c, or

$$\frac{ax^m+bx^n+\text{ \&c.}}{a'x^{m'}+b'x^{n'}+\text{ \&c.}}$$

and u' being put for the new value which the function acquires when x becomes $x+h$,

$$u'=u+ph+qh^2+rh^3+\text{ \&c.}$$

where p, q, r, &c. denote functions of x that are independent of h, therefore,

$$u'-u=ph+qh^2+rh^3+\text{ \&c.}$$

and

$$\frac{u'-u}{h}=p+qh+rh^2+\text{ \&c.}$$

or,

$$\frac{u'-u}{h}=p+h(q+rh+\text{ \&c.})$$

Thus it appears, that whatever be the form of the function, the ratio $\frac{u'-u}{h}$ is always expreſſed by a quantity which may be reſolved into two parts; one of theſe, viz. p, is independent of the increment h, and the other, viz. $h(q+rh+\text{ \&c.})$, is the product of h by a ſeries, the firſt term of which is a function of x, and the remaining terms alſo functions of x multiplied by the firſt, ſecond, third, and higher powers of h. Now from the particular form of this laſt part of the general expreſſion for the ratio, it is manifeſt, that h being conceived to be continually diminiſhed, the quantity $h(q+rh+\text{ \&c.})$ will alſo be continually diminiſhed, and may become leſs than any aſſignable quantity; therefore, the limit of the ratio $\frac{u'-u}{h}$ is ſimply p, that is, the function of x, which is the coefficient of the firſt or ſimple power of h in the general expreſſion for the increment.

14. From what has been juſt ſhewn, we may infer the truth of the following general propoſition relative to the ſimultaneous changes that take place in a variable quantity and its function.

Let x *denote a variable quantity and* u *any function of that quantity, let* x *be conceived to change its value and become* x+h, *where* h *denotes an arbitrary increment, and let* u′ *denote the new value that the function acquires, in conſequence of the change in the magnitude of* x. *Then, obſerving that* h *and* u′—u *are the ſimultaneous increments of the variable quantity and its function, if* h *be conceived to be continually diminiſhed, the ratio* $\frac{u'-u}{h}$ *will continually approach to a certain Limit, which will be different for different functions, but always the ſame for the ſame function, and in every caſe quite independent of the magnitude of the increments.*

The ratio which is the *limit* of the ratio of the increments, when theſe increments are conceived to be continually diminiſhed, may be called the *limiting ratio* of the increments.

15. The analytical fact contained in the preceding propoſition affords the foundation for a mathematical theory of great extent, and which may be divided into

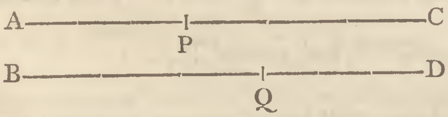
into two distinct branches; one having for its object the resolution of the following problem. *Having given the relation of any number of variable quantities to each other, to determine the limiting ratios of their increments*; and the other the converse of that problem, namely, *Having given the limiting ratios, to determine the relations of the quantities themselves.*

The theory to which we have alluded constitutes the METHOD OF FLUXIONS, and in explaining the foundation of the method, we have endeavoured to show, that it rests upon a principle purely analytical, namely the theory of limiting ratios; and this being the case, the subject may be treated as a branch of pure mathematics, without having occasion to introduce any ideas foreign to geometry.

16. Sir Isaac Newton, however, in first delivering the principles of the method, thought proper to employ considerations drawn from the theory of motion. But he appears to have done this chiefly for the purpose of illustration, for he immediately has recourse to the theory of limiting ratios, and it has been the opinion of several mathematicians of great eminence (A) that the consideration of motion was introduced into the method of fluxions at first without necessity, and that succeeding writers on the subject ought to have established the theory upon principles purely mathematical, independent of the ideas of time, and velocity, both of which seem foreign to investigations relating to abstract quantity.

17. That we may conform to the usual method of treating this subject, we proceed to show how the theory of motion is commonly applied to the illustration of the nature of variable quantities, and of the relations that result from their being conceived to change their value.

As quantities of every kind, if we abstract from their position, figure, and such affections, and consider their magnitude only, may be represented by lines, we may consider a variable quantity x, and u any function of that quantity, to be represented by two lines AP, BQ, which have A, B, one extremity of each given, and which vary by the points P, Q, their other extremities, moving in the directions AC, BD, while the equation expressing the relation between x and u, or their representative lines AP, BQ, remains always the same.



18. The lines AP, BQ being thus conceived to vary, the relation that is supposed always to subsist between them, in respect of their magnitudes, will necessarily give rise to another relation, namely, that which will constantly subsist between the velocities of the moving points P and Q, by which the lines are generated.

With a reference to this particular mode of conceiving variable quantities to exist, the quantities themselves have been called *flowing quantities* or *fluents*, and the measures of the velocities with which the variable quantities increase have been called their *fluxions*.

19. To simplify the hypothesis, we may suppose that the point which generates the line AP, or x, moves uniformly; thus the measure of its velocity, or the fluxion of x, will be a given quantity, with which the measure of the velocity of the point Q, or the fluxion of u, may be continually compared. To determine then the fluxions, or rather the ratio of the fluxions of x a variable quantity, and u, any function of that quantity, is in effect to resolve the following problem.

Having given an equation expressing the relation at every instant between the spaces passed over by two points, one of which moves with an uniform velocity. It is required to find an expression for the ratio that the measures of the velocities have at every instant to each other.

20. Now it is a fundamental principle in the theory of motion, resulting indeed from the very nature of a variable velocity, that when two velocities are compared together, whether they be both variable, or one of them uniform, and the other variable, *the measures of their velocities are any quantities having to each other the ratio that is the limit of the ratio of the spaces described in the same time, when those spaces are conceived to be continually diminished.* And hence it follows that the ratio of the fluxions of two variable quantities is no other than the limiting ratio of their simultaneous increments.

That the theory of motion may be applied to the generation of variable algebraic quantities, we have supposed them to be represented by lines; this however is not necessary, if the variable quantities are themselves geometrical magnitudes; for like as a line is conceived to be generated by the motion of a point, so a surface may be considerated as generated by the motion of a line, a solid by the motion of a surface, and an angle by the rotation of one of the lines which contain it; and the fluxions of those quantities at any instant, or position, will be the measures of the velocities, or degrees of swiftness, according to which they increase at that instant or position.

But in every case the ratio of the rates of increase, or fluxions of two homogeneous magnitudes, will be the limiting ratio of their simultaneous increments.

21. Having thus found that by conceiving variable quantities as generated by motion, and taking their velocities, or rates of increase, as an object for the mind to contemplate and reason on, we are in the end led to the consideration of the limiting ratios of their increments, a subject which is purely mathematical, and independent of the ideas of time or velocity, we shall exchange the definition of a fluxion given in § 18, which involves those ideas, for another that rests entirely upon the existence of limiting ratios.

By the fluxions then of two variable quantities having any assigned relation to each other, we are in the following treatise always to be understood to mean *any indefinite*

(A) Such as *Lagrange*, *Cousin*, *La Croix*, &c. abroad, and *Landen* in this country.

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indefinite quantities which have to each other the limiting ratio of their simultaneous increments (B).

In conformity to this definition of fluxions it is evident that we are to consider them, not as absolute, but as relative quantities, which derive their origin from the comparison of variable quantities with each other in respect of their simultaneous variations of magnitude.

22. Sir Isaac Newton employed different symbols at different times to denote the fluxions of variable quantities. It is now however common in Britain to denote them by the same letters employed to express the quantities themselves, and each having a dot over it. Thus $\dot{x}$ denotes the fluxion of the variable quantity expressed by x, and in the like manner $\dot{u}$, $\dot{v}$, $\dot{z}$, denote the fluxions of the variable quantities u, v, z, respectively.

23. Suppose now that u is any function of a variable quantity x, and that the limiting ratio of the simultaneous increments of u and x is the ratio of p to 1, where p denotes some other function of x, then, from the definition just given of fluxions, we have

$$\frac{\dot{u}}{\dot{x}}=p, \text{ and } \dot{u}=p\dot{x}$$

Hence it follows as a consequence of the preceding definition, that the fluxion of u, any function of a variable quantity x, is *the product arising from the multiplication of that function of x which is the expression for the limiting ratio of the increments by the fluxion of the variable quantity x itself.*

Sect. II. *Investigation of the Rules of the Direct Method of Fluxions.*

24. The method of fluxions naturally resolves itself into two parts, as we have already observed, § 15. We proceed to explain the first of these, which is called the *Direct Method*, and which treats of finding the ratios of the fluxions of variable quantities, having given the relations of those quantities to each other.

25. We shall begin with investigating the ratio of the fluxions of two variable quantities in that particular case, when one of them is any power of the other.

Let us suppose then, that u is such a function of a variable quantity x, that $u=x^n$, where n denotes any number whatever, it is required to determine the ratio of the fluxions of u and x.

If we recur to the definition which has been given of the fluxions of variable quantities in § 21, it will appear that we have in effect resolved the problem just proposed in three particular cases, when treating of the limiting ratios of the increments of variable quantities. For it has been shown in § 12. that when $u=x^2$, and x is supposed to change its value, so as to become $x+h$, where h denotes an indefinite increment, and in consequence of this change in the magnitude of x, u also changes its value, and becomes u', then, observing that $u'-u$ and h are the simultaneous increments of u and x, the limiting ratio of $\frac{u'-u}{h}$ is $2x$. Let this expression for the limiting ratio be put equal to the ratio of the fluxions of u and x, that is to $\frac{\dot{u}}{\dot{x}}$, thus we have $\frac{\dot{u}}{\dot{x}}=2x$, and $\dot{u}=2x\dot{x}$. Hence it appears that whatever be the magnitude of the quantity that expresses the fluxion of x, the fluxion of u or x^2 will be expressed by the fluxion of x multiplied by $2x$.

Again, when $u={}^3x$, and u', $u'-u$ and h denote the same as before, it has been shown, § 12, that the limiting ratio of $\frac{u'-u}{h}$ is $3x^2$, therefore, § 21, $\frac{\dot{u}}{\dot{x}}=3x^2$, and $\dot{u}=3x^2\dot{x}$; that is, the fluxion of x^3 is expressed by the fluxion of x multiplied by $3x^2$.

And when $u=x^4$ it has been shown, § 12, that the limiting ratio of $\frac{u'-u}{h}$ is $4x^3$. Therefore, § 21, $\frac{\dot{u}}{\dot{x}}=4x^3$ and $\dot{u}=4x^3\dot{x}$.

To resolve the problem generally, or when $u=x^n$, let us suppose x to become $x+h$, and u to become u', then $u'=(x+h)^n$. But this last quantity, when expanded into a series by the binomial theorem (Algebra, Sect. XVII.) is

$$x^n+ph+qh^2+rh^3+\&c.$$
$$\text{or } u+ph+h^2(q+rh+\&c.),$$

where p, q, r, &c. denote functions of x, indpendent of h. Therefore,

$$u'-u=ph+h^2(q+rh+\&c.),$$
$$\text{and } \frac{u'-u}{h}=p+h(q+rh+\&c.)$$

Therefore, supposing h to be continually diminished, the limit of $\frac{u'-u}{h}$ is p; but, whatever be the nature of the exponent n, p is always nx^{n-1}, (Algebra, § 267.), therefore, the limit of $\frac{u'-u}{h}$ is nx^{n-1}, and consequently $\frac{\dot{u}}{\dot{x}}=nx^{n-1}$, and $\dot{u}=nx^{n-1}\dot{x}$.

26. As we shall have frequently occasion to employ the result of this investigation, it will be proper to express it in the form of a practical rule, thus.

To find the fluxion of any power of a variable quantity. Multiply the fluxion of the variable quantity itself by the exponent of the power, and by a power of the quantity whose exponent is less by unity than the given exponent, and the product will be the fluxion required.

27.

(B) We are here to be understood to mean the ratio of the *numerical* values of the increments, which may always be compared with each other, whether the variable quantities be of the same kind, as both lines, or both surfaces, &c. or of different kinds, as the one a line, and the other a surface.

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27. In determining the limit of the ratio of the simultaneous increments of x and x^n, we have referred to the binomial theorem, but the only application we have had occasion to make of that theorem was to determine the numeral coefficient of the second term of the developement of $(x+h)^n$, when n is supposed to be any number whatever, which is an inquiry of a more simple nature than the general investigation of the theorem. We shall now show how that coefficient may be deduced from the first principles of algebra. Thus the investigation of the fluxion of x^n will be rendered independent of the general demonstration of the binomial theorem; and we shall hereafter show that the theorem itself is easily investigated by the direct method of fluxions.

28. Since $x+h$ is equal to $x\left(1+\frac{h}{x}\right)$ it follows that $(x+h)^n=x^n\left(1+\frac{h}{x}\right)^n$, thus the development of $(x+h)^n$ is reduced to that of $\left(1+\frac{h}{x}\right)^n$, or putting $\frac{h}{x}=v$, to $(1+v)^n$. Now if we give particular values to n, and suppose it to be 1, 2, 3, &c. or —1, —2, &c. or lastly $\frac{1}{2}$, $\frac{1}{3}$, &c. we can find the series that express the powers of $1+v$, whose exponents are those numbers, by the operations of multiplication, division, and evolution, and in every particular case we shall find, that the powers of $1+v$ are expressed by a series of this form,

$$1+A\,v+B\,v^2+C\,v^3+D\,v^4+\text{ \&c.}$$

Where A, B, C, D, &c. denote numeral coefficients which depend for their value only on n the exponent of the power, and not on the quantity v; and as the form of the series will be found to be the same whatever particular values we may give to the exponent, we may conclude that it is the same, whether the exponent be positive or negative, whole or fractional.

29. First let us suppose that the exponent is a whole positive number, then, because

$$(1+v)^n=1+A\,v+B\,v^2+\text{ \&c.}$$

if we multiply both sides of this equation by $1+v$, and collect together the like powers of v, it will appear that

$$(1+v)^{n+1}=1+\left.\begin{matrix}A\\+1\end{matrix}\right\}v\;\left.\begin{matrix}+B\\+A\end{matrix}\right\}v^2+\text{ \&c.}$$

Hence it appears that the coefficient of the second term of any power of $1+v$ exceeds that of the next less power by unity. Now in the case of the first power of $1+v$, the coefficient of the second term is obviously 1, therefore, in the second power it is 2, in the third power 3, and universally, in the nth power it is n; so that n being a whole positive number,

$$(1+v)^n=1+n\,v+\text{ \&c.}$$

30. Let us next suppose the exponent to be a fraction denoted by $\frac{m}{n}$, so that

$$(1+v)^{\frac{m}{n}}=1+A\,v+B\,v^2+\text{ \&c.}$$

Let both sides of this equation be raised to the power n, having first substituted M v for A v+B v^2+ &c. then

$$(1+v)^m=(1+M\,v)^n.$$

Now as we have just found that m and n being integers,

$$(1+v)^m=1+m\,v+\text{ \&c.}$$
$$\text{and }(1+M\,v)^n=1+n\,M\,v+\text{ \&c.}$$

Here we stop at the second term, that being the only one whose coefficient is required. Substitute now for M v its value A v + &c. then, stopping again at the second term, we get

$$(1+M\,v)^n=1+n\,A\,v+\text{ \&c.}$$

therefore,

$$1+m\,v+\text{ \&c.}=1+n\,A\,v+\text{ \&c.}$$

and making the coefficients of v in each series equal to each other,

$$n\,A=m,\text{ and }A=\frac{m}{n}.$$

31. In the last place let us suppose that the exponent is a negative quantity either whole or fractional, so that

$$(1+v)^{-\frac{m}{n}}=1+A'v+B'v^2+\text{ \&c.}$$

$$\text{or }\frac{1}{(1+v)^{\frac{m}{n}}}=1+A'\,v+B'\,v^2+\text{ \&c.}$$

then, multiplying both sides by $(1+v)^{\frac{m}{n}}$ we get

$$1=(1+v)^{\frac{m}{n}}(1+A'v+B'\,v^2+\text{\&c.})$$

or, substituting $1+A\,v+B\,v^2+$&c. for $(1+v)^{\frac{m}{n}}$ and actually multiplying the two series,

$$1=1+\left.\begin{matrix}A\\+A'\end{matrix}\right\}v\;\left.\begin{matrix}+B\\+A\,A'\\+B'\end{matrix}\right\}v^2+\text{ \&c.}$$

Now that this equation may subsist, whatever be the value of v, it is necessary that

$$A+A'=0,$$
$$B+A\,A'+B'=0,$$
&c.

and by these equations we may determine A′, B′, C′, &c. It is however only required at present to find the first of these, viz A′, now we have A′ = — A; but A being the coefficient of the second term of the series expressing $(1+v)^{\frac{m}{n}}$, the exponent of which is positive, we have already found it to be $\frac{m}{n}$, therefore, $A'=-\frac{m}{n}$.

32. As we have found that the coefficients of the second term of the developements of $(1+v)^n$, $(1+v)^{\frac{m}{n}}$ and $(1+v)^{-\frac{m}{n}}$ are m, $\frac{m}{n}$, and $-\frac{m}{n}$ respectively, it appears that whatever be the number denoted by n, the two first terms of the series expressing $(1+v)^n$ are, $1+n\,v$, and therefore, substituting for v its value $\frac{h}{x}$, and multiplying by x^n, the two first terms of the series expressing $(x+h)^n$ are $x^n+n\,x^{n-1}h$, agreeing with what we have

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have assumed in § 25 as given by the binomial theorem (c).

33. The mode of reasoning employed to determine the ratio of the fluxions of u and x, when the former is a function of the latter of the form x^n, will apply equally when the function has any other assigned form. But instead of investigating in this manner the fluxion of every particular function, it is better to consider a complex function as the sum, or difference, or product or quotient, &c. of other simple functions, and to investigate rules for each of these cases, supposing that the fluxions of the simple functions are previously known.

34. Let us first suppose that u, a function of a variable quantity x, is equal to the sum of v and w, two other functions of x. It is required to find the fluxion of u, having given the fluxions of v and w.

Let x be conceived to change its value, and to become $x+h$, then, as v and w will also change their values, § 11, the one to

$$v'=v+p\,h+q\,h^2+r\,h^3+\&c.$$

and the other to

$$w'=w+p'\,h+q'\,h^2+r'\,h^3+\&c.$$

if u' as usual denote the corresponding new value of u, we have

$$u=v+w$$
$$u'=\begin{cases}v+p\,h+q\,h^2+\&c.\\+w+p'\,h+q'\,h^2+\&c.\end{cases}$$
$$u'-u=(p+p')h+(q+q')h^2+\&c.$$
$$\frac{u'-u}{h}=p+p'+(q+q')h+\&c.$$

If we now conceive h to be continually diminished, we shall have the limit of $\frac{u'-u}{h}$ expressed by $p+p'$. But p is the limit of $\frac{v'-v}{h}$, § 14, and in like manner p' is the limit of $\frac{w'-w}{h}$, therefore,

$$\text{limit of }\frac{u'-u}{h}=\text{limit of }\frac{v'-v}{h}+\text{limit of }\frac{w'-w}{h}.$$

Substitute now the ratio of the fluxions instead of the limiting ratios, and we have

$$\frac{\dot{u}}{\dot{x}}=\frac{\dot{v}}{\dot{x}}+\frac{\dot{w}}{\dot{x}};$$

$$\text{therefore,}\quad \dot{u}=\dot{v}+\dot{w}.$$

35. If we suppose s to be a function of x, and u, v, w, &c. other functions of x, such that

$$s=au+b\,v+c\,w+\&c.$$

where a, b, c, denote any given numbers, positive or negative, then, by reasoning as above, it is evident that

$$\dot{s}=a\,\dot{u}+b\,\dot{v}+c\,\dot{w}+\&c.$$

Therefore, to find the fluxion of the sum of any number of functions, each multiplied by a constant quantity. Multiply the fluxion of each function by its constant coefficient, and the sum of the products is the fluxion required.

36. If c denote a constant quantity, and $u\,v$, be functions of x, such, that $u=c+v$; then x being supposed to become $x+h$, and consequently v to become v', or $v+p\,h+q\,h^2+$ &c. and $c+v$ to become $c+v+p\,h+q\,h^2+$ &c. we have

$$u=c+v,$$
$$\text{and }u'=c+v+p\,h+q\,h^2+\&c.$$
$$\text{and hence }u'-u=p\,h+q\,h^2+\&c.$$
$$\text{or }u'-u=v'-v,$$
$$\text{therefore, }\frac{u'-u}{h}=\frac{v'-v}{h},$$

and these ratios being always equal, their limits must also be equal; therefore, substituting for the limiting ratios those of the fluxions, we have $\frac{\dot{u}}{\dot{x}}=\frac{\dot{v}}{\dot{x}}$ and $\dot{u}=\dot{v}$; that is to say, the fluxion of $c+v$ is $\dot{v}$, from which it appears, *That the fluxion of any variable function is the very same as the fluxion of the same function, increased or diminished by any constant quantity.* This is a remark of great importance in the theory of fluxions, as will appear hereafter.

37. Let us now suppose that u, v, w, are functions of x, such, that $u=v\,w$, it is required to find the fluxion of u, supposing the fluxions of v and w to be given.

By supposing that x, u, v and w change their values as usual, we have

$$u=v\,w$$
$$u'=(v+p\,h+q\,h^2+\&c.)(w+p'\,h+q'\,h^2+\&c.)$$

and this last expression by multiplication becomes

$$u'=\left.\begin{matrix}v\,w+v\,p'\,h+v\,q'\,h^2\\+w\,p\,h+w\,q\,h^2\end{matrix}\right\}+\&c.$$

therefore

$$u'-u=(v\,p'+w\,p)\,h+(v\,q'+w\,q)\,h^2+\&c.$$

dividing now by h, and taking the limit of $\frac{u'-u}{h}$, we have that limit expressed by $v\,p'+w\,p$; but p' is the limit of $\frac{w'-w}{h}$ § 14, and in like manner p is the limit of $\frac{v'-v}{h}$; therefore

the

(c) In this investigation we have supposed n to be a rational number. If, however, it were irrational, still the result would be the same; for, corresponding to every such number, two rational numbers, one greater, and the other less than it, may be found, which shall differ from each other by less than any assignable quantity. Therefore, the general properties of these numbers must belong also to the irrational number which is their limit.

$$\text{the limit of } \frac{u'-u}{h} = \left\{ \begin{array}{l} v \times \text{limit of } \frac{w'-w}{h} \\ +w \times \text{limit of } \frac{v'-v}{h}; \end{array} \right.$$

Hence, by substituting for the limiting ratios the ratios of the fluxions, we have

$$\frac{\dot{u}}{\dot{x}} = \frac{v\,\dot{w}}{\dot{x}} + \frac{w\,\dot{v}}{\dot{x}} \text{ and } \dot{u} = v\,\dot{w} + w\,\dot{v}.$$

Therefore, to find the fluxion of the product of any two functions, multiply the fluxion of each function by the other function, and the sum of these products is the fluxion required.

38. We have just now seen that when

$$u = v\,w$$

$$\text{then } \dot{u} = w\dot{v} + v\,\dot{w}$$

Let each side of the latter equation be divided by the corresponding side of the former, thus we get

$$\frac{\dot{u}}{u} = \frac{\dot{v}}{v} + \frac{\dot{w}}{w};$$

suppose now that the function w is the product of two other functions s, t, so that

$$u = v\,s\,t,$$

then, because $w = s\,t$, from what has been shewn it follows that $\frac{\dot{w}}{w} = \frac{\dot{s}}{s} + \frac{\dot{t}}{t}$; therefore, substituting this value of $\frac{\dot{w}}{w}$ in the equation $\frac{\dot{u}}{u} = \frac{\dot{v}}{v} + \frac{\dot{w}}{w}$, it becomes

$$\frac{\dot{u}}{u} = \frac{\dot{v}}{v} + \frac{\dot{s}}{s} + \frac{\dot{t}}{t}$$

In general, if we suppose that

$$u = v\,s\,t\,r \text{ \&c.}$$

by reasoning as above it will be found that

$$\frac{\dot{u}}{u} = \frac{\dot{v}}{v} + \frac{\dot{s}}{s} + \frac{\dot{t}}{t} + \frac{\dot{r}}{r} + \text{\&c.}$$

whatever be the number of factors.

Suppose the number of factors to be three, so that

$$u = v\,s\,t$$

$$\text{and } \frac{\dot{u}}{u} = \frac{\dot{v}}{v} + \frac{\dot{s}}{s} + \frac{\dot{t}}{t}$$

then substituting $v\,s\,t$ for u in this last equation, and taking away the denominators, we find

$$\dot{u} = s\,t\,\dot{v} + v\,t\,\dot{s} + v\,s\,\dot{t}.$$

And as a similar result will be found, whatever be the number of factors, we may conclude that *The fluxion of the product of any number of functions is equal to the sum of the products of the fluxion of each function by all the other functions.*

39. Let us in the last place suppose that $u = \frac{v}{w}$, and that it is required to find the fluxion of u, having given the fluxions of v and w.

From the given equation we have $v = wu$, and therefore (§ 37.) $\dot{v} = w\,\dot{u} + u\,\dot{w}$, let $\frac{v}{w}$ be substituted for u in this equation, and it becomes $\dot{v} = w\dot{u} + \frac{v\,\dot{w}}{w}$, from which we easily obtain

$$\dot{u} = \frac{w\,\dot{v} - v\,\dot{w}}{w^2},$$

Hence we have the following rule for finding the fluxion of a fraction.

Multiply the fluxion of the numerator by the denominator, and from the product subtract the fluxion of the denominator multiplied by the numerator, and divide the remainder by the square of the denominator; the result is the fluxion required.

40. It will now be proper to shew the application of these general rules for determining the fluxions of variable functions to some particular examples.

Example 1. Suppose $u = a + b\sqrt{x} - \frac{c}{x}$. Required the fluxion of u.

Here a being a constant quantity, the fluxion of $a + b\sqrt{x} - \frac{c}{x}$ is the same as the fluxion of $b\sqrt{x} - \frac{c}{x}$, § 36, or $b\,x^{\frac{1}{2}} - c\,x^{-1}$. Now, by § 26 the fluxion of $x^{\frac{1}{2}}$ is $\frac{1}{2}x^{\frac{1}{2}-1}\,\dot{x}$, which expression is equivalent to $\frac{1}{2}x^{-\frac{1}{2}}\dot{x}$, or to $\frac{\dot{x}}{2\sqrt{x}}$, and in like manner the fluxion of x^{-1} is $-x^{-1-1}\,\dot{x}$ or $-x^{-2}\,\dot{x}$, or $\frac{-\dot{x}}{x^2}$, therefore, multiplying the fluxion of $x^{\frac{1}{2}}$ by b, and the fluxion of x^{-1} by c, and taking the sum of the products, agreeably to the rule in § 35. we have

$$\dot{u} = \frac{b\,\dot{x}}{2\sqrt{x}} + \frac{c\,\dot{x}}{x^2}$$

$$\text{or } \dot{u} = \left(\frac{b}{2\sqrt{x}} + \frac{c}{x^2}\right)\dot{x}.$$

Ex. 2. Suppose $u = a + \frac{b}{\sqrt[3]{x^2}} - \frac{c}{x.\sqrt[3]{x}} + \frac{d}{x^2}$.

By writing the function thus

$$u = a + b\,x^{-\frac{2}{3}} - c\,x^{-\frac{4}{3}} + d\,x^{-2}$$

the application of the same rules employed in the last example gives us

$$\dot{u} = -\tfrac{2}{3}\,b\,x^{-\frac{5}{3}}\dot{x} + \tfrac{4}{3}\,c\,x^{-\frac{7}{3}}\dot{x} - 2\,d\,x^{-3}\,\dot{x}$$

or, exchanging the fractional indices for the radical sign, and otherwise reducing,

$$\dot{u} = \frac{-2\,b\,\dot{x}}{3\,x\,\sqrt[3]{x^2}} + \frac{4\,c\,\dot{x}}{3x^2\,\sqrt[3]{x}} - \frac{2\,d\dot{x}}{x^3}$$

Ex. 3.

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Ex. 3. Suppose $u=(a+bx^m)^n$.

In order to find the fluxion of this function by the rules already laid down, it will be necessary to consider it first as a function of a variable quantity that is itself a function of x. Let us then put $a+bx^m$ equal to v, and thus the proposed equation becomes $u=v^n$; then, u being considered as a function of v, we have by § 26. $\dot{u}=nv^{n-1}\dot{v}$. Again, v being considered as a function of x, from the equation $v=a+bx^m$, we find by § 36, and § 26, $\dot{v}=mbx^{m-1}\dot{x}$; Let this value of $\dot{v}$ be substituted in the expression for $\dot{u}$, and it becomes

$$\dot{u}=mnbv^{n-1}x^{m-1}\dot{x},$$

which, by substituting for v its value $a+bx^m$, is also

$$\dot{u}=mnbx^{m-1}(a+bx^m)^{n-1}\dot{x}.$$

Ex. 4. Suppose $u=\sqrt{(a^2-x^2)}$.

Here we are to proceed as in the last example, and first put $a^2-x^2=v$, then $u=\sqrt{v}=v^{\frac{1}{2}}$; and therefore (§ 26) $\dot{u}=\frac{1}{2}v^{\frac{1}{2}-1}\dot{v}=\frac{\dot{v}}{2v^{\frac{1}{2}}}=\frac{\dot{v}}{2\sqrt{v}}$. Again, since $v=a^2-x^2$, by § 26, we find $\dot{v}=-2x\dot{x}$. Substitute this value of $\dot{v}$ in the expression for $\dot{u}$, and we have

$$\dot{u}=-\frac{2x\dot{x}}{2\sqrt{v}}$$

which, by restoring $\sqrt{(a^2-x^2)}$ for v, and leaving out the number common to the numerator and denominator, becomes

$$\dot{u}=\frac{-x\dot{x}}{\sqrt{(a^2-x^2)}}.$$

Ex. 5. Suppose $u=\sqrt{(a+bx+cx^2)}$.

By proceeding in the same manner as in last example we find

$$\dot{u}=\frac{(b+2cx)\dot{x}}{\sqrt{(a+bx+cx^2)}}.$$

Ex. 6. Suppose $u=x(a^2+x^2)\sqrt{(a^2-x^2)}$.

Here the proposed function is the product of these three functions, viz x, a^2+x^2, and $\sqrt{(a^2-x^2)}$. Therefore, its fluxion will be found by proceeding according to the rule in § 38.

Now the fluxion of x is $\dot{x}$, and the fluxion of a^2+x^2 is $2x\dot{x}$, and the fluxion of $\sqrt{(a^2-x^2)}$ has been found in last example to be $\frac{-x\dot{x}}{\sqrt{(a^2-x^2)}}$. Therefore, multiplying the fluxion of each function by the product of the other two functions, and taking the sum of all these products, we find

$$\dot{u}=\begin{cases}(a^2+x^2)\sqrt{a^2-x^2}\,\dot{x}\\ +2x^2\sqrt{a^2-x^2}\,\dot{x}\\ -\dfrac{x^2(a^2+x^2)\dot{x}}{\sqrt{(a^2-x^2)}}\end{cases}$$

and this equation, by reducing all the terms on the latter side of it to a common denominator, is more simply expressed thus,

$$\dot{u}=\frac{(a^4+a^2x^2-4x^4)\dot{x}}{\sqrt{(a^2-x^2)}}.$$

Ex. 7. Suppose $u=\frac{a+x}{a^2+x^2}$.

Here we employ the rule given in § 39, for finding the fluxion of a fractional function; thus we find

$$\dot{u}=\frac{(a^2+x^2)\dot{x}-2x(a+x)\dot{x}}{(a^2+x^2)^2},$$

which when reduced is

$$\dot{u}=\frac{(a^2-2ax-x^2)\dot{x}}{(a^2+x^2)^2}.$$

Ex. 8. Suppose

$$u=\sqrt{\left\{\left(a-\frac{b}{\sqrt{x}}+\sqrt[3]{(c^2-x^2)^2}\right)^3\right\}}$$

To simplify this expression we put

$$\frac{b}{\sqrt{x}}=y,\quad \sqrt[3]{(c^2-x^2)^2}=z,$$

Thus we have

$$u=\sqrt{(a-y+z)^3}=(a-y+z)^{\frac{3}{2}}$$

Now as the fluxion of $a-y+z$, is $-\dot{y}+\dot{z}$ (§ 35), we find from § 26, that by considering $a-y+z$ as a single variable quantity,

$$\begin{aligned}\dot{u}&=\tfrac{3}{2}(a-y+z)^{\frac{3}{2}-1}(-\dot{y}+\dot{z})\\ &=\tfrac{3}{2}(a-y+z)^{\frac{1}{2}}(-\dot{y}+\dot{z})\\ &=\tfrac{3}{2}\sqrt{a-y+z}\,(-\dot{y}+\dot{z})\end{aligned}$$

but, since $y=\frac{b}{\sqrt{x}}=bx^{-\frac{1}{2}}$, we have, § 26,

$$\dot{y}=-\tfrac{1}{2}bx^{-\frac{1}{2}-1}\dot{x}=-\frac{b\dot{x}}{2x\sqrt{x}};$$

and since $z=\sqrt[3]{(c^2-x^2)^2}=(c^2-x^2)^{\frac{2}{3}}$, by considering c^2-x^2 as a single variable quantity, and observing that its fluxion is $-2x\dot{x}$, we find by § 26, that

$$\dot{z}=\tfrac{2}{3}(c^2-x^2)^{\frac{2}{3}-1}\times-2x\dot{x}=\frac{-4x\dot{x}}{3\sqrt[3]{(c^2-x^2)}}$$

Instead of y, z, $\dot{y}$, $\dot{z}$, substitute now their values in the expression for the fluxion of u, thus it becomes

$$\dot{u}=\tfrac{3}{2}\sqrt{\left(a-\frac{b}{\sqrt{x}}+\sqrt[3]{(c^2-x^2)^2}\right)}\times\left(\frac{b\dot{x}}{2x\sqrt{x}}-\frac{4x\dot{x}}{3\sqrt[3]{(c^2-x^2)}}\right).$$

Ex. 9. Suppose $u=av^my^n$, where v, and y denote any functions of a variable quantity.

Then, § 37,

$$\dot{u}=\begin{Bmatrix}ay^n\times\text{ fluxion of }v^m\\ +av^m\times\text{ fluxion of }y^n\end{Bmatrix}$$

But

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But fluxion of $v^m = m v^{m-1} \dot{v}$, § 26,

and fluxion of $y^n = n y^{n-1} \dot{y}$;

therefore,

$$\dot{u} = am\, y^n v^{m-1} \dot{v} + an\, v^m y^{n-1} \dot{y},$$
$$= a v^{m-1} y^{n-1} (my \dot{v} + n v \dot{y}).$$

Ex. 10. Suppose $u = \frac{v+z}{y^3}$, where v, z and y denote any functions of a variable quantity. Then, because fluxion $(v+z) = \dot{v} + \dot{z}$, § 34, and fluxion $y^3 = 3\, y^2 \dot{y}$, § 26, we have, § 39,

$$\dot{u} = \frac{y^3(\dot{v}+\dot{z}) - 3(v+z)y^2\dot{y}}{y^6},$$
$$= \frac{y(\dot{v}+\dot{z}) - 3(v+z)\dot{y}}{y^4}.$$

41. As when u denotes that particular function of x which is x^n, we have (§ 25.)

$$\frac{\dot{u}}{\dot{x}} = n\, x^{n-1};$$

so in general, whatever be the form of the function denoted by u, we have always

$$\frac{\dot{u}}{\dot{x}} = p,$$

where p denotes a new function of x, resulting from the analytical process employed to find the fluxion of the function u, and depending for its form upon the particular form of that function: just as in involution, or any of the other operations of algebra, a result is obtained depending upon the particular nature of the operation, and the quantities operated upon.

Let us put p to denote the particular function $n\,x^{n-1}$, or the expression for $\frac{\dot{u}}{\dot{x}}$ the ratio of the fluxion of u to the fluxion of x when $u = x^n$, then, supposing that $n-1$ is not equal to 0, (for in that case $n\,x^{n-1}$ would be simply n, a given number,) we may reason concerning the ratio of the fluxions of the variable quantities p and x, in all respects as concerning the ratio of the fluxions of u and x; and accordingly, from the equation

$$p = n\, x^{n-1},$$

we get, by taking the fluxions,

$$\frac{\dot{p}}{\dot{x}} = n\,(n-1)\, x^{n-2},$$

or, considering p as denoting generally the function of x that results from the operation of finding the fluxion of the original function u, whatever be the form of that function, we have

$$\frac{\dot{p}}{\dot{x}} = q,$$

where q denotes a new function of x, derived from p, the former function, by the same kind of operation as that by which p was deduced from u.

Suppose now q to denote the particular function $n\,(n-1)\,x^{n-2}$, then,

$$\frac{\dot{q}}{\dot{x}} = n\,(n-1)(n-2)\,x^{n-3},$$

or $\frac{\dot{q}}{\dot{x}} = r$,

where r denotes a function of x derived from q, as q was derived from p, or p from the original function u. And it is evident that we may proceed in this manner as far as we please, unless it happen that in finding the series of functions p, q, r, &c. we at last arrive at a result that is a constant quantity, and then the series of operations will terminate. Thus if the function was $a\,x^4$, we should have

$$u = a\,x^4,$$
$$\frac{\dot{u}}{\dot{x}} = 4\,a\,x^3 = p,$$
$$\frac{\dot{p}}{\dot{x}} = 4.3\,a\,x^2 = q,$$
$$\frac{\dot{q}}{\dot{x}} = 4.3.2\,a\,x = r,$$
$$\frac{\dot{r}}{\dot{x}} = 4.3.2.1.a = 24\,a$$

Here the expression for $\frac{\dot{r}}{\dot{x}}$ is a constant quantity, which has no fluxion.

Hence it appears, that relatively to any function of a variable quantity, there exists a series of limiting ratios, deducible from that function, and from each other, by a repetition of the operation of finding the fluxion of a variable function.

42. In treating of the fluxion of a function, we have hitherto regarded the fluxion of the variable quantity x, from which the function is formed, merely as one of the terms of a ratio, without considering whether it was a constant or a variable quantity.

Now as we may assume any hypothesis respecting the nature of the fluxion of x, that is not inconsistent with what has been already delivered, we shall suppose it to be constant. This assumption, if we consider the fluxions of variable quantities as the measures of their respective velocities, or rates of increase, is in effect the same thing as to suppose that the variable quantity x increases uniformly. Then, as in the expressions

$$\frac{\dot{u}}{\dot{x}} = p,\ \frac{\dot{p}}{\dot{x}} = q,\ \frac{\dot{q}}{\dot{x}} = r,\ \&c.$$

or these others, which follow from them,

$$\dot{u} = p\dot{x},\ \dot{p} = q\dot{x},\ \dot{q} = r\dot{x},\ \&c.$$

the symbol $\dot{x}$ is to be understood as denoting a constant quantity, it follows that if p be variable, then $p\dot{x}$, or $\dot{u}$ will be variable; and if q be variable, then $q\dot{x}$, or $\dot{p}$, will

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$\dot{p}$, will be variable; and if r be variable, then $r\dot{x}$, or $\dot{q}$ will be variable and ſo on.

43. Let us now recur to the relation in which the ſucceeding functions p, q, r, &c. ſtand to the original function u.

By performing that particular analytical operation upon the function u, which conſiſts in finding its fluxion, we obtain $p\dot{x}$ as the expreſſion for its fluxion, that is, we get $\dot{u}=p\dot{x}$; and by repeating the operation on the function p, we get $\dot{p}=q\dot{x}$; and therefore $\dot{p}\dot{x}=q\dot{x}^2$; but, $\dot{x}$ being regarded as a conſtant quantity, $\dot{p}\dot{x}$ is deduced from $p\dot{x}$, conſidered as a function of x, juſt in the ſame manner as $p\dot{x}$ is derived from the original function u; therefore the expreſſion $q\dot{x}^2$ is deduced from the function u by performing the operation of taking the fluxion twice; that is, firſt upon the function u itſelf, and then upon $\dot{u}$, or $p\dot{x}$, the expreſſion for its fluxion; and in this ſecond operation $\dot{x}$ (or the fluxion of the quantity from which the function is formed) is conſidered as a conſtant quantity.

The expreſſion $q\dot{x}^2$, obtained in this manner from the function u, is called the *ſecond fluxion* of the function; and to expreſs its relation to the function u, it is denoted by $\ddot{u}$, that is, by the letter denoting the function itſelf with two dots over it. Thus, like as $\dot{u}=p\dot{x}$, we have

$$\ddot{u}=q\dot{x}^2, \text{ and } \frac{\ddot{u}}{\dot{x}^2}=q.$$

Again, ſince $\dot{q}=r\dot{x}$, it follows that $\dot{q}\dot{x}^2=r\dot{x}^3$; but, as $\dot{x}$ is conſtant, $\dot{q}\dot{x}^2$ is derived from $q\dot{x}^2$, by the operation of finding its fluxion, conſidering it as a function of x, juſt in the ſame manner as $q\dot{x}^2$, or $\ddot{u}$ is derived from $p\dot{x}$, or $\dot{u}$, and in the ſame manner as $\dot{u}$ is derived from the original function u; therefore, like as $p\dot{x}$ or $\dot{u}$ is the firſt fluxion of the function, and $q\dot{x}^2$ or $\ddot{u}$ is its ſecond fluxion, ſo $r\dot{x}^3$ is called its *third fluxion*, and is denoted by $\dddot{u}$, that is by the letter expreſſing the function itſelf, having three dots placed over it, ſo that

$$\dddot{u}=r\dot{x}^3 \text{ and } \frac{\dddot{u}}{\dot{x}^3}=r.$$

The fourth fluxion of a variable function u is denoted by $\ddddot{u}$, that is by the letter u with four dots over it, and is derived from the third fluxion, in the ſame manner as the third is derived from the ſecond, or the ſecond from the firſt, or the firſt fluxion from the variable function itſelf; obſerving, that in repeating the operation of taking the fluxions, the ſymbol $\dot{x}$ (or the fluxion of the variable quantity from which the function is formed) is conſidered as a conſtant quantity. And the ſame mode of notation and deduction is to be underſtood as applying to a fluxion of any order whatever of a variable function.

44. To illuſtrate what has been ſaid reſpecting the ſecond and higher orders of fluxions of a function, let us ſuppoſe u to denote the particular function ax^n; then, proceeding agreeably to what has been laid down in laſt ſection, we obtain, by the rule for finding the fluxion of any power of a variable quantity (§ 26)

$$\dot{u}=nax^{n-1}\dot{x},$$

$$\ddot{u}=n(n-1)ax^{n-2}\dot{x}^2,$$

$$\dddot{u}=n(n-1)(n-2)ax^{n-3}\dot{x}^3,$$

$$\ddddot{u}=n(n-1)(n-2)(n-3)ax^{n-4}\dot{x}^4, \text{ \&c.}$$

Here we have exhibited the firſt, ſecond, third, and fourth fluxions of the function ax^n; the law of continuation is obvious, and it appears that when n is any poſitive integer, the function ax^n will have as many orders of fluxions, as there are units in n, and no more; for if n were ſuppoſed $=3$, then, as the fourth fluxion, and all the ſubſequent ones, are multiplied by $n-3$, or in that caſe by $3-3=0$, they conſequently would vaniſh, and a ſimilar obſervation may be made when n is any other whole poſitive number.

45. That we might be able to apply the rules of § 26, § 34, &c. to the determination of the fluxion of a complex function of a variable quantity, we have found it convenient in ſome caſes to conſider ſuch a function as compoſed of other more ſimple functions of the ſame quantity, and we have expreſſed its fluxion by means of the fluxions of thoſe other functions. In finding the fluxion of any higher order than the firſt of ſuch a complex function by thoſe rules, we muſt keep in mind, that it is only the fluxion of x, the variable quantity from which the functions are all formed, that is to be conſidered as conſtant, and that the fluxions of the functions themſelves are in general variable quantities; ſo that each of them may have a ſecond, third, &c. fluxion, as well as the function which is compoſed of them.

Let us ſuppoſe for example, that

$$u=\sqrt{(a^2+x^2)};$$

then, conſidering a^2+x^2 as a function of x, and putting v to denote it, we have $u=\sqrt{v}=v^{\frac{1}{2}}$, and $\dot{u}=\frac{1}{2}v^{-\frac{1}{2}}\dot{v}=\frac{\frac{1}{2}\dot{v}}{\sqrt{v}}$; but ſince $v=a^2+x^2$, it follows that $\dot{v}=2x\dot{x}$; therefore, ſubſtituting for v and $\dot{v}$ their reſpective values, we have

$$\dot{u}=\frac{x\dot{x}}{\sqrt{(a^2+x^2)}}.$$

Now, to find the ſecond fluxion of u, we may either take the fluxion of this laſt expreſſion, viz. $\frac{x\dot{x}}{\sqrt{(a^2+x^2)}}$, and conſider the ſymbol $\dot{x}$, which is found in it, as denoting a conſtant quantity; or we may recur to the equation $\dot{u}=\frac{\frac{1}{2}\dot{v}}{\sqrt{v}}$, and take the fluxion of this other expreſſion for $\dot{u}$; and in this caſe, we muſt conſider that both v and $\dot{v}$ denote variable functions of x, and therefore that the fluxion of $\frac{\frac{1}{2}\dot{v}}{\sqrt{v}}$ may be found by the rule

for

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for finding the fluxion of a function; observing that $\ddot{v}$ is to be substituted as the fluxion of $\dot{v}$. Accordingly, proceeding by this last method, and considering that the fluxion of $\sqrt{v}$ the denominator of the fraction is $\frac{\frac{1}{2}\dot{v}}{\sqrt{v}}$, we find

$$\dot{u}\begin{cases} =\dfrac{\frac{1}{2}\sqrt{v}\,\ddot{v}-\dfrac{\frac{1}{4}\dot{v}}{\sqrt{v}}\dot{v}}{v}, \\[2ex] =\dfrac{2v\ddot{v}-\dot{v}^2}{4v\sqrt{v}}. \end{cases}$$

Now from the equation $v=a^2+x^2$, we have $\dot{v}=2x\dot{x}$, and (observing that $\dot{x}$ is constant) $\ddot{v}=2\dot{x}^2$. Let these values of v, $\dot{v}$, and $\ddot{v}$, be now substituted in the expression for $\dot{u}$, and it becomes

$$\ddot{u}\begin{cases} =\dfrac{4(a^2+x^2)\dot{x}^2-4x^2\dot{x}^2}{4(a^2+x^2)\sqrt{(a^2+x^2)}} \\[2ex] =\dfrac{a^2\dot{x}^2}{(a^2+x^2)^{\frac{3}{2}}}, \end{cases}$$

The very same expression for $\ddot{u}$ would have been found if we had employed the other method.

By proceeding as in this last example, the rules already delivered for finding the first fluxion of any function of a variable quantity will apply to the finding of the fluxion of any higher order.

Thus if we had $u=vt$, where v and t denote each a function of another variable quantity x, and it were required to find the different orders of fluxions of u, considered also as a function of x; then, by the rule of § 37, we have

$$\dot{u}=t\dot{v}+v\dot{t},$$
and $\ddot{u}=$ fluxion of $t\dot{v}$ + fluxion of $v\dot{t}$;

but v and t being variable functions of x, we may consider $\dot{v}$ and $\dot{t}$ as denoting also variable functions of x, the the fluxions of which are to be denoted by $\ddot{v}$ and $\ddot{t}$ respectively; now by the rule in § 37, we have

fluxion of $t\dot{v}=\dot{v}\dot{t}+t\ddot{v}$,
and fluxion of $v\dot{t}=\dot{t}\dot{v}+v\ddot{t}$,
therefore, $\ddot{u}=2\dot{v}\dot{t}+t\ddot{v}+v\ddot{t}$.

By considering v, $\dot{v}$, $\ddot{v}$, also t, $\dot{t}$, $\ddot{t}$, as denoting each a distinct function of x, we may find the third fluxion of u from the second, in the same manner as the second has been found from the first, and so on for the other orders of fluxions of u. If it be now required to express the successive orders of fluxions of u in terms of x and its fluxion, we must find the values of $\dot{v}$, $\ddot{v}$, &c. also of $\dot{t}$, $\ddot{t}$ &c. in terms of x and its fluxion, and these values, also the particular functions of x denoted by v and t, being substituted in the expressions found for $\dot{u}$, $\ddot{u}$, &c. will give to these expressions the form required.

If for example we suppose that

$$v=a+bx^m, \qquad t=c+dx^n,$$
then $\dot{v}=mbx^{m-1}\dot{x}$, $\quad\dot{t}=ndx^{n-1}\dot{x}$

and, considering $\dot{x}$ as constant,

$$\ddot{v}=m(m-1)bx^{m-2}\dot{x}^2, \qquad \ddot{t}=n(n-1)dx^{n-2}\dot{x}^2$$
&c.

these values of v, t, $\dot{v}$, $\dot{t}$, &c. being substituted in the expressions of $\dot{u}$, $\ddot{u}$, &c. will give the successive fluxions of u in terms of x and $\dot{x}$ only.

46. If the fluxion of a variable quantity be considered as the measure of its rate of increase, if that rate be uniform, then its measure will be a constant quantity; but if it be variable, then its measure will be a variable quantity, which will also have a certain rate of increase or decrease; and the measure of this rate will be its fluxion, or will be the fluxion of the fluxion of the original variable quantity; that is, it will be the second fluxion of the original variable quantity. And if this second fluxion is not a constant quantity, then the measure of its rate of variation will be its fluxion, or will be the third fluxion of the original variable quantity, and so on. Thus a quantity will have a successive order of fluxions till some one fluxion become constant, and then it will have no more.

47. We have hitherto supposed the equation expressing the relation between a variable quantity, and a function of that quantity, to be of such a form, that the function was found alone, and of the first degree on one side of the equation, and some power, or combination of powers, of the variable quantity on the other; as in these examples,

$$u=ax^n, \qquad u=\frac{a+bx^m}{c+dx^n}.$$

In such cases as these, u is said to be an *explicit* function of x. We are now to consider how the ratio of the fluxions is to be found when the relation between the variable quantity and its function is expressed by an equation, the terms of which involve different powers, both of the function, and the variable quantity; as in the following example,

$$y^2-axy+bx^2-c=0,$$

where we are to consider y as a function of x; but from the particular manner in which its relation to x is expressed, it is said to be an *implicit* function of that quantity.

Now in this example, by the resolution of a quadratic equation, we find

$$y=\frac{ax\pm\sqrt{\{(a^2-4b)x^2+4c\}}}{2},$$

and as y is here an *explicit* function of x, its fluxion, or the ratio of its fluxion to that of x, might be determined by the rules already laid down. But it is to be observed that it is only in the particular case of the proposed equation being of the second degree that we can effect the solution generally in this manner. If it were

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were of a higher order, this particular mode of solution would be often impracticable, for want of a general method of resolving equations.

48. We may however in all cases resolve the problem, without a previous resolution of the equation, by reasoning as follows.

Whatever be the degree of the equation, by giving particular values to x, we can, by the theory of equations, obtain corresponding particular values of y; therefore, we may be assured that in every case y is expressible by means of x in some way or other, if not in finite terms, at least in the form of a series, the terms of which shall involve powers of x. Hence we may infer, as in the case of *explicit* functions, that when x changes its value, and becomes $x+h$, y will also change its value, and become

$$y+p\,h+q\,h^2+\text{\&c.}$$

where p, q, &c. denote functions of x, that are independent of the arbitrary quantity h. Let us denote $p\,h+q\,h^2+$ &c. the increment of y, by the single letter k; then $y+k$ is the new value of y, corresponding to $x+h$, the new value of x. Let these new values be substituted instead of x and y in the proposed equation

$$y^2-a\,x\,y+b\,x^2-c=0,$$

and as the result must still be $=0$, we have

$$(y+k)^2-a(x+h)(y+k)+b(x+h)^2-c=0\,;$$

which equation, by actually involving its terms, substituting for k its value $p\,h+q\,h^2+$&c. and arranging the result in the form of a series proceeding by the powers of h, becomes

$$\left.\begin{array}{r} y^2-a\,x\,y+b\,x^2-c \\ (2p\,y-a(p\,x+y)+2\,b\,x)h \\ +\mathrm{Q}\,h^2+\mathrm{R}\,h^3+\text{\&c.} \end{array}\right\}=0$$

Here Q, R, &c. denote quantities independent of h, and involving x, y, p, q, &c. that is to say, x, and functions of x, and therefore Q, R, &c. are also functions of x. Now as this equation must subsist whatever h may be, which is a quantity quite arbitrary and independent of the coefficients by which its powers are multiplied; it follows (as has been observed when treating of the method of indeterminate coefficients, ALGEBRA, § 261.) that the coefficients of the different powers of h must be each equal to 0.

Therefore,

$$\begin{gathered} y^2-a\,x\,y+b\,x^2-c=0 \\ 2p\,y-a(p\,x+y)+2\,b\,x=0, \\ \text{\&c.} \end{gathered}$$

From the first of these equations we can infer nothing, as it is no other than the proposed equation itself; but from the second we find

$$p=\frac{a\,y-2\,b\,x}{2\,y-a\,x}.$$

Now h, and $k=ph+q\,h^2+$ &c. being the simultaneous increments of x and y, we have $\frac{k}{h}=p+q\,h+$ &c. therefore, supposing h to be continually diminished, and putting $\frac{\dot{y}}{\dot{x}}$ equal to the limit of $\frac{k}{h}$, we have $\frac{\dot{y}}{\dot{x}}=p$, therefore

$$\frac{\dot{y}}{\dot{x}}=\frac{a\,y-2\,b\,x}{2\,y-a\,x};$$

thus we have obtained an expression for the ratio of the fluxions of y and x, from which we find

$$2\,y\dot{y}-a\,(x\dot{y}+y\dot{x})+2\,b\,x\dot{x}=0,$$

and this is precisely the expression we should have obtained, had we taken the fluxion of each term of

$$y^2-a\,x\,y+b\,x^2-c=0,$$

the proposed equation, and put the result equal to 0.

49. But to see that this will always be the case, whatever be the degree of the equation, we have only to observe, that, by the very same process employed to deduce from the original equation

$$y^2-a\,x\,y+b\,x^2-c=0,$$

these two others

$$2\,y\,p-a\,(x\,p+y)+2\,b\,x=0,$$

$$2\,y\,\dot{y}-a\,(x\,\dot{y}+y\,\dot{x})+2\,b\,x\,\dot{x}=0\,;$$

if we suppose the equation to be generally expressed thus,

$$y^l+a\,y^m\,x^n\cdots+x^r+c=0,$$

where the exponents l, m, n, &c. r denote constant quantities, we shall obtain

$$\left.\begin{array}{l} l\,y^{l-1}p+a\,(m\,y^{m-1}x^n p+n\,y^m x^{n-1}) \\ \qquad\ldots+r\,x^{r-1} \end{array}\right\}=0,$$

and hence, by substituting for p its value $\frac{\dot{y}}{\dot{x}}$, and bringing $\dot{x}$ from the denominator,

$$\left.\begin{array}{l} l\,y^{l-1}\dot{y}+a\,(m\,y^{m-1}x^n\dot{y}+n\,y^m\,x^{n-1}\dot{x}) \\ \qquad\ldots+r\,x^{r-1}\dot{x} \end{array}\right\}=0.$$

From which it appears that, when the relation between x, a variable quantity, and y, a function of that quantity, is expressed by an equation, the terms of which are brought all to one side, so as to produce an expression $=0$; *the relation of the fluxions will be found, by taking the fluxion of each term of the equation (considering* y *as a function of* x*), and putting the sum of these fluxions equal to* 0.

50. Having from the equation

$$y^2-a\,x\,y+b\,x^2-c=0,$$

found that

$$\dot{y}=\frac{(a\,y-2\,b\,x)\,\dot{x}}{2\,y-a\,x},$$

if it be required to find the second fluxion of y, we have only to take the fluxion of the latter side of this equation,

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equation, considering $\dot{x}$ as constant, and y as a function of x; thus we have

$$\ddot{y}=\frac{\left\{\begin{array}{l}(2y-ax)(a\dot{y}-2b\dot{x})\dot{x}\\-(ay-2bx)(2\dot{y}-a\dot{x})\dot{x}\end{array}\right\}}{(2y-ax)^2}$$

an equation which abbreviates to

$$\ddot{y}=\frac{(4l-a^2)(x\dot{y}-y\dot{x})\dot{x}}{(2y-ax)^2},$$

and from which we may exterminate $\dot{y}$ by means of the equation

$$\dot{y}=\frac{(ay-2bx)\dot{x}}{2y-ax}.$$

By the same mode of proceeding we may determine the third, or any higher fluxion of the function y.

51. As far as we have yet gone in explaining the principles of fluxions, we have had continually occasion to employ the rule for finding the fluxion of the particular function x^n, where x denotes a variable quantity, and n any constant number; and we may therefore, in respect of other functions consider x^n as a simple function. Besides the function x^n, writers on Analysis have considered each of the following as also constituting a simple analytic function of a variable quantity; viz.

a^x, where a is constant, and x is variable.

Log. x, that is the logarithm of x, a variable number.

Sin. x, that is the sine of x, a variable arch of a circle, radius being unity.

Cos. x, that is the cosine of x, a variable arch of a circle, radius being as before unity.

52. We have already found the fluxion of x^n, and we proceed to find the fluxions of the other simple functions of x; and, as in the investigation of these we shall have occasion to employ the binomial theorem, it will be proper to show how that theorem may be deduced from the principles already explained. We are then to find the series that expresses $(a+x)^n$, when n is any number whatever. Or, since $(a+x)^n$ is equal to $a^n\ (1+v)^n$, where v denotes the fraction $\frac{x}{a}$, we may leave the quantity a^n out of consideration, as has been formerly observed, § 28, and seek the series that expresses $(1+v)^n$. As we have already pointed out (§ 28) the process of induction by which we may find the general form of the series, we shall not here repeat it, but assume

$$(1+v)^n=1+Av+Bv^2+Cv^3+Dv^4+\&c.$$

where A, B, C, D, &c. denote numbers that are independent of v.

Now, as the fluxion of a variable function must be the same, whether that function be expressed by one term, or developed into a series of terms; by performing the operation of taking the fluxion on each side of the above equation, the results must be equal, that is, § 26.

$$n(1+v)^{n-1}\dot{v}=A\dot{v}+2Bv\dot{v}+3Cv^2\dot{v}+4Dv^3\dot{v}+\&c.$$

or, leaving out the quantity $\dot{v}$, common to each term,

$$n(1+v)^{n-1}=A+2Bv+3Cv^2+4Dv^3+\&c.$$

Let both sides of this equation be multiplied by $1+v$, and divided by n, thus we shall have

$$(1+v)^n=\frac{1}{n}\left\{\begin{array}{l}A+2Bv+3Cv^2+4Dv^3+\&c.\\ \quad+Av+2Bv^2+3Cv^3+\&c.\end{array}\right\}$$

Thus, by performing on the quantities the analytical process of taking their fluxions, we have obtained a new expression for $(1+v)^n$. Let the quantities that are independent of v in each expression be put equal to each other, and also the co-efficients of like powers of v; thus we obtain

$$1=\frac{A}{n},\ \text{and hence } A=n$$

$$A=\frac{A+2B}{n},\quad B=\frac{n-1}{2}A$$

$$B=\frac{2B+3C}{n},\quad C=\frac{n-2}{3}B$$

$$C=\frac{3C+4D}{n},\quad D=\frac{n-3}{4}C$$

&c. &c.

Or, substituting successively the expression for each coefficient in that which follows it,

$$A=n,$$

$$B=\frac{n(n-1)}{2},$$

$$C=\frac{n(n-1)(n-2)}{2\cdot 3},$$

$$D=\frac{n(n-1)(n-2)(n-3)}{2\cdot 3\cdot 4},$$

&c.

Hence it appears that

$$(1+v)^n=1+nv+\frac{n(n-1)}{2}v^2+\frac{n(n-1)(n-2)}{2\cdot 3}v^3$$
$$+\frac{n(n-1)(n-2)(n-3)}{2\cdot 3\cdot 4}v^4+\&c.$$

and therefore, substituting $=\frac{x}{a}$ for v, and multiplying by a^n,

$$(a+x)^n=a^n+na^{n-1}x+\frac{n(n-1)}{2}a^{n-2}x^2$$
$$+\frac{n(n-1)(n-2)}{2\cdot 3}a^{n-3}x^3+\&c.$$

where the law of continuation is evident.

53. We now proceed to investigate the fluxion of the function $u=a^x$, a being supposed constant, and x the variable quantity, to which the function is referred.

 Let

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Let x be supposed, as formerly, to change its value, and to become $x+h$, and put u' for the new value that the function acquires by this change in the magnitude of x, then we have

$$u'=a^{x+h}=a^x \times a^h,$$

and, taking the difference between the two succeeding values,

$$u'-u=a^x \times a^h - a^x = a^x(a^h-1).$$

We must now develope the expression a^h-1 into a series, the terms of which are arranged according to the successive powers of the increment h. To effect this, let us put $b=a-1$, so that $a=1+b$, and $a^h=(1+b)^h$; but by the binomial theorem, this last expression may be expanded into the following series:

$$1+hb+\frac{h(h-1)}{2}b^2+\frac{h(h-1)(h-2)}{2\cdot 3}b^3+\&c.$$

Therefore,

$$a^h=1+hb+\frac{h(h-1)}{2}b^2+\frac{h(h-1)(h-2)}{2\cdot 3}b^3+\&c.$$

As the terms of this series are not arranged according to the powers of h, but according to the powers of b, it is necessary that we transform it into another having the required form; now this may be effected by actually multiplying together all the factors that constitute each term, and arranging the series anew in such a manner, that each of its terms may be a power of h, multiplied by a coefficient composed only of the powers of b, and given numbers;

Accordingly we have

$$\begin{aligned} hb \quad . \quad . \quad . \quad &= bh, \\ \frac{h(h-1)}{2}b^2 \quad &= -\frac{b^2}{2}h+\frac{b^2}{2}h^2, \\ \frac{h(h-1)(h-2)}{2\cdot 3}b^3 &= \frac{b^3}{3}h-\frac{b^3}{2}h^2+\frac{b^3}{6}h^3, \\ \&c. \end{aligned}$$

Therefore, by taking the sum of all the quantities on each side of these equations, we get the series,

$$1+hb+\frac{h(h-1)}{2}b^2+\frac{h(h-1)(h-2)}{2\cdot 3}b^3+\&c.$$

otherwise expressed thus,

$$1+A\,h+B\,h^2+C\,h^3+\&c.$$

where A is equal to the infinite series $b-\frac{b^2}{2}+\frac{b^3}{3}-\frac{b^4}{4}+\&c.$

that is, to

$$\frac{a-1}{1}-\frac{(a-1)^2}{2}+\frac{(a-1)^3}{3}-\frac{(a-1)^4}{4}+\&c.$$

and B, C, &c. are also quantities composed of the powers of b, and consequently are independent of h; but as these are all to disappear in the course of the investigation, it is not necessary to express them otherwise, than by a general symbol. Therefore, we have now got

$$a^h=1+A\,h+B\,h^2+C\,h^3+\&c.$$

and consequently,

$$u'-u=a^x(a^h-1)=a^x(A\,h+B\,h^2+Ch^3+\&c.)$$

and

$$\frac{u'-u}{h}=A\,a^x+B\,a^xh+C\,a^xh^2+\&c.$$

Hence, when h is conceived to be continually diminished, we have the limit of $\frac{u'-u}{h}$, expressed by Aa^x, and therefore § 21,

$$\frac{\dot{u}}{\dot{x}}=Aa^x, \text{ and } \dot{u}=A\,a^x\dot{x}.$$

54. In the preceding investigation, we have had occasion to develope the exponential expression a^h into a series of this form,

$$1+A\,h+B\,h^2+C\,h^3+\&c.$$

that is, a series the terms of which are the successive powers of the exponent, each multiplied by a coefficient, which is independent of the exponent.

We have however only determined the coefficients of the first two terms of the series, these being the only ones we had occasion to employ.

The result of the investigation however may be applied to determine all the coefficients by the very same kind of process as that which we have employed in § 53, to determine the coefficients of the terms of the series which constitutes the other expansion of a^h.

Instead of denoting the exponent by h, let us consider it as a variable quantity, and express it by x, then, from what has been shewn it appears that

$$a^x=1+A\,x+B\,x^2+C\,x^3+D\,x^4+\&c.$$

where A, B, C, &c. express constant quantities. Let the operation of taking the fluxions be now performed on both sides of this equation, (observing that the fluxion of a^x is $A\,a^x\,\dot{x}$) and let all the terms be divided by $\dot{x}$, which is common to each, thus we obtain

$$A\,a^x=A+2B\,x+3C\,x^2+4D\,x^3+\&c.$$

and, dividing by A,

$$a^x=1+2\frac{B}{A}x+\frac{3\,C}{A}x^2+\frac{4\,D}{A}x^3+\&c.$$

Let the coefficients of the same powers of x in each of the two series expressing a^x be put equal to each other, then,

$$\begin{aligned} &\frac{2B}{A}=A, \text{ hence, } &B=\frac{A^2}{2}, \\ &\frac{3C}{A}=B, \quad . \quad . \quad . &C=\frac{A^3}{2.3}, \\ &\frac{4D}{A}=C, \quad . \quad . \quad . \quad . &D=\frac{A^4}{2.3.4}, \\ &\&c. &\&c. \end{aligned}$$

Therefore,

Therefore, substituting these values of B, C, D, &c. in the original series, we have

$$a^x = 1 + Ax + \frac{A^2x^2}{2} + \frac{A^3x^3}{2.3} + \frac{A^4x^4}{2.3.4} + \&c.$$

the same result as has been found in the article ALGEBRA, § 293. by proceeding in a different manner.

55. If we suppose $x=1$, then the preceding equation becomes

$$a = 1 + A + \frac{A^2}{2} + \frac{A^3}{2.3} + \frac{A^4}{2.3.4} + \&c.$$

and if we suppose $x = \frac{1}{A}$, it becomes

$$a^{\frac{1}{A}} = 1 + 1 + \frac{1}{2} + \frac{1}{2.3} + \frac{1}{2.3.4} + \&c.$$

thus the quantity $a^{\frac{1}{A}}$ is equal to a constant number which is the value of a when $A=1$, and which, by taking the sum of the first ten terms of the series, is found to be 2·7182818, or, by taking the sum of a greater number of terms, more accurately

$$2{\cdot}718281828459045\ldots$$

We shall, in the remainder of this treatise, denote this number always by e, then $a^{\frac{1}{A}} = e$, and $a = e^A$, and taking the logarithms, log. $a = A \times$ log. e, hence

$$A = \frac{\text{log.}\,a}{\text{log.}\,e}.$$

56. If we now substitute this value of A in the expression for the fluxion of $u=a^x$, found in § 53, it becomes

$$\dot{u} = \frac{\text{log.}\,a}{\text{log.}\,e}\, a^x \dot{x}.$$

Hence it appears, that the fluxion of the function a^x *is equal to the fluxion of* x *multiplied by the function itself, and by the quotient arising from the division of the logarithm of* a *by the logarithm of* e, *where* e *denotes* $1 + \frac{1}{1} + \frac{1}{1.2} + \frac{1}{1.2.3} + \frac{1}{1.2.3.4} + \&c.$ *a series whose sum is* 2·7182818 *nearly.*

57. Let us now consider the third simple function of x, namely $u=$log. x. Let a be the radical number of the particular system, in which u is a logarithm, and x the corresponding number; then from the nature of logarithms (see ALGEBRA, § 277.) we have $a^u = x$. Now, whether we consider u as a function of x, or x as a function of u, the limiting ratio of their simultaneous increments, and consequently the ratio of their fluxions will be the very same. But by considering x as a function of u, we have immediately, from what has been shewn in § 53, and § 55,

$$\frac{\dot{x}}{\dot{u}} = A\,a^u = Ax,$$

and therefore, $\dot{u} = \frac{1}{A}\frac{\dot{x}}{x} = \frac{\text{log.}\,e}{\text{log.}\,a}\frac{\dot{x}}{x}$, but as a is the radical number of the system, log. $a=1$, therefore

$$\dot{u} = \text{log.}\,e\,\frac{\dot{x}}{x}.$$

The number which we have denoted by e occurs very often in analytical investigations; it is the radical number of the system of logarithms first invented by *Baron Napier*, and called by some writers *Hyperbolic* logarithms, but by others, with more propriety, *Napierean* logarithms. The expression $\frac{\text{log.}\,e}{\text{log.}\,a}$ is called the *modulus* of the system of logarithms whose radical number is a. In the Napierean system $\frac{\text{log.}\,e}{\text{log.}\,a} = \frac{\text{log.}\,e}{\text{log.}\,e} = 1$, that is, the *modulus* is unity; but in the common system, or that in which $a=10$, the *modulus* $\frac{\text{log.}\,e}{\text{log.}\,a} = 0{\cdot}434294482$. The rule for finding the fluxion of the logarithm of a variable quantity may now be expressed thus:

Multiply the fluxion of the variable quantity by the modulus of the system, and divide the product by the variable quantity itself, the result is the fluxion required.

58. By the application of the rule for finding the fluxion of the logarithm of a variable quantity we may readily find the fluxions of exponential functions in general. Thus, for example, if $u=z^y$, z and y being both functions of any variable quantity x, then log. $u = y \times$ log. z; and taking the fluxions (considering $y \times$log. z as the product of two functions y and log. z, and proceeding by the rules of § 37 and last),

$$\frac{\dot{u}}{u} = \dot{y}\,\text{log.}\,z + y\frac{\dot{z}}{z},$$

and hence

$$\dot{u} = u\left(\dot{y}\,\text{log.}\,z + y\frac{\dot{z}}{z}\right),$$

$$= z^y\left(\dot{y}\,\text{log.}\,z + \frac{y\dot{z}}{z}\right).$$

59. We are next to consider the functions $u=$sin. x; and $u=$cos. x.

Suppose x to change its value, and to become $x+h$, and u to become u', then, since

$$u = \text{sin.}\,x, \text{ and } u' = \text{sin.}\,(x+h),$$

$$u' - u = \text{sin.}\,(x+h) - \text{sin.}\,x;$$

but by the arithmetic of sines (see ALGEBRA, § 353), sin. $(x+h)=$sin. x cos. $h+$cos. x sin. h, therefore,

$$u' - u = \text{cos.}\,x\,\text{cos.}\,h + \text{cos.}\,x\,\text{sin.}\,h - \text{sin.}\,x.$$

$$= \text{cos.}\,x\,\text{sin.}\,h - \text{sin.}\,x\,(1 - \text{cos.}\,h).$$

In this case, as when treating formerly of other functions, we might consider the above expression for $u'-u$, as resolvable into a series $p\,h + q\,h^2 +$ &c. proceeding by the powers of the increment, and thence we might

might find the limit of $\frac{u'-u}{h}$ as before. But we may diſcover the limit otherwiſe, by proceeding as follows; Becauſe

$$\sin^2 h = 1-\cos^2 h = (1+\cos h)\,(1-\cos h)$$

therefore, $1-\cos h = \frac{\sin^2 h}{1+\cos h}$;

Let this value of $1-\cos h$ be ſubſtituted in the expreſſion for $u'-u$, and it becomes

$$u'-u = \cos x \sin h - \frac{\sin x \sin^2 h}{1+\cos h};$$

And hence, dividing by h, and arranging the terms ſo as to exhibit the ratio $\frac{\sin h}{h}$, we get

$$\frac{u'-u}{h} = \frac{\sin h}{h}\left\{\cos x - \frac{\sin h \sin x}{1+\cos h}\right\}.$$

Conceive now h to be continually diminiſhed, and we ſhall have the limit of $\frac{u'-u}{h}$ equal to the limit of $\frac{\sin h}{h}$ multiplied by the limit of the following expreſſion

$$\cos x - \frac{\sin h \sin x}{1+\cos h}.$$

Now, the ſine of an arch being leſs than the arch itſelf, we have $\frac{\sin h}{h} < 1$. Again, the arch being leſs than its tangent, $\frac{\sin h}{h} > \frac{\sin h}{\tan h}$; but $\tan h = \frac{\sin h}{\cos h}$, and therefore $\frac{\sin h}{\tan h} = \cos h$; conſequently $\frac{\sin h}{h} > \cos h$. Hence it appears, that the expreſſion for the ratio $\frac{\sin h}{h}$ is leſs than 1, or radius, but greater than $\cos h$. But h being conceived to be continually diminiſhed, $\cos h$ continually approaches to 1, and may come nearer to it than by any aſſignable difference; therefore, the limit of $\frac{\sin h}{h}$ is 1. As to the other expreſſion, $\cos x - \frac{\sin h \sin x}{1+\cos h}$; when h is ſuppoſed to be continually diminiſhed, its ſecond term, to wit, $\frac{\sin h \sin x}{1+\cos h}$ may become leſs than any aſſignable quantity; therefore the limit of the expreſſion is ſimply $\cos x$: thus, upon the whole, we have found that the limit of $\frac{u'-u}{h}$ s $\cos x$, and therefore

$$\frac{\dot u}{\dot x} = \cos x, \text{ and } \dot u = \dot x \cos x.$$

The fluxion of the other function, $u = \cos x$, is eaſily deduced from that which we have juſt found, by proceeding thus:

Put c to denote a quadrant, then $\cos x = \sin (c-x)$, and therefore

$$u = \sin (c-x).$$

Now, it has been juſt ſhewn that

$$\text{flux. of } \sin (c-x) = \cos (c-x) \times \text{flux. of } (c-x)$$

but $\cos (c-x) = \sin x$, and the fluxion of $c-x$ is $-\dot x$, therefore

$$\dot u = -\dot x \sin x.$$

Thus it appears, that the fluxion of the ſine of a variable arch is equal to the fluxion of the arch multiplied by its coſine; and that the fluxion of the coſine is equal to the fluxion of the arch (taken with a negative ſign) multiplied by the ſine.

60. We can now very readily find the fluxion of any other function of an arch of a circle. Thus, ſuppoſe $u = \tan x$; then, becauſe $\tan x = \frac{\sin x}{\cos x}$, we have $u = \frac{\sin x}{\cos x}$. This expreſſion being conſidered as a fractional function of x, we have, by § 39, and what has been juſt now ſhewn,

$$\dot u = \frac{\dot x \cos^2 x + \dot x \sin^2 x}{\cos^2 x},$$

$$= \frac{\dot x (\cos^2 x + \sin^2 x)}{\cos^2 x};$$

or, ſince $\cos^2 x + \sin^2 x = 1$, and $\frac{1}{\cos x} = \text{ſecant } x$,

$$\dot u = \frac{\dot x}{\cos^2 x} = \dot x \sec^2 x.$$

Hence alſo we have $\dot x = \frac{\dot u}{\sec^2 x} = \frac{\dot u}{1+u^2}$.

In like manner, if we ſuppoſe $u = \sec x$, then, becauſe $\sec x = \frac{1}{\cos x}$, we have $u = \frac{1}{\cos x}$, and

$$\dot u = \frac{\dot x \sin x}{\cos^2 x},$$

or, ſince $\frac{\sin x}{\cos x} = \tan x$, and $\frac{1}{\cos x} = \sec x$,

$$\dot u = \dot x \tan x \sec x.$$

Proceeding in this manner, we find that when $u = \operatorname{cotan} x$, then

$$\dot u = \frac{-\dot x}{\tan^2 x \cos^2 x} = \frac{-\dot x}{\sin^2 x}$$

And when $u = \operatorname{cosec} x$, then

$$\dot u = \frac{-\dot x \cos x}{\sin^2 x} = -\dot x \operatorname{cotan} x \operatorname{cosec} x.$$

61. Let us now conſider the fluxions of geometrical magnitudes: And firſt let it be required to find the expreſſion for the fluxion of BDPC the area bounded by CP, a curve line, and by CB, PD, the ordinates at its extremities, and BD, the portion of AE, the line of the abſciſſas, which lies between thoſe ordinates. Let the numerical meaſures of AD and PD, the co-ordinates at the point P, be denoted by x and y, and the numerical meaſure of the area BDPC by s; then

Plate CCXIX. fig. 1.

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then y and s may both be considered as functions of the abscissa x.

Let x, or AD, be supposed to change its value, and to become AD′, and let D′P′, and BD′P′C be the corresponding new values of y and s; then DD′, and DD′P′P will be the geometrical expressions for the simultaneous increments of the abscissa and area. But, as one of these quantities is a line, and the other a space, they cannot be compared in respect of their ratio. Therefore, let us consider a as denoting a line whose numerical value is unity, and then the numerical values of the increments of the abscissa and area may be considered as analogous to the geometrical quantities $DD' \times a$, and the area DD′P′P respectively, which quantities being homogeneous may now be compared with each other. We are now to investigate the limit of $\frac{\text{area } DD'P'P}{a \times DD'}$, the general expression for the ratio of the increments of s and x. Draw PM and P′N parallel to AE, meeting the ordinates in M and N. The curvilineal area DD′P′P is greater than the rectangle DD′MP, that is greater than $PD \times DD'$; but less than the rectangle DD′P′N, that is, less than $P'D' \times DD'$, therefore

$$\frac{\text{area } DD'P'P}{a \times DD'} > \frac{PD \times DD'}{a \times DD'} > \frac{PD}{a},$$

$$\text{and } \frac{\text{area } DD'P'P}{a \times DD'} < \frac{P'D' \times DD'}{a \times DD'} < \frac{P'D'}{a}.$$

But the increments being supposed to be continually diminished, $\frac{PD}{a}$ is the limit of $\frac{P'D'}{a}$, therefore $\frac{PD}{a}$ is also the limit of $\frac{\text{area } DD'P'P}{a \times DD'}$, and hence (§ 21.)

$$\frac{\dot{s}}{\dot{x}} = \frac{PD}{a} = \frac{y}{1} = y, \text{ and } \dot{s} = y\dot{x}.$$

That is, the fluxion of a curvilineal area is equal to the product of the ordinate, and the fluxion of the abscissa.

62. Before we proceed to investigate the expression for the fluxion of an arch of a curve, it is necessary that we should inquire what is the limiting ratio of an arch of a curve to its chord.

Fig. 2. Let APB be any curve line, all the parts of which are concave towards its chord AP. Let AQ, QP be tangents at the extremities of the arch, and let apq be a triangle similar to APQ, but having its base ap of a given magnitude, then

$$AQ + QP : AP :: aq + qp : ap.$$

Suppose now the point P to approach to A, then the angles at A and P, and consequently the angles at a and p, which are equal to them, will decrease, and may become less than any assignable angles; therefore, the limit of the ratio of $aq + qp$ to ap is evidently a ratio of equality; hence also the limit of the ratio of $AQ + QP$ to AP is the ratio of equality; and since the arch AP is less than $AQ + QP$, but greater than its chord AP, the limit of the arch AP to its chord AP must also be the ratio of equality.

63. We proceed now to find the fluxion of an arch of a curve. Let APP′ be a curve line of any kind, and AB, BP any two co-ordinates at a point P in the curve. Put x for AB, the abscissa, y for BP, the ordinate, and z for the curve line AP, then z and y may be considered as each a function of x. Draw P′B′ another ordinate, and draw PM parallel to AB, meeting P′B′ in M, and draw the chord PP′; then PM, MP′ and the arch PP′ are the simultaneous increments of x, y, and z respectively. Now we have Fig. 3.

$$\frac{\text{arch } PP'}{PM} = \frac{\text{arch } PP'}{\text{chord } PP'} \times \frac{\text{chord } PP'}{PM.}$$

But $\text{chord } PP' = \sqrt{(PM^2 + MP'^2)} = PM\sqrt{\left(1 + \frac{MP'^2}{PM^2}\right)}$;

herefore,

$$\frac{\text{arch } PP'}{PM} = \frac{\text{arch } PP'}{\text{chord } PP} \times \sqrt{\left(1 + \frac{MP'^2}{PM^2}\right)}.$$

Suppose now the increments to be continually diminished, then, as $\frac{\dot{z}}{\dot{x}} = \text{limit of } \frac{\text{arch } PP'}{PM}$, and $\frac{\dot{y}^2}{\dot{x}^2} = \text{limit of}$ $\frac{MP'^2}{PM^2}$ (§ 21.), and $1 = \text{limit of } \frac{\text{arch } PP'}{\text{chord } PP'}$ (last §) we have

$$\frac{\dot{z}}{\dot{x}} = \sqrt{\left(1 + \frac{\dot{y}^2}{\dot{x}^2}\right)}, \text{ and } \dot{z} = \sqrt{(\dot{x}^2 + \dot{y}^2)}.$$

Hence it appears that the square of the fluxion of a curve line of any kind is equal to the sum of the squares of the fluxions of the co-ordinates.

64. The expression for the fluxion of a solid may be found by the same mode of reasoning as that which we have employed, § 61, to find the fluxion of a curvilineal area. Let $APQp$ be a portion of a solid generated by the revolution of APB, a curve line, about AC, a line taken in the plane of the curve, as an axis. Let PDp, $P'D'p'$ be the lines in which BAb, a plane passing along the axis AC, meets PQp, $P'Q'p'$, the planes of two circles formed by sections of the solid perpendicular to its axis. Draw PM and P′N parallel to AD. Put $AD = x$, $DP = y$, let s denote the solid $APQp$, having y for the radius of its circular base, and x for its altitude; put π for the number 3·14159··· viz. the circumference of a circle having its diameter $= 1$, and let a denote an area, having its numerical measure expressed by unity; then, DD′, or $a \times DD'$ being considered as the increment of x, the portion of the solid comprehended between the parallel planes PQp, $P'Q'p'$ will be the corresponding increment of s, which we are to consider as a function of x; hence (§ 21.) $\frac{\dot{s}}{\dot{x}}$ is equal to the limiting ratio of the portion of the solid, comprehended between the planes PQp, and $P'Q'p'$ to the solid $a \times DD'$. But the former of these solids being evidently greater than a cylinder Pm, having the circle PQp for its base, and DD′ for its altitude, that is greater than $\pi PD^2 \times DD'$, and less than a cylinder Np', having the circle $P'Q'p'$ for its base, and DD′ for its altitude, that is less than $\pi P'D'^2 \times DD'$; Fig. 4.

it

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it follows, that as long as DD′ has an assignable magnitude,

$$\frac{\dot{s}}{\dot{x}} > \pi\, PD^2 \times DD' \times \frac{1}{a \times DD'},$$
$$> \frac{\pi\, PD^2}{a};$$
$$\text{and } \frac{\dot{s}}{\dot{x}} < \pi\, P'D'^2 \times DD' \times \frac{1}{a \times DD'},$$
$$< \frac{\pi\, P'D'^2}{a};$$

but the increment DD′ being continually diminished, $\frac{\pi\, P'D'^2}{a}$, the greater limit of $\frac{\dot{s}}{\dot{x}}$, approaches continually to its lesser limit $\frac{\pi\, PD^2}{a} = \frac{\pi y^2}{a} =$ (because $a=1$) πy^2, so as to come nearer to it than by any assignable difference, therefore $\frac{\dot{s}}{\dot{x}} = \pi y^2$, and $\dot{s} = \pi y^2 \dot{x}$. Now, if we observe that πy^2 is the area of the circle PQp, it will appear, *that the fluxion of a solid generated by the revolution of a curve about its axis is equal to the fluxion of the axis multiplied by the general expression for the area of a circle formed by supposing the solid to be cut by a plane perpendicular to its axis.*

65. To find the fluxion of the surface of the solid, let us denote that surface by s, and let x and y denote as before; then the surface contained between the circles PQp and P′Q′p' will be the increment of s, corresponding to DD′ the increment of x. Draw the chord PP′; then, the curve line PP′ being supposed to revolve about the axis AC, and thus to generate the increment of the surface of the solid, the chord PP′ will generate at the same time the convex surface of a frustum of a cone; now the limiting ratio of the curve line PP′ to its chord PP′ being the ratio of equality, the limiting ratio of the surfaces generated by the revolution of those lines will also be the ratio of equality; therefore $\frac{\dot{s}}{\dot{x}}$, which is equal to the limit of

Fig. 5.

$$\frac{\text{surf. gener. by arch } PP'}{1 \times DD'}$$

will also be equal to the limit of

$$\frac{\text{surf. gener. by chord } PP'}{DD'.};$$

but the convex surface of a frustum of a cone is equal to the product of its slant side into half the sum of the circumferences of its two bases (see GEOMETRY), and in the present case these circumferences are equal to 2 PD $\times \pi$, and 2 P′D′$\times \pi$, therefore $\frac{\dot{s}}{\dot{x}}$ is equal to the limit of

$$\frac{\pi\,(PD+P'D')\,PP'}{DD'} = \pi(PD+P'D')\frac{PP'}{DD'};$$

but the point D′ being supposed to approach to D, the limit of PD+P′D′, will manifestly be 2 PD$=2y$; and since $\frac{PP'}{DD'} = \frac{\sqrt{(DD'^2+P'M^2)}}{DD'} = \sqrt{\left(1+\frac{P'M^2}{DD'^2}\right)}$, the limit of this expression (if we consider that P′M and DD′ are the simultaneous increments of y and x) is evidently equal to $\sqrt{\left(1+\frac{\dot{y}^2}{\dot{x}^2}\right)}$, therefore

$$\frac{\dot{s}}{\dot{x}} = 2\pi y \sqrt{\left(1+\frac{\dot{y}^2}{\dot{x}^2}\right)},$$

and consequently

$$\dot{s} = 2\pi y \sqrt{(\dot{x}^2+\dot{y}^2)}.$$

If we now observe that $2\pi y$ is the circumference of the circle PQp, and $\sqrt{(\dot{x}^2+\dot{y}^2)}$ is the fluxion of the curve line AP, § 63, it will appear, *that the fluxion of the surface of a solid generated by the revolution of a curve about its axis is equal to the fluxion of the curve line multiplied by the general expression for the circumference of a circle formed by supposing the curve to be cut by a plane perpendicular to its axis.*

SECT. III. *The Application of the Direct Method of Fluxions.*

HAVING explained the principles of the direct method of fluxions at as great a length as we think suitable to the work of which this treatise forms a part, we proceed to shew how the calculus may be applied to the resolution of some general problems in Analysis and Geometry.

Investigation of a general formula for expanding a Function into a Series.

66. In treating of the principles of the method of fluxions, we have from an examination of particular functions, inferred by induction, that u being any function of a variable quantity x, which was either actually expressed, or capable of being expressed by a combination of the powers of x, then, x being supposed to change its value, and to become $x+h$, the new value which the function u will acquire when $x+h$ is substituted in it instead of x will always be capable of being expanded into a series of this form,

$$u+p\,h+q\,h^2+r\,h^3+\&c.$$

where p, q, &c. denote functions of x that are quite independent of h.

We have shewn that, from the particular form of this developement, it happens that the ratio of $p\,h+q\,h^2+r\,h^3+$&c. the increment of the function, to h the increment of the variable quantity x itself, admits of a limit, which is always expressed by p, the coefficient of its second term; and as we have defined this limit to be the expression for the ratio of the fluxions of u and x, so that $p=\frac{\dot{u}}{\dot{x}}$, the new value of the function may also be expressed thus

$$u+\frac{\dot{u}}{\dot{x}}h+q\,h^2+r\,h^3+\ \&c.$$

And

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And this expression may be considered as indicating not only the general form of the series, but also the particular relation subsisting between u, the original function, and p, the coefficient of the second term of the series, the latter being in every case that function of x which results from the operation of taking the fluxion of the former, and dividing by $\dot{x}$.

We are now to investigate the relation that subsists between each of the remaining coefficients and the original function.

67. First let us suppose the function u to have the particular form x^n, n being a constant number. Then x changing its value to $x+h$, u changes to $u'=(x+h)^n$, therefore, by the binomial theorem (§ 52.)

$$u'=x^n+n\,x^{n-1}\,h+\frac{n\,(n-1)}{2}\,x^{n-2}\,h^2 + \frac{n\,(n-1)\,(n-2)}{2\cdot 3}\,x^{n-3}\,h^3+\text{\&c.}$$

But since $u=x^n$, by taking the successive fluxions of u, and considering $\dot{x}$ as constant, we have,

$$\frac{\dot{u}}{\dot{x}}=n\,x^{n-1},$$

$$\frac{\ddot{u}}{\dot{x}^2}=n\,(n-1)\,x^{n-2},$$

$$\frac{\dddot{u}}{\dot{x}^3}=n\,(n-1)\,(n-2)\,x^{n-3},$$

$$\frac{\ddddot{u}}{\dot{x}^4}=n\,(n-1)\,(n-2)\,(n-3)\,x^{n-4}.$$

&c.

Let u, $\frac{\dot{u}}{\dot{x}}$, $\frac{\ddot{u}}{\dot{x}^2}$ &c. be now substituted for x^n, $n\,x^{n-1}$, $n\,(n-1)\,x^{n-2}$, &c. respectively, in the series for u', and we have

$$u'=u+\frac{\dot{u}}{\dot{x}}\,h+\frac{\ddot{u}}{\dot{x}^2}\,\frac{h^2}{2}+\frac{\dddot{u}}{\dot{x}^3}\,\frac{h^3}{2\cdot 3}+\frac{\ddddot{u}}{\dot{x}^4}\,\frac{h^4}{2\cdot 3\cdot 4}+\text{\&c.}$$

68. This manner of expressing the developement of u', or $(x+h)^n$, indicates directly the relation that each of the coefficients of the successive powers of h has to the original function.

The first term of the series is the original function u, or x^n, itself, or it is what the function $(x+h)^n$ becomes upon the supposition that $h=0$. The second term is h, or $\frac{h}{1}$, multiplied by the coefficient $\frac{\dot{u}}{\dot{x}}$, which coefficient is a function of x derived from the original function by the operation of taking its fluxion, and dividing the result by $\dot{x}$. The third term is $\frac{h^2}{1.2}$ multiplied by the coefficient $\frac{\ddot{u}}{\dot{x}^2}$, that is, by a function of x derived from the preceding coefficient $\frac{\dot{u}}{\dot{x}}$ by the same operation as that coefficient was derived from the original function, namely by taking the fluxion of $\frac{\dot{u}}{\dot{x}}$, considering $\dot{x}$ as constant, and dividing by $\dot{x}$. The fourth term is $\frac{h^3}{1.2.3}$ multiplied by $\frac{\dddot{u}}{\dot{x}^3}$, that is, by a function of x deduced from the third coefficient by the very same operation as that by which the third was derived from the second, or the second from the first. And so on with respect to all the other terms of the series, the nth term being the product of $\frac{h^{n-1}}{1.2.3\ldots(n-1)}$, and the $(n-1)$th fluxion of the function u divided by $\dot{x}^{n-1}$.

69. Let us now suppose that u denotes any other function of x, then, whatever be its nature, it may always be conceived as capable of being expressed by a series, the terms of which are powers of x, in this manner;

$$A\,x^a+B\,x^b+C\,x^c+D\,x^d+\text{\&c.}$$

where A, B, C, &c. a, b, c, &c. denote constant numbers. Thus we have

$$u=A\,x^a+B\,x^b+C\,x^c+\text{\&c.}$$

Then, x being supposed to become $x+h$, and (in consequence of the change in the value of x) u to become u', we have

$$u'=A\,(x+h)^a+B\,(x+h)^b+C\,(x+h)^c+\text{\&c.}$$

Let us now denote $A\,x^a$ by P, $B\,x^b$ by Q, $C\,x^c$ by R, &c. then by last §

$$A\,(x+h)^a=P+\frac{\dot{P}}{\dot{x}}\,h+\frac{\ddot{P}}{\dot{x}^2}\,\frac{h^2}{2}+\frac{\dddot{P}}{\dot{x}^3}\,\frac{h^3}{2\cdot 3}+\text{\&c.}$$

$$B\,(x+h)^b=Q+\frac{\dot{Q}}{\dot{x}}\,h+\frac{\ddot{Q}}{\dot{x}^2}\,\frac{h^2}{2}+\frac{\dddot{Q}}{\dot{x}^3}\,\frac{h^3}{2\cdot 3}+\text{\&c.}$$

$$C\,(x+h)^c=R+\frac{\dot{R}}{\dot{x}}\,h+\frac{\ddot{R}}{\dot{x}^2}\,\frac{h^2}{2}+\frac{\dddot{R}}{\dot{x}^3}\,\frac{h^3}{2\cdot 3}+\text{\&c.}$$

&c.

Therefore, substituting these developements in the series expressing u',

$$u'=\begin{cases} P+Q+R+\text{\&c.} \\ +\left(\frac{\dot{P}}{\dot{x}}+\frac{\dot{Q}}{\dot{x}}+\frac{\dot{R}}{\dot{x}}+\text{\&c.}\right)h \\ +\left(\frac{\ddot{P}}{\dot{x}^2}+\frac{\ddot{Q}}{\dot{x}^2}+\frac{\ddot{R}}{\dot{x}^2}+\text{\&c.}\right)\frac{h^2}{2} \\ +\left(\frac{\dddot{P}}{\dot{x}^3}+\frac{\dddot{Q}}{\dot{x}^3}+\frac{\dddot{R}}{\dot{x}^3}+\text{\&c.}\right)\frac{h^3}{2\cdot 3} \\ +\text{\&c.} \end{cases}$$

But

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But

$$u = P + Q + R + \text{\&c.}$$

$$\frac{\dot{u}}{\dot{x}} = \frac{\dot{P}}{\dot{x}} + \frac{\dot{Q}}{\dot{x}} + \frac{\dot{R}}{\dot{x}} + \text{\&c.}$$

$$\frac{\ddot{u}}{\dot{x}^2} = \frac{\ddot{P}}{\dot{x}^2} + \frac{\ddot{Q}}{\dot{x}^2} + \frac{\ddot{R}}{\dot{x}^2} + \text{\&c.}$$

&c.

Therefore, substituting $u, \frac{\dot{u}}{\dot{x}}$, &c. for the series to which they are respectively equal,

$$u' = u + \frac{\dot{u}}{\dot{x}}\frac{h}{1} + \frac{\ddot{u}}{\dot{x}^2}\frac{h^2}{1.2} + \frac{\dddot{u}}{\dot{x}^3}\frac{h^3}{1.2.3} + \text{\&c.}$$

Hence it appears that u being any function of x whatever, if $x+h$ be substituted in that function instead of x, the series expressing the developement of this new value of the function will have the general properties which have been shewn, in last §, to belong to it in the case of the function having the particular value x^n.

The very general theorem which we have just now investigated is one of the most elegant and important in analysis. It was first published by *Dr Brooke Taylor* in a work entitled *Methodus Incrementorum*, which made its appearance about the year 1716. The theorem itself is generally known by the name of *Taylor's* theorem. It is more general than the celebrated *Binomial* theorem, inasmuch as this last, and innumerable others, are comprehended in it as particular cases.

70. We shall now give some examples to shew the manner of applying Taylor's theorem, as well as its great utility as an instrument of analysis.

Example 1. Suppose $u = a^x$, a being constant and x variable. Then x becoming $x+h$, u becomes $u' = a^{x+h}$. Now from the equation $u = a^x$ we derive (§ 56.) $\frac{\dot{u}}{\dot{x}} = A\,a^x$ (here A denotes $\frac{\log. a}{\log. e}$). Again, considering $\dot{x}$ as constant, and repeating the operation of taking the fluxion on $\frac{\dot{u}}{\dot{x}} = A\,a^x$, we get $\frac{\ddot{u}}{\dot{x}^2} = A^2 a^x$, and hence again $\frac{\dddot{u}}{\dot{x}^3} = A^3\,a^x$, &c. Therefore, substituting for $u', u, \frac{\dot{u}}{\dot{x}}, \frac{\ddot{u}}{\dot{x}^2}$, &c. their values in the general theorem $u' = u + \frac{\dot{u}}{\dot{x}}h + \frac{\ddot{u}}{\dot{x}^2}\frac{h^2}{2} + \text{\&c.}$ it becomes

$$a^{x+h} = a^x\left(1 + A\,h + \frac{A^2}{2}h^2 + \frac{A^3}{2.3}h^3 + \text{\&c.}\right)$$

Suppose now, that $x=0$, then, as in this case $a^x = 1$, we have

$$a^h = 1 + A\,h + \frac{A^2}{2}h^2 + \frac{A^3}{2.3}h^3 + \text{\&c.}$$

or, exchanging h for x

$$a^x = 1 + Ax + \frac{A^2x^2}{2} + \frac{A^3x^3}{2.3} + \text{\&c.}$$

the same result as we formerly obtained in § 54.

Ex. 2. Suppose $u = \log. x$. Then, x becoming $x+h$, u becomes $u' = \log. (x+h)$. Now from the equation $u = \log. x$, we find (by § 57.) $\frac{\dot{u}}{\dot{x}} = \frac{M}{x}$. Here M denotes the modulus of the system. Again, supposing $\dot{x}$ constant, we find by § 26, $\frac{\ddot{u}}{\dot{x}^2} = -\frac{M}{x^2}$, $\frac{\dddot{u}}{\dot{x}^3} = \frac{2M}{x^3}$, $\ddddot{u} = -\frac{2.3M}{x^4}$ &c. Therefore, substituting as before the values of $u', u, \frac{\dot{u}}{\dot{x}}$, &c. in the general formula $u' = u + \frac{\dot{u}}{\dot{x}}h + \frac{\ddot{u}}{\dot{x}^2}\frac{h^2}{2} + \text{\&c.}$ it becomes

$$\log. (x+h) = \log. x + \frac{M}{x}h - \frac{M}{2x^2}h^2 + \frac{M}{3x^3}h^3 - \text{\&c.}$$

If we suppose $x=1$, and change h into y, we have, because $\log. x = \log. 1 = 0$,

$$\log. (1+y) = M\left(y - \frac{y^2}{2} + \frac{y^3}{3} - \text{\&c.}\right)$$

For the particular method of applying these two series to the calculation of logarithms, see ALGEBRA § 285 to § 291. See also LOGARITHMS.

Ex. 3. Suppose now $u = \text{fin.}\ x$. Then $u' = \text{fin.}\ (x+h)$. From $u = \text{fin.}\ x$, by the application of the rule in § 59, we deduce $\frac{\dot{u}}{\dot{x}} = \text{cof.}\ x$, $\frac{\ddot{u}}{\dot{x}^2} = -\text{fin.}\ x$, $\frac{\dddot{u}}{\dot{x}^3} = -\text{cof.}\ x$, $\frac{\ddddot{u}}{\dot{x}^4} = \text{fin.}\ x$, &c. Therefore, substituting for $u', u, \frac{\dot{u}}{\dot{x}}$, &c. their values in the general formula as before, we have

$$\text{fin.}\ (x+h) = \text{fin.}\ x + \text{cof.}\ x\,\frac{h}{1} - \text{fin.}\ x.\frac{h^2}{1.2}$$
$$-\text{cof.}\ x\,\frac{h^3}{1.2.3} + \text{fin.}\ x\,\frac{h^4}{1.2.3.4} + \text{\&c.}$$

or fin. $(x+h)$ is equal to

$$\text{fin.}\ x\left(1 - \frac{h^2}{2} + \frac{h^4}{1.2.3.4} - \text{\&c.}\right)$$
$$+\text{cof.}\ x\left(h - \frac{h^3}{1.2.3} + \frac{h^5}{1.2.3.4.5} - \text{\&c.}\right)$$

If we suppose $x=0$, then, as in that case fin. $x=0$, the preceding formula becomes

fin.

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$$\text{sin. } h = h - \frac{h^3}{1.2.3} + \frac{h^5}{1.2.3.4.5} - \&c.$$

or, substituting x instead of h,

$$\text{sin. } x = x - \frac{x^3}{1.2.3} + \frac{x^5}{1.2.3.4.5} - \&c.$$

Ex. 4. Suppose $u = \text{cos. } x$, then $u' = \text{cos. } (x+h)$, and since $u = \text{cos. } x$, by § 59, $\frac{\dot{u}}{\dot{x}} = -\text{sin. } x$, $\frac{\ddot{u}}{\dot{x}^2} = -\text{cos. } x$, $\frac{\dddot{u}}{\dot{x}^3} = \text{sin. } x$, &c. Therefore, substituting as before these values in the general formula $u' = u + \frac{\dot{u}}{\dot{x}} h +$ &c. it becomes

$$\text{cos. } (x+h) = \text{cos. } x - \text{sin. } x \frac{h}{1} - \text{cos. } x \frac{h^2}{1.2} + \text{sin. } x \frac{h^3}{1.2.3} + \&c.$$

or cos. $(x+h)$ is equal to

$$\text{cos. } x \left(1 - \frac{h^2}{1.2} + \frac{h^4}{1.2.3.4} - - \&c.\right)$$
$$- \text{sin } x \left(h - \frac{h^3}{1.2.3} + \frac{h^5}{1.2.3.4.5} - \&c.\right)$$

which expression, when $x = 0$, and therefore cos. $x = 1$, sin. $x = 0$, becomes simply

$$\text{cos. } h = 1 - \frac{h^2}{1.2} + \frac{h^4}{1.2.3.4} - \&c.$$

or substituting x for h,

$$\text{cos. } x = 1 - \frac{x^2}{1.2} + \frac{x^4}{1.2.3.4} - \&c.$$

71. It may be remarked that in each of these examples, from the developement of u' the new value of the function u, we have been able to deduce a developement of u the function itself. But it is easy to see, that by proceeding in the same manner with the general formula as we have done in these particular examples, we shall obtain a general expression for the developement of any function whatever.

The general formula is

$$u' = u + \frac{\dot{u}}{\dot{x}} \frac{h}{1} + \frac{\ddot{u}}{\dot{x}^2} \frac{h^2}{1.2} + \frac{\dddot{u}}{\dot{x}^3} \frac{h^3}{1.2.3} + \&c.$$

Now, u' being the value that u assumes when $x+h$ is substituted in it instead of x, if we suppose $x=0$, then u' becomes the very same function of h, that u is of x. Let us denote the values which each of the functions u, $\frac{\dot{u}}{\dot{x}}$, $\frac{\ddot{u}}{\dot{x}^2}$, &c. acquire, when $x=0$, by U, U′, U″ &c. respectively.

Then (F) u' (considered as the same function of h that u is of x) is equal to

$$U + U' \frac{h}{1} + U'' \frac{h^2}{1.2} + U''' \frac{h^3}{1.2.3} + \&c.$$

Let x be now supposed to be substituted both in u', and the series which is its developement instead of h, then u' becomes u, and we have

$$u = U + U' \frac{x}{1} + U'' \frac{x^2}{1.2} + U''' \frac{x^3}{1.2.3} + \&c.$$

and in this formula it is to be considered, as already stated, that U, U′, U″, &c. denote the particular values which the functions u, $\frac{\dot{u}}{\dot{x}}$, $\frac{\ddot{u}}{\dot{x}^2}$, $\frac{\dddot{u}}{\dot{x}^3}$, &c. acquire respectively, by supposing that in each of them x is taken $=0$.

72. As an example of the application of this series let us resume the equation $u = a^x$, then $\frac{\dot{u}}{\dot{x}} = Aa^x$ (§ 56.), $\frac{\ddot{u}}{\dot{x}^2} = A^2 a^x$, $\frac{\dddot{u}}{\dot{x}^3} = A^3 a^x$, &c.

Suppose now that $x=0$, then u, or a^x becomes $a^0 = 1$, $\frac{\dot{u}}{\dot{x}} = A a^x$ becomes A, $\frac{\ddot{u}}{\dot{x}^2} = A^2 a^x$ becomes A^2, &c. so that $U=1$, $U'=A$, $U''=A^2$, &c. substituting therefore these values in the general formula, it becomes

$$a^x = 1 + A \frac{x}{1} + A^2 \frac{x^2}{1.2} + A^3 \frac{x^3}{1.2.3} + \&c.$$

Let us next suppose that u is an arch of a circle of which the sine is x (radius being unity), then $x = \text{sin. } u$. Now the ratio of the fluxion of u to the fluxion of x will be the very same whether we consider u as a function of x, or x as a function of u; therefore (§ 59.) $\dot{x} = \dot{u} \text{ cos. } u$, and $\frac{\dot{u}}{\dot{x}} = \frac{1}{\text{cos. } u}$, but since sin. $u = x$, cos. $u = \sqrt{(1-x^2)}$, therefore,

$$\frac{\dot{u}}{\dot{x}} = \frac{1}{\sqrt{(1-x^2)}}.$$

 Taking

(F) For the sake of illustration let us take a particular example. Suppose $u = (a+x)^n$, then $\frac{\dot{u}}{\dot{x}} = n(a+x)^{n-1}$, $\frac{\ddot{u}}{\dot{x}^2} = n(n-1)(a+x)^{n-2}$, &c. Suppose now that $x=0$, then u becomes a^n, $\frac{\dot{u}}{\dot{x}}$ becomes $n\, a^{n-1}$, $\frac{\ddot{u}}{\dot{x}^2}$ becomes $n(n-1)a^{n-2}$, &c. so that in this particular case we have $U = a^n$, $U' = n\, a^{n-1}$, $U'' = n(n-1)a^{n-2}$, &c.

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Taking now the fluxion of $\frac{1}{\sqrt{(1-x^2)}}$, and the fluxion of the result &c. we have

$$\frac{\ddot{u}}{\dot{x}^2}=\frac{x}{(1-x^2)^{\frac{3}{2}}},$$

$$\frac{\dddot{u}}{\dot{x}^3}=\frac{1}{(1-x^2)^{\frac{3}{2}}}+\frac{3x^2}{(1-x^2)^{\frac{5}{2}}},$$

$$\frac{\ddddot{u}}{\dot{x}^4}=\frac{3\cdot 3x}{(1-x^2)^{\frac{5}{2}}}+\frac{3\cdot 5x^3}{(1-x^2)^{\frac{7}{2}}},$$

&c.

Suppose now that $x=0$, then u becomes 0, $\frac{\dot{u}}{\dot{x}}$ becomes 1, $\frac{\ddot{u}}{\dot{x}^2}$ becomes 0, $\frac{\dddot{u}}{\dot{x}^3}$ becomes 1, $\frac{\ddddot{u}}{\dot{x}^4}$ becomes 0, &c. so that $U=0$, $U'=1$, $U''=0$, $U'''=1$, $U''''=0$, &c. Therefore, substituting in the general formula, we find

$$u=x+\frac{x^3}{1.2.3}+\text{ \&c.}$$

By prosecuting the computations farther, we may find

$$u=x+\frac{1^2x^3}{2.3}+\frac{3^2x^5}{2.3.4.5}+\frac{3^2 5^2 x^7}{2.3.4.5.6.7}+\text{\&c.}$$

Application of the Method of Fluxions to the drawing of Tangents.

73. The theory of tangents to curve lines furnishes a good illustration of the truth of the principle which we have considered as the foundation of the method of fluxions, namely, that whatever be the form of a function, the ratio of its increment to the increment of the variable quantity from which the function is formed, is in every case susceptible of a limit.

Fig. 6. Let AB, the abscissa of a curve, be the geometrical expression of a variable quantity x, and let BP the corresponding ordinate, be the expression for y, any function of x; then the curve line itself is the locus of the equation expressing the relation between x and y. Let PT, a tangent to the curve at P, meet AB the abscissa in T; through P draw any straight line meeting the abscissa in D, and the curve in p; draw the ordinate pb, and from P draw Pn parallel to the abscissa, meeting the ordinate bp in n.

The triangles DBP, Pnp are similar; therefore

$$pn : nP :: PB : BD.$$

Now pn, and nP, or Bb, are the increments of PB and BA, or of y and x respectively, therefore the ratio of the simultaneous increments of PB and BA, or y and x, whatever be their magnitudes, is equal to the ratio of PB to BD. Conceive now the point p to approach continually to P, then the angle contained by the straight line pPD, and the tangent PT, will decrease, and the point D will approach to T; at the same time np, and nP, the increments of y and x will be continually diminished; still, however, they will have to each other the ratio of PB to BD, but this ratio approaches continually to the ratio of PB to BT, and becomes at last more nearly equal to it than any assignable ratio; therefore the ratio of PB to BT is the limit of the ratio of PB to BD, and consequently is also the limit of the ratio of pn, the increment of y to nP, the increment of x. And as this conclusion does not depend upon the particular nature of the curve, or upon any particular relation supposed to subsist between x and y, we may conclude, that whatever be the form of the function, the ratio of the simultaneous increments of the function, and the variable quantity from which it is formed, has a limit to which it approaches when the increments are conceived to be continually diminished.

It is now easy to see how the method of fluxions may be applied to the determination of tangents to curves, for since the ratio of the ordinate PB to the subtangent BT is always the limiting ratio of the increments of the ordinate and abscissa, it is equal to the ratio of their fluxions, that is

$$\dot{y} : \dot{x} :: y : \text{subtan. BT}.$$

Hence in any curve whatever, referred to an axis, the subtangent, (that is, the segment of the abscissa between the ordinate and tangent) is equal to $\frac{\dot{x}}{\dot{y}}y$ where x denotes the abscissa, and y the ordinate at the point of contact; and the subtangent being found, the position of the tangent is thereby determined.

Let us apply the above general formula to some examples.

Example 1. Let the proposed curve be a circle. It is required to determine the position of PT, a tangent at any point P in its circumference. Fig. 7.

Put $2a$ for AE the diameter, also x for AB the abscissa, and y for BP the ordinate at the point of contact.

From the nature of the curve, we have

$$AB\times BE=BP^2, \text{ that is}$$

$$x(2a-x)=y^2.$$

Hence taking the relations of the fluxions of x and y, we have

$$2a\dot{x}-2x\dot{x}=2y\dot{y},$$

$$\text{therefore } \frac{\dot{x}}{\dot{y}}=\frac{y}{a-x},$$

$$\text{and BT}=\frac{\dot{x}}{\dot{y}}y=\frac{y^2}{a-x};$$

from which it appears that BT the sub-tangent is a third proportional to $a-x$ and y, that is, to CB the distance of the ordinate from the centre, and BP the ordinate, agreeing with what is known from the elements of geometry.

Ex. 2. Let the curve be a parabola, required the same as before. Fig. 8.

Put x for AB, the abscissa, and y for BP the ordinate at P the point of contact; also a for the parameter; then, from the nature of the curve

$$PB^2=a\times AB, \text{ that is}$$

$$ax=y^2$$

therefore,

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therefore, taking the fluxions, we get $a\dot{x}=2y\dot{y}$, and

$$\frac{\dot{x}}{\dot{y}}=\frac{2y}{a}, \text{ and}$$

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{2y^2}{a}=\frac{2ax}{a}=2x;$$

from which it appears that the sub-tangent BT is double the abscissa BA.

Fig. 9. *Ex.* 3. Let the curve be an ellipse. Put $AB=x$, $BP=y$, AC, the semi-transverse axis $=a$, CH the semi-conjugate axis$=b$.

The nature of the curve is such, that

$$AC^2 : CH^2 :: AB\times BE : BP^2$$

$$\text{or } a^2 : b^2 :: (2a-x)\,x : y^2$$

$$\text{Hence } a^2y^2=b^2\,(2a-x)\,x,$$

and taking the relation of the fluxions,

$$a^2y\dot{y}=b^2\,(a-x)\,\dot{x};$$

$$\text{Therefore } \frac{\dot{x}}{\dot{y}}=\frac{a^2y}{b^2\,(a-x)}, \text{ and}$$

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{a^2y^2}{b^2\,(a-x)}.$$

But from the preceding equation expressing the nature of the curve, $\frac{ay^2}{b^2}=(2a-x)\,x$; therefore

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{(2a-x)\,x}{a-x}.$$

To this expression for BT, let $BC=a-x$ be added, and we have

$$CT=a-x+\frac{(2a-x)\,x}{a-x}=\frac{a^2}{a-x};$$

from which it appears that CB : CA :: CA : CT.

Fig. 10. *Ex.* 4. Suppose the curve to be a hyperbola, and let it be required to find, as in the preceding examples.

Put a and b as in the case of the ellipse to express the semitransverse and semiconjugate axes, then the equation of the curve is

$$a^2y^2=b^2\,(2a+x)\,x,$$

and taking the relation of the fluxions,

$$a^2y\dot{y}=b^2\,(a+x)\,\dot{x},$$

from which we find

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{a^2y^2}{b^2(a+x)},$$

or, substituting $(2a+x)\,x$ for $\frac{a^2y^2}{b^2}$,

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{(2a+x)\,x}{a+x}.$$

Let this expression for BT be subtracted from the expression for CB, that is from $a+x$, and we have

$$CT=a+x-\frac{2ax+x^2}{a+x}=\frac{a^2}{a+x},$$

therefore CB : CA :: CA : CT.

Ex. 5. Suppose the curve APD to be a cycloid, of which AE is the axis, and AQE a semicircle described on the axis as a diameter. Suppose AC, the radius, to be unity; put $AB=x$, $BP=y$, and the arch $AQ=v$; then, $AB=1-\text{cos}.\,v$, and $BQ=\text{sin}.\,v$. Now, from the nature of the curve, $PB=\text{arch } AQ+BQ$; hence we have Fig. 11.

$$x=1-\text{cos}.\,v, \qquad y=v+\text{sin}.\,v,$$

and taking the fluxions, by § 59,

$$\dot{x}=\dot{v}\,\text{sin}.\,v, \qquad \dot{y}=\dot{v}+\dot{v}\,\text{cos}.\,v;$$

therefore,

$$BT=\frac{\dot{x}}{\dot{y}}y=\frac{\dot{v}\,y\,\text{sin}.\,v}{\dot{v}+\dot{v}\,\text{cos}.\,v}=\frac{y\,\text{sin}.\,v}{1+\text{cos}.\,v}$$

$$=\frac{PB\times BQ}{EB};$$

but from the nature of the circle $\frac{BQ}{EB}=\frac{AB}{BQ}$, therefore, $BT=\frac{PB\times AB}{BQ}$, and consequently BQ : BA :: BP : BT, from which it appears that if the chord AQ be drawn, the tangent PT is parallel to the chord QA.

74. If PT be a tangent to the curve AP at the point P, and PC be drawn perpendicular to the tangent, meeting AC the axis of the curve in C, then the line PC is called a *normal* to the curve at the point P; and BC, the distance between the ordinate and the extremity of the normal, is called the *sub-normal*. Fig. 6.

The triangles TBP, BPC being similar, we have TB : BP :: BP : BC; or, since TB : BP :: $\dot{x}:\dot{y}$, (§ 73) $\dot{x}:\dot{y}::y:BC$, hence in any curve, BC the sub-normal is equal to $\frac{y\dot{y}}{\dot{x}}$; and from this expression, we may find the sub-normal in the same way as we have found the sub-tangent in the examples of last §.

75. As by plane trigonometry

$$TB : BP :: \text{rad.} : \text{tangent of } T,$$

and from § 73, TB : BP :: $\dot{x}:\dot{y}$,

therefore $\dot{x}:\dot{y}::1:\text{tan}.\ T$,

hence it appears that $\frac{\dot{y}}{\dot{x}}$ expresses the numeral tangent of the angle T, that is the angle contained by a tangent to the curve, and the axis of the curve. In like manner we have

$$\dot{y}:\dot{x}::BP:BD::CB:BP::1:\text{tan}.\ C,$$

therefore $\frac{\dot{x}}{\dot{y}}$ expresses the tangent of the angle C, that is the angle contained by a normal to the curve and its axis.

Application

Application of Fluxions to Problems relating to MAXIMA *and* MINIMA.

76. If a variable quantity be ſuppoſed to change its magnitude, then any function of that quantity will alſo change its magnitude. When the variable quantity is ſuppoſed to increaſe continually ſo as to acquire ſucceſſively all degrees of magnitude, there are ſome functions of ſuch a form, that they either increaſe continually, or decreaſe continually; but there are others again which either increaſe to a certain limit, after which they decreaſe; or elſe they decreaſe to a certain limit, after which they increaſe.

If, in conſequence of the continual increaſe of a variable quantity, a function of that quantity firſt increaſes to a certain limit, and afterwards decreaſes, when it arrives at that limit it is then ſaid to be a *maximum*. Or if it decreaſe to a certain limit, and afterwards increaſe, when it arrives at that limit, it is then ſaid to be a *minimum*.

77. Let us conſider the function $y=b-(x-a)^2$. If we ſuppoſe $x=0$, then $y=b-a^2$. Suppoſe now x to be at firſt very ſmall, and to increaſe; then as $(x-a)^2$ will decreaſe, y will alſo increaſe, till x become $=a$, and then y will become $=b$, when it is a *maximum;* for x being ſuppoſed to become greater than a, y will be leſs than b. By ſuppoſing x to increaſe till $(x-a)^2$ become equal to b, then y will decreaſe to 0; and x being ſtill ſuppoſed to increaſe, y will become negative.

Let us next ſuppoſe $y=b+(x-a)^2$. In this caſe when $x=0$, $y=b+a^2$; as x increaſes, $(x-a)^2$ decreaſes, and conſequently y decreaſes, till $x=a$, and then $y=b$, a *minimum;* for x becoming greater than a, y becomes greater than b.

78. Every function that either increaſes or decreaſes continually has neither *maximum* nor *minimum;* for for whatever value ſuch a function may acquire, in the one caſe it may always have a greater, and in the other a leſs value.

The characteriſtic property of a *maximum* value of a function, by which it is made the object of analytical inquiry, conſiſts in its being greater than the values immediately preceding, and alſo greater than the values immediately following it; and that of a *minimum* conſiſts in its being leſs than the values immediately preceding, and alſo leſs than the values immediately following it.

In ſome caſes a function may increaſe to a certain limit and then decreaſe, and afterwards increaſe again indefinitely; or the contrary. Hence it may happen that ſuch a function may have values greater than its *maximum* or leſs than its *minimum* as they have been here defined. And indeed it is eaſy to conceive that a function may increaſe and decreaſe alternately ſeveral times; in ſuch a caſe it muſt be conſidered as having ſeveral *maxima* and *minima*.

79. Since y any function of a variable quantity x may be conſidered as the ordinate of a curve, of which x is the abſciſſa, it is evident that to determine the greateſt or leaſt value of ſuch a function, we have only to ſeek the greateſt or leaſt ordinate of the curve which is the locus of the equation expreſſing the relation between x and y. Let us ſuppoſe this curve to be DPE, and that AB is the value of x, correſponding to BP the *maximum* or *minimum* value of the ordinate y; it is evident, that in the caſe of a *maximum*, the curve muſt be concave towards AC, at leaſt to a certain extent, on each ſide of the point P, as in fig. 12, but that in the caſe of a *minimum* it muſt be convex towards AC, as in fig. 13; and alſo, that in either caſe, if a ſtraight line be drawn through P parallel to AC, the curve muſt be wholly on one ſide of that line, to a certain extent on each ſide of the point P, and therefore, that the line PQ muſt be a tangent to the curve at the point P. Figs. 12. and 13.

Now when PQ a tangent to a curve at P (fig. 8) meets the axis in T, it has been ſhewn, § 75, that $\frac{\dot{y}}{\dot{x}}$ is the expreſſion for the tangent of the angle T, radius being unity; but this angle vaniſhes, when PQ, inſtead of meeting AC, is parallel to it, as in fig. 12, and fig. 13; therefore, as in this caſe the tangent of the angle is $=0$, we have $\frac{\dot{y}}{\dot{x}}=0$.

Hence it appears, that to determine the maximum *or* minimum *of* y, *a function of* x, *we muſt find the fluxion of the function, and divide it by* $\dot{x}$, *and put the reſult equal to* 0.

80. We proceed to illuſtrate this rule by ſome examples.

Ex. 1. To divide a given number a into two ſuch parts, that their product may be the greateſt poſſible.

Let x denote the one part, then $a-x$ will be the other part, and $x(a-x)$ the product of the two parts. Therefore, by the queſtion

$$y=x(a-x)=ax-x^2, \text{ a } maximum,$$

hence, taking the fluxion of the function,

$$\dot{y}=a\dot{x}-2x\dot{x}, \text{ and } \frac{\dot{y}}{\dot{x}}=a-2x,$$

$$\text{therefore, } a-2x=0, \text{ and } x=\tfrac{1}{2}a.$$

Thus it appears that the product of the parts will be the greateſt poſſible, when each is half the given number.

Ex. 2. To find the fraction which ſhall exceed its cube by the greateſt quantity poſſible.

Let x denote the fraction, then its cube is x^3, ſo that we have

$$y=x-x^3, \text{ a } maximum;$$

therefore, taking the fluxion of the function,

$$\dot{y}=\dot{x}-3x^2\dot{x}, \text{ and } \frac{\dot{y}}{\dot{x}}=1-3x^2=0,$$

hence $3x^2=1$, and $x=\sqrt{\tfrac{1}{3}}$, the fraction required,

Ex. 3. To determine the greateſt rectangle that can be inſcribed in a given triangle.

Put the baſe A C of the triangle $=b$, and its altitude B D$=a$, and let B n, the altitude of the rectangle $p\,q\,r\,s$, conſidered as variable, be denoted by x, then, becauſe Fig. 14.

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because of the parallel lines A C, $p\,q$, it will be, as B D : A C :: D n : $p\,q$, that is $a : b :: a - x : p\,q$, hence $p\,q = \frac{b(a-x)}{a}$, and the area of the rectangle, or $p\,q \times$ B n, will be $= \frac{b(a-x)x}{a}$, therefore $y = \frac{b(a-x)x}{a}$ must be a *maximum*, and hence $\dot{y} = \frac{ba\dot{x} - 2bx\dot{x}}{a}$: thus we have,

$$\frac{\dot{y}}{\dot{x}} = \frac{ba - 2bx}{a} = 0,$$

and $b\,a - 2b\,x = 0$, and $x = \frac{1}{2}a$; hence it appears that the greatest inscribed rectangle is that whose altitude is half the altitude of the triangle.

81. It is proper to observe that the value of a quantity when a *maximum* or *minimum* may often be determined more readily by considering that any given multiple, or part of the function, likewise any power or root of it, must then be also a *maximum* or *minimum*. Thus in the preceding example, in which the function to be a *maximum* is $\frac{b(a-x)x}{a}$, we may reject the constant multiplier $\frac{b}{a}$, and then the function to be a maximum is $y = (a-x)x = ax - x^2$, the fluxion of which being taken, we have $\dot{y} = a\dot{x} - 2x\dot{x}$ and $\frac{\dot{y}}{\dot{x}} = a - 2x = 0$, hence $x = \frac{1}{2}a$, the same value as before.

82. *Ex.* 4. Of all the right-angled plane triangles having the same given hypothenuse, to find that whose area is greatest.

Fig. 15. Let A B C be the triangle; put A B$=x$, and A C, the given hypothenuse, $=a$, then B C$=\sqrt{(a^2-x^2)}$, and consequently the area of the triangle is $\frac{x}{2}\sqrt{(a^2-x^2)}$, which being a *maximum*, its square $\frac{x^2(a^2-x^2)}{4}$, also four times that square, or $x^2(a^2-x^2)$, will likewise be a *maximum*, therefore, $y = x^2(a^2-x^2) = a^2x^2 - x^4$, a *max.* hence $\dot{y} = 2a^2x\dot{x} - 4x^3\dot{x}$, and

$$\frac{\dot{y}}{\dot{x}} = 2a^2x - 4x^3 = 0,$$

hence $2x^2 = a^2$, and $x = a\sqrt{\frac{1}{2}}$.

Ex. 5. To determine the greatest cylinder that can be inscribed in a given cone.

Fig. 16. Put A C the base of the cone $=b$, B H its altitude $=a$, and D F, the diameter of the end of the cylinder DIGF inscribed in the cone, $=x$. From the similar triangles BAC, BDF, we have AC : BH :: DF : BE, that is $b : a :: x :$ BE, hence BE$=\frac{ax}{b}$, and EH$=$BH $-$BE$= a - \frac{ax}{b} = \frac{ab - ax}{b}$. Put c for the number .78539, then the area of the base of the cylinder is (by the Elements of Geometry) $c \times$DF^2, and its solid content $c \times$DF$^2 \times$EH$= \frac{cax^2(b-x)}{b}$, hence $\frac{cax^2(b-x)}{b}$ is to be a *maximum*, therefore, leaving out the constant multiplier $\frac{c\,a}{b}$, we have $y = x^2(b-x) = bx^2 - x^3$, a *maximum*; taking now the fluxions, we get $\dot{y} = 2bx\dot{x} - 3x^2\dot{x}$, and $\frac{\dot{y}}{\dot{x}} = 2bx - 3x^2 = 0$,

hence $3x^2 = 2bx$, and $x = \frac{2}{3}b$, and consequently HE $=\frac{1}{3}$BH.

Ex. 6. To find the sun's place in the ecliptic, when that part of the equation of time which arises from the obliquity of the ecliptic is a *maximum*.

Let EQ be the equator, EC the ecliptic, S the sun's place, and SA his declination, then this part of the equation of time is the difference of the sun's longitude ES, and right ascension EA, turned into time. Put the arch ES$=x$, the arch EA$=v$, which is to be considered as a function of x, and put a for the cosine of the angle E$=23°\ 28'$. Then, by Spherical Trigonometry, in the right-angled spherical triangle EAS, we have tan. EA$=$cos. E $\times$ tan. ES; therefore, to determine x we have tan. $v = a$ tan. x, and $y = x - v$, a *maximum*. Fig 17.

From the second of these equations we get

$$\dot{y} = \dot{x} - \dot{v}, \text{ and } \frac{\dot{y}}{\dot{x}} = 1 - \frac{\dot{v}}{\dot{x}} = 0,$$

and from the first, by § 60,

$$\dot{v} \text{ sec.}^2 v = a\dot{x} \text{ sec.}^2 x, \text{ and } \frac{\dot{v}}{\dot{x}} = \frac{a \text{ sec.}^2 x}{\text{sec.}^2 v},$$

therefore, $1 - \frac{a \text{ sec.}^2 x}{\text{sec.}^2 v} = 0$, and sec.$^2 v = a$ sec.$^2 x$,

or $1 + \text{tan.}^2 v = a + a \text{ tan.}^2 x$, but from the first equation tan.$^2 v = a^2$ tan.$^2 x$, therefore,

$$1 + a^2 \text{ tan.}^2 x = a + a \text{ tan.}^2 x,$$

$$\text{or } a(a-1) \text{ tan.}^2 x = a - 1,$$

hence tan. $x = \frac{1}{\sqrt{a}} = 1.04416$, the tangent of $46°\ 14'$, the sun's longitude when this part of the equation is a *maximum*.

83. We have deduced the rule of § 79. for determining when a function is a maximum, or minimum, from the consideration of curve lines. The whole theory of *maxima* and *minima* may however be explained in a manner purely analytical, as follows:

Let us suppose that y is any function whatever of x, and that x has acquired the value that produces the *maximum* or *minimum* of the function; then, if we suppose $x-h$ and $x+h$ to be substituted successively in the function instead of x, the two resulting values ought to be both less than the maximum or both greater than the minimum value.

Let

Direct Method.

Let us denote the value of the function that results from the substitution of $x-h$ by ${}_{\prime}y$ and that which results from the substitution of $x+h$ by y', then by the theorem given in § 69,

$${}_{\prime}y=y-\frac{\dot{y}}{\dot{x}}h+\frac{\ddot{y}}{\dot{x}^2}\frac{h^2}{2}-\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\&c.$$

$$y'=y+\frac{\dot{y}}{\dot{x}}h+\frac{\ddot{y}}{\dot{x}^2}\frac{h^2}{2}+\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\&c.$$

In each of these values, $\frac{\dot{y}}{\dot{x}}$, the coefficient of h, must either be equal to some quantity, positive or negative, or else it must $=0$. Let us suppose, if possible, that it is equal to some quantity, positive or negative; now as h may be conceived to be so small that the term $\frac{\dot{y}}{\dot{x}}h$, or any other term, shall exceed the sum of all the terms that follow it in each series, (D) if we suppose h to have such a value, then, because of the term $\frac{\dot{y}}{\dot{x}}h$ having the sign $-$ in the one series, and $+$ in the other, it follows that the one value of the function is greater, and the other less than y, the *maximum* or *minimum* value: But this conclusion is inconsistent with the nature of a *maximum* or *minimum*, therefore $\frac{\dot{y}}{\dot{x}}$ cannot in the case of a maximum or minimum be equal to any positive or negative quantity whatever.

If however we assume $\frac{\dot{y}}{\dot{x}}=0$, so that the two values are,

$${}_{\prime}y=y+\frac{\ddot{y}}{\dot{x}^2}\frac{h^2}{2}-\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\&c.$$

$$y'=y+\frac{\ddot{y}}{\dot{x}^2}\frac{h^2}{2}+\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\&c.$$

then as the second term $\frac{\ddot{y}}{\dot{x}^2}\frac{h^2}{2}$ has the same sign in both, when that term is greater than all the terms that follow it, we shall have both values greater than y when $\frac{\ddot{y}}{\dot{x}^2}$ is positive, and both less when it is negative, the first case corresponding to a *maximum*, and the second to a *minimum*.

Direct Method.

Hence, to determine the *maximum* or *minimum* of the function y, it appears that we must take the fluxion of y, and divide it by $\dot{x}$, and put the result equal to 0, which agrees with what was shewn in § 79.

84. Although in the case of a function admitting of a *maximum* or *minimum* we have always $\frac{\dot{y}}{\dot{x}}=0$, yet we must not conclude that conversely the one or the other of these has place every time that $\frac{\dot{y}}{\dot{x}}=0$. For if it so happens that the value of x that renders $\frac{\dot{y}}{\dot{x}}=0$, causes also $\frac{\ddot{y}}{\dot{x}^2}$ to vanish, without at the same time making $\frac{\dddot{y}}{\dot{x}^3}$ to disappear, then we have

$${}_{\prime}y=y-\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\frac{\ddddot{y}}{\dot{x}^4}\frac{h^4}{2.3.4}-\&c.$$

$$y'=y+\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}+\frac{\ddddot{y}}{\dot{x}^4}\frac{h^4}{2.3.4}+\&c.$$

and as by giving a proper value to h, $\frac{\dddot{y}}{\dot{x}^3}\frac{h^3}{2.3}$ may be rendered greater than the sum of all the following terms in each series, it follows, that $\frac{\dddot{y}}{\dot{x}^3}$ being supposed to be any quantity either positive or negative, because of its sign being different in the two values, the one of them will be greater, and the other less than y, the *maximum* or *minimum* value, which result is inconsistent with the nature of a maximum or minimum. If however $\frac{\dddot{y}}{\dot{x}^3}$ be assumed $=0$, then

${}_{\prime}y=$

(D) If this should not appear sufficiently obvious, let

$$Ah+Bh^2+Ch^3+Dh^4+\&c.$$

be such a series, where A, B, C, D, &c. denote quantities either positive or negative, but which are independent of h. Then, writing the series thus,

$$h(A+Bh+Ch^2+Dh^3+\&c.)$$

it is obvious that if h be conceived to be continually diminished, and at last to become $=0$, the part

$$Bh+Ch^2+Dh^3+\&c.$$

will also become $=0$, therefore before it vanishes it will be less than A, or any other assignable quantity, therefore $Bh^2+Ch^3+Dh^4+\&c.$ may become less than Ah.

$$y=y+\frac{\ddot{y}}{\dot{x}^4}\frac{h^4}{2.3.4}-\&c.$$

$$y=y+\frac{\ddot{y}}{\dot{x}^4}\frac{h^4}{2.3.4}+\&c.$$

here again, the coefficient of the second term having in both values the same sign, the conditions of the maximum or minimum are fulfilled, and the sign of $\frac{\ddot{y}}{\dot{x}^4}$ shews when the one or the other is to have place.

It must now be sufficiently evident, without proceeding any further, *that a function can only admit of a* maximum *or a* minimum *when the first of its fluxions that does not vanish, is of an even order (or is its second or fourth fluxion, &c.), and that the sign of that fluxion is negative in the case of a* maximum, *but positive in the case of a* minimum.

85. We shall conclude this theory by applying it to an example. Let y be such a function of x that

$$y^2-2mxy+x^2-a^2=0,$$

then by § 49,

$$(y-mx)\dot{y}-(my-x)\dot{x}=0,$$

and hence $\frac{\dot{y}}{\dot{x}}=\frac{my-x}{y-mx}=0,$

therefore $my-x=0$, and $y=\frac{x}{m}$.

To find the value of x, let this value of y be substituted in the original equation, it thus becomes

$$\frac{x^2}{m^2}-x^2-a^2=0,$$

hence we find

$$x=\frac{ma}{\sqrt{(1-m^2)}},\text{ and } y=\frac{a}{\sqrt{(1-m^2)}}.$$

We must now examine what is the nature of the expression for $\frac{\ddot{y}}{\dot{x}^2}$. Taking the fluxion of the equation $\frac{\dot{y}}{\dot{x}}=\frac{my-x}{y-mx}$, and considering that $\dot{x}$ is constant, we have

$$\frac{\ddot{y}}{\dot{x}}=\frac{(1-m^2)(x\dot{y}-y\dot{x})}{(y-mx)^2},$$

therefore, dividing by $\dot{x}$,

$$\frac{\ddot{y}}{\dot{x}^2}=\frac{1-m^2}{(y-mx)^2}\left\{\frac{\dot{y}}{\dot{x}}x-y\right\},$$

but as in the present case $\frac{\dot{y}}{\dot{x}}=0$, and $y=\frac{x}{m}$, this expression becomes simply

$$\frac{\ddot{y}}{\dot{x}^2}=\frac{-m}{x(1-m^2)},$$

which equation, by putting instead of x its value $\frac{ma}{\sqrt{(1-m^2)}}$, becomes

$$\frac{\ddot{y}}{\dot{x}^2}=-\frac{1}{a\sqrt{(1-m^2)}},$$

and as this result is negative, we conclude that the value which we have found for y is a *maximum.*

Of the values of fractions, the numerators and denominators of which vanish at the same time.

86. There are some fractional functions of such a nature, that by giving a particular value to the variable quantity, both the numerator and denominator of the fraction vanish, and thus the fraction is reduced to this form $\frac{0}{0}$, an expression from which nothing can be concluded. We have an example of this in the fraction $\frac{x-a}{x^2-a^2}$, which, by supposing $x=a$ becomes $\frac{a-a}{a^2-a^2}=\frac{0}{0}$; we must not however conclude that the fraction has no determinate value in this particular case, for if we consider that its numerator and denominator have a common divisor, viz. $x-a$, it is evident that by taking this divisor out of both, the fraction $\frac{x-a}{x^2-a^2}=\frac{x-a}{(x-a)(x+a)}$, becomes $\frac{1}{x+a}$, an expression, which in the case of $x=a$ is equal to $\frac{1}{2a}$.

87. In general, if we make $x=a$ in an expression of this form $\frac{P(x-a)^m}{Q(x-a)^n}$, it becomes $\frac{0}{0}$; however its true value is either nothing, or finite, or infinite, according as $m>n$, or $m=n$, or $m<n$; for by taking out the factors common to the numerator and denominator, the fraction becomes $\frac{P(x-a)^{m-n}}{Q}$ in the first case, $\frac{P}{Q}$ in the second, and $\frac{P}{Q(x-a)^{n-m}}$ in the third; here we suppose that P and Q are such functions as neither become nothing, nor infinite, by the supposition of $x=a$.

88. Therefore, when by giving a particular value to x a function of that quantity assumes the form $\frac{0}{0}$, to discover the true value of the function in this particular case, we must disengage the factors which are common to the numerator and denominator. This may be done in most cases by finding their common measure (ALGEBRA, § 49.) but the direct method of fluxions furnishes us with another method.

In the expression $P(x-a)$, where P denotes any function of x that is independent of $x-a$, if we suppose $x=a$, then the expression vanishes; the fluxion however of the expression, viz. $(x-a)\dot{P}+P\dot{x}$, is a quantity which does not vanish when $x=a$, but is then reduced to its last term, that is to $P\dot{x}$.

Again,

Direct Method.

Again, the function $P(x-a)^2$ vanishes by supposing $x=a$, but if we take its fluxion, viz. $(x-a)^2 \dot{P} + 2(x-a)P\dot{x}$, and again the fluxion of this quantity we get

$$(x-a)^2\ddot{P}+4(x-a)\dot{P}\dot{x}+1\cdot2\,P\dot{x}^2,$$

an expression which does not vanish upon the hypothesis of $x=a$, but is reduced to its last term. viz. $1\cdot2\,P\dot{x}^2$. By proceeding in this manner, it is easy to see that by taking the fluxion of a function of the form $P(x-a)^m$ m times successively (m being a whole number) we shall finally obtain an expression, all the terms of which, except the last, vanish by supposing that $x=a$; and that the last term will be $1.2.3\ldots m\,P\dot{x}^m$, an expression free from the factor $(x-a)^m$, and involving only the function P.

89. It is not necessary that we should know the number n, nor that we should exhibit the factor $(x-a)^n$, in order to determine when the expression $P(x-a)^n$ is freed from that factor. We have only to ascertain after each operation of taking the fluxion, whether the result vanishes or not, when we substitute a instead of x; for in the last case the operation is finished, and the result is the quantity $1.2.3..P\dot{x}^m$. Suppose for example the function to be $x^3-ax^2-a^2x+a^3$, which vanishes when $x=a$, its first fluxion also vanishes when $x=a$, but not its second fluxion, which is $(6x-2a)\dot{x}^2$, hence we may conclude that the function has the form $P(x-a)^2$, which is besides obvious, because

$$x^3-ax^2-a^2x+a^3=(x+a)(x-a)^2.$$

90. In applying these observations to the fraction $\frac{P(x-a)^m}{Q(x-a)^n}$, it appears, that by repeating the operation of taking the fluxions of its numerator and denominator, they will be freed at once from the factor $x-a$, if $m=n$. If a result, which does not vanish, be obtained first from the numerator, then we may be assured, that the factor $(x-a)$ is found in the numerator raised to a less power than in the denominator, and in this case the fraction is infinite when $x=a$. If on the contrary the first result that does not vanish is found from the denominator, then the numerator contains a higher power of $(x-a)$ than the denominator, and in this case, when $x=a$, the fraction vanishes.

The rule for finding the value of a function which becomes $\frac{0}{0}$ by giving a particular value to x may therefore be expressed thus. *Take the successive fluxions of both the numerator and denominator until a result which does not vanish be obtained from either the one or the other, or from both at the same time; in the first case the function is infinite, in the second it is equal to* 0, *and in the last case its value is finite.*

91. We proceed to illustrate this rule by a few examples.

Ex. 1. The value of the function $\frac{x^3-1}{x^2-1}$ is required when $x=1$.

The fluxion of the numerator is $3x^2\dot{x}$, and that of the denominator is $2x\dot{x}$, neither of which quantities vanish when $x=1$, therefore in this particular case, the value of the fraction is $\frac{3x^2}{2x}=\frac{3}{2}$.

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Ex. 2. Suppose the fraction to be $\frac{ax^2-2acx+ac^2}{bx^2-2bcx+bc^2}$, which vanishes when $x=c$.

By taking the fluxions of the numerator and denominator we obtain $\frac{2ax\dot{x}-2ac\dot{x}}{2bx\dot{x}-2bc\dot{x}}=\frac{ax-ac}{bx-bc}$, a fraction, the numerator and denominator of which still vanish upon the hypothesis of $x=c$, we therefore take the fluxions a second time, and get $\frac{2a\dot{x}^2}{2b\dot{x}^2}=\frac{a}{b}$ for the value of the proposed fraction in the particular case of $x=c$.

Ex. 3. Suppose the fraction to be

$$\frac{x^3-ax^2+a^2x-a^3}{x^2-a^2}$$

which vanishes when $x=a$. In this example, by taking the fluxions of the numerator and denominator once, we get

$$\frac{3x^2\dot{x}-2ax\dot{x}-a^2\dot{x}}{2x\dot{x}}=\frac{3x^2-2ax-a^2}{2x},$$

an expression, of which only the numerator vanishes upon the supposition of $x=a$, hence we may conclude the true value of the fraction in this case to be 0.

The contrary happens in the fraction

$$\frac{ax-x^2}{a^4-2a^3x+2ax^3-x^4};$$

we may therefore conclude that when $x=a$ this last fraction becomes infinite.

92. The rule of § 90 can only be applied when the factors common to the numerator and denominator are integer powers of $x-a$, for as by taking the fluxions, the index of $(x-a)^m$ is diminished by an unit at each operation; when m is a fraction we shall at last arrive at a result containing negative powers of $x-a$, which therefore, when $x=a$, will become infinite. The following mode of proceeding will however apply to all cases whatever.

Let $\frac{X}{X'}$ be a fraction of which the numerator and denominator both vanish when $x=a$; by substituting in it $a+h$ instead of x, the functions X and X′ may be expanded into a series of this form,

$$A\,h^{\alpha}+B\,h^{\beta}+\&c. \qquad A'\,h^{\alpha'}+B\,h^{\beta'}+\&c.$$

which are *ascending*, that is, having the exponents of the powers positive and increasing; because the series must become 0, upon the hypothesis that $h=0$. We have therefore

$$\frac{A\,h^{\alpha}+B\,h^{\beta}+\&c.}{A'h^{\alpha'}+B'h^{\beta'}+\&c.}$$

instead of the proposed fraction.

Now

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Now if $\alpha > \alpha'$, by dividing the numerator and denominator of this expression by the factor $h^{\alpha'}$, which is common to all the terms of each, it becomes

$$\frac{A h^{\alpha-\alpha'} + B h^{\beta-\alpha'} + \&c.}{A' + B h^{\beta-\alpha'} + \&c.},$$

a quantity which, by supposing $h = 0$, is reduced to $\frac{0}{A'}$, that is to 0. If again $\alpha = \alpha'$, the expression for the fraction, after dividing the numerator and denominator by h^{α}, is

$$\frac{A + B h^{\beta-\alpha'} + \&c.}{A' + B h^{\beta'-\alpha'} + \&c.}$$

which, by supposing h to be $= 0$, becomes simply $\frac{A}{A'}$, a finite quantity. If, however, $\alpha < \alpha'$, then the expression for the fraction is

$$\frac{A + B h^{\beta-\alpha} + \&c.}{A h^{\alpha'-\alpha} + B h^{\beta'-\alpha} + \&c.},$$

which, when $h = 0$, becomes $\frac{A}{0}$, an expression which may be considered as infinite. Thus it appears that in each case the true value of the fraction depends only on A and A′, the first terms of the series.

The following rule is applicable to every function that can appear under the indeterminate form $\frac{0}{0}$.

Find the first term of each of the ascending series which express the developements of the numerator and denominator when a+h *is substituted in them instead of* x. *Reduce the new function formed of these first terms to its most simple form, and make* h=0; *the results shall be the different values of the proposed function when* x *is made equal to* a.

Example. Suppose the function to be

$$\frac{\sqrt{x} - \sqrt{a} + \sqrt{(x-a)}}{\sqrt{(x^2-a^2)}},$$

which, when $x = a$, becomes $\frac{0}{0}$. By substituting $a + h$ instead of x, and developing the results into series, the numerator becomes $h^{\frac{1}{2}} + \frac{h}{2\sqrt{a}} + \&c.$ and the denominator $\sqrt{2a}\,h^{\frac{1}{2}} + \frac{h^{\frac{3}{2}}}{2\sqrt{2a}} + \&c.$ Taking now the first term of each series, we have $\frac{h^{\frac{1}{2}}}{2\sqrt{2a}\,h^{\frac{1}{2}}} = \frac{1}{2\sqrt{2a}}$, an expression in which h is not found; therefore the value of the function is $\frac{1}{\sqrt{2a}}$, when $x = a$.

Fig. 18.

Of the Radii of Curvature.

93. Let HC′CF represent a material curve, or mould. Let a thread be fastened to it at H, and made to pass along the curve, so as to coincide with it in its whole extent from H to F. Let the thread be now unlapped or *evolved* from the curve, then its extremity F will describe another curve line FAPP′. The curve HCF is called the Evolute of the curve FAP; and the curve FAP is called the Involute of the curve HCF.

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94. From this mode of conceiving the curve to be generated, we may draw the following conclusions.

1st. Suppose PC to be a portion of the thread detached from the evolute, then PC will be a tangent to the evolute at C.

2dly. The line PC will be perpendicular to a tangent to the curve FAP at the point P, or will be a normal to the curve at that point. For the point P may be considered as describing at the same time an element of the curve FAP, and an element of a circle $q\,P\,q'$ whose momentary centre is C, and which has PC for its radius.

3dly. That part of the curve between F and P, which is described with radii all of which are shorter than CP is more incurvated than a circle described on P as a centre, with a radius equal to CP. And in like manner PP′, the part of the curve on the other side of P, which is described with radii greater than PC, is less incurvated than that circle.

4thly. The circle $q\,P\,q'$ has the same curvature as the curve APP′ itself has at P: hence it is called an Equicurve circle, and its radius PC is called the Radius of Curvature at the point C.

95. We are now to investigate how the radius of curvature at any point in FAP any proposed curve may be found.

Let AB and BP be the co-ordinates at P any point in the curve, and PC its radius of curvature; and let PC meet AB in E. Put the abscissa $AB = x$, the ordinate $BP = y$, the arch $AP = z$, the angle AEP (that is, the arch which measures that angle, radius being unity) $= v$, the radius of curvature $PC = r$. Take P′ another point in the curve, and let P′C′ be the radius of curvature at that point. Let P′C′ meet AB in E′, and PC in D, and on D as a centre, with a radius $= 1$, describe an arch of a circle, meeting the radii PC, P′C′ in m and n. Then the arch PP′ will be the increment of z; and since the angle PDP′ is the difference of the angles PEA, P′E′A, the arch $m\,n$ will be the corresponding increment of v.

Suppose now the point P′ to approach continually to P, then the points C′ and D will approach to C, and the ratio of the arch PP′, the increment of z, to the arch $m\,n$ the increment of v, will approach to the ratio of CP to Cm, that is to the ratio of r to 1; therefore the ratio of r to 1 is the limit of the ratio of PP′ to mn, or $r =$ limit of $\frac{PP'}{m\,n}$, and passing to the ratio of the fluxions, $r = \frac{\dot{z}}{\dot{v}}$, thus we have obtained a formula expressing the radius of curvature, by means of the fluxion of the arch of the curve, and the fluxion of the angle which a normal to the curve makes with the line of the abscissas. We proceed to deduce from this formula other

other expressions which may involve the fluxions of x and y only.

96. Because PE is a normal to the curve at E, the tangent of the angle PEA or v is equal to $\frac{\dot x}{\dot y}$ (§ 75.), put $\frac{\dot x}{\dot y}=t$, then because tan. $v=t$, we have by taking the fluxions (§ 60.), $\dot v$ sec.^{2} $v=\dot t$, but sec.$^2 v=1+$tan.$^2 v$ $=1+\frac{\dot x^2}{\dot y^2}=\frac{\dot x^2+\dot y^2}{\dot y^2}=\frac{\dot z^2}{\dot y^2}$ (§ 63.), therefore $\frac{\dot v\,\dot z^2}{\dot y^2}=\dot t$ and $\dot v=\frac{\dot t\,\dot y^2}{\dot z^2}$.

Substituting now this value of $\dot v$ in the formula $r=\frac{\dot z}{\dot v}$

it becomes $r=\frac{\dot z^3}{\dot t\,\dot y^2}$.

If we now recollect that $t=\frac{\dot x}{\dot y}$, and that $\dot z^2=\dot x^2+\dot y^2$, it will appear that this other expression which we have found for r involves in effect the fluxions of x and y only.

97. In computing the values of $t=\frac{\dot x}{\dot y}$, and $\frac{\dot z^3}{\dot t\,\dot y^2}$ we may consider any two of the three quantities x, y, z, as a function of the remaining quantity; and upon that hypothesis compute their fluxions.

Thus if we suppose that y and z are functions of x, then, as in taking the fluxions of y, t, and z, we must consider $\dot x$ as a given or constant quantity, from the equation $t=\frac{\dot x}{\dot y}$ we have $\dot t=-\frac{\dot x\,\ddot y}{\dot y^2}$ (§ 39.), and substituting this value of $\dot t$ in $\frac{\dot z^3}{\dot t\,\dot y^2}$, the value last found for r, it becomes

$$r=\frac{\dot z^3}{-\dot x\,\ddot y}=\frac{(\dot x^2+\dot y^2)^{\frac{3}{2}}}{-\dot x\,\ddot y}.$$

If again, instead of considering y and z as functions of x, we consider x and z as functions of y, then from the equation $t=\frac{\dot x}{\dot y}$ (as $\dot y$ must now be reckoned constant), we get $\dot t=\frac{\ddot x}{\dot y}$, thus the formula $r=\frac{\dot z^3}{\dot t\,\dot y^2}$ becomes

$$r=\frac{\dot z^3}{\ddot x\,\dot y}=\frac{(\dot x^2+\dot y^2)^{\frac{3}{2}}}{\ddot x\,\dot y}.$$

We shall now apply these formulæ to some examples.

98. *Example* 1.—It is required to find the general expression for the radius of curvature of a parabola.

The equation of the parabola is $y=a^{\frac12}\,x^{\frac12}$, therefore, $\dot y=\frac12 a^{\frac12}\dot x\,x^{-\frac12}=\frac{a^{\frac12}\dot x}{2x^{\frac12}}$, and, making $\dot x$ constant, $\ddot y=-\frac14 a^{\frac12}\dot x^2 x^{-\frac32}=\frac{-a^{\frac12}\dot x^2}{4x^{\frac32}}$, therefore, $\dot z=\sqrt{(\dot x^2+\dot y^2)}$ $\frac{\dot x}{2}\sqrt{\left(\frac{4x+a}{x}\right)}$, and, putting r for the radius of curvature,

$$r=\frac{\dot z^3}{-\dot x\,\ddot y}=\frac{(a+4x)^{\frac32}}{2\sqrt a}.$$

If in this general expression, we put $x=0$, we find $\frac{a^{\frac32}}{2\sqrt a}=\frac12 a$ for the radius of curvature at the vertex of the curve.

Ex. 2. Suppose the curve to be an ellipse, required as in the last example.

Putting a and c to denote the two axes, the equation of the ellipse is $a^2y^2=c^2(ax-x^2)$. Hence taking the first and second fluxions, we have $2a^2y\dot y=c^2\dot x(a-2x)$, and $2a^2\dot y^2+2a^2y\ddot y=-2c^2\dot x^2$; whence $\dot y=\frac{c^2\dot x\,(a-2x)}{2a^2y}$, and $-\ddot y=\frac{a^2\dot y^2+c^2\dot x^2}{a^2y}$, which expressions, by substituting the values of y and $\dot y$ become

$$\dot y=\frac{c\dot x\,(a-2x)}{2a\sqrt{(ax-x^2)}}$$

$$-\ddot y=\left\{\begin{array}{c}\dfrac{a^2c^2\dot x^2\,(a-2x)^2}{4a^3c\,(ax-x^2)\sqrt{(ax-x^2)}}\\ +\dfrac{c\dot x^2}{a\sqrt{(ax-x^2)}}\end{array}\right.$$

$$=\frac{c\dot x^2}{a}\times\frac{(a-2x)^2+4\,(ax-x^2)}{4\,(ax-x^2)\sqrt{(ax-x^2)}}$$

$$=\frac{ca\dot x^2}{4\,(ax-x^2)^{\frac32}}.$$

therefore,

$$\dot z=\sqrt{(\dot x^2+\dot y^2)}$$

$$=\sqrt{\left(\frac{c^2\dot x^2\,(a-2x)^2}{4a^2\,(ax-x^2)}+\dot x^2\right)}$$

$$=\frac{\dot x}{2a}\sqrt{\left(\frac{c^2a^2+(a^2-c^2)\,(4ax-4x^2)}{ax-x^2}\right)}$$

and

$$r=\frac{\dot z^3}{-\dot x\,\ddot y}$$

$$=\frac{(a^2c^2+4\,(a^2-c^2)\,(ax-x^2))^{\frac32}}{2a^4c};$$

which expression, when $x=0$, becomes simply $\frac{c^2}{2a}$, the radius of curvature at the vertices of the transverse axis; but when $x=\frac12 a$, it becomes $\frac{a^2}{2c}$, the radius of curvature at the vertices of the conjugate axis.

PART

PART II. THE INVERSE METHOD OF FLUXIONS.

99. AS the DIRECT METHOD of fluxions treats of finding the relation between the fluxions of variable quantities, having given the relation subsisting between the quantities themselves; so the INVERSE METHOD treats of finding the relation subsisting between the variable quantities, having given the relation of their fluxions.

Whatever be the relation between variable quantities, we can in every case assign the relation of their fluxions; therefore the direct method of fluxions may in this respect be considered as perfect. But it is not the same with the inverse method, for there are no direct and general rules, by which we can in every case determine from the relation of the fluxions, that of their flowing quantities or fluents. All we can do is to compare any proposed fluxion with such fluxions as are derived from known fluents by the rules of the direct method, and if we find it to have the same form as one of these, we may conclude that the fluents of both, or at least the variable parts of these fluents, are identical.

100. In the direct method we have shewn, that by proper transformations, the finding of the fluxion of any proposed function is reducible to the finding of the fluxions of a few simple functions, and of the sums, or products, or quotients of such functions. In like manner, in the inverse method we must endeavour to transform complex fluxionary expressions into others more simple, so as to reduce them, if possible, to some fluxion, the fluent of which we already know.

SECT. I. *Of the Fluents of Fluxions involving one variable quantity.*

101. As when y is such a function of a variable quantity x, that $y=\mathrm{A}\,x^m+\mathrm{C}$, where A, m and C denote constant quantities, we find by the direct method (§ 36. and § 26.) that $\dot{y}=m\,\mathrm{A}\,x^{m-1}\dot{x}$, or (putting a instead of m A, and n instead of $m-1$), $\dot{y}=a\,x^n\,\dot{x}$; so on the contrary, as often as we have the fluxional equation

$$\dot{y}=a\,x^n\,\dot{x},$$

we may conclude that the relation of the fluents is expressed by the equation

$$y=\frac{a\,x^{n+1}}{n+1}+\mathrm{C};$$

for by substituting m A instead of a, and $m-1$ instead of n in this equation, it becomes $y=\mathrm{A}\,x^m+\mathrm{C}$, the same equation as that from which the fluxional equation was derived.

102. The value of the constant quantity C, which is generally called by writers on fluxions, the *correction* of the fluent, is to be determined from the particular inquiry in which the fluxional equation $\dot{y}=a\,x^n\dot{x}$ occurs. If it be known that $y=0$, when x acquires some known magnitude, which may be denoted by b, then the general equation $y=\frac{a\,x^{n+1}}{n+1}+\mathrm{C}$, becomes in that particular case

$$0=\frac{a\,b^{n+1}}{n+1}+\mathrm{C};$$

Hence, by subtracting each side of this last equation from the corresponding side of the former, we get

$$y=\frac{a\,(x^{n+1}-b^{1+n})}{n+1}$$

an equation that is independent of the constant and arbitrary quantity C.

103. By giving particular values to n in the fluxional equation $\dot{y}=a\,x^n\,\dot{x}$, and in that of the fluents $y=\frac{a\,(x^{n+1}-b^{n+1})}{n+1}$, we may obtain particular fluxional equations, and corresponding equations of the fluents. There is, however, one case which requires to be noticed; it is when n is $=-1$; then the equation of the fluxions is $\dot{y}=a\,x^{-1}\dot{x}=\frac{a\dot{x}}{x}$, and that of the fluents, according to the general formula $y=\frac{a(x^{-1+1}-b^{-1+1})}{-1+1}$ $=\frac{a(x^0-b^0)}{0}$, $=\frac{a(1-1)}{0}=\frac{0}{0}$, but from this expression it is manifest, that nothing can be concluded. The value of the function $\frac{a\,(x^{n+1}-b^{n+1})}{n+1}$, in the particular case of $n+1=0$ may be found by the rule given in § 90 for determining the value of a function when it assumes the form $\frac{0}{0}$; but it may be otherwise found by proceeding thus. Put $n+1=m$, and let $p=\frac{\log.\,x}{\log.\,e}$, and $q=\frac{\log.\,b}{\log.\,e}$; then, by the formula of § 54,

$$x^m=1+p\,m+\frac{p^2\,m^2}{2}+\ \&c.$$

$$b^m=1+q\,m+\frac{q^2m^2}{2}+\ \&c.$$

and therefore

$$x^m-b^m=(p-q)\,m+(p^2-q^2)\frac{m^2}{2}+\ \&c.$$

and $\frac{x^m-b^m}{m}=(p-q)+(p^2-q^2)\frac{m}{2}+\ \&c.$

Thus

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Thus we have $\frac{x^m-b^m}{m}$, or $\frac{x^{n+1}-b^{n+1}}{n+1}$ expressed generally by a series, all the terms of which, except the first, being multiplied by m or $n+1$, will vanish when $n+1=0$, or when $n=-1$, hence it appears, that the general equation $y=\frac{a(x^{n+1}-b^{n+1})}{n+1}$, becomes in the particular case of $n=-1$, $y=a(p-q)$, which, substituting for p and q their values, and observing that

$$\frac{\log. x}{\log. e}-\frac{\log. b}{\log. e}=\frac{1}{\log. e}\times\log.\frac{x}{b}, \text{ becomes}$$

$$y=\frac{a}{\log. e}\times\log.\frac{x}{b}$$

where log. e, and log. $\frac{x}{b}$ are to be taken according to the same system, which may be any system of logarithms whatever. So that if we take the Napierean system, in which log. $e=1$, then

$$y=a\,\mathrm{l}.\frac{x}{b}=a\,\mathrm{l}.x-a\,\mathrm{l}.b=a\,\mathrm{l}.x+C,$$

where C denotes a constant quantity, and where the letter l, in this formula, and in others in which it may occur, is put as an abbreviation of the words *Napierean logarithm*, so that by a l. x is meant a multiplied by the Napierean logarithm of x, &c.

This expression which we have found for the value of y in the particular case of $\dot{y}=ax^{-1}\dot{x}$, or $\frac{a\dot{x}}{x}$, coincides with what we might have found by considering that when $y=$l. x, it has been shewn (§ 57.) that $\dot{y}=\frac{\dot{x}}{x}$, so that conversely, when $\dot{y}=\frac{a\dot{x}}{x}$, we may conclude that $y=a$ l. $x+$C where C denotes a constant quantity, to be determined from the particular question in which the fluxional equation may occur.

104. It must now be evident that if

$$\dot{y}=ax^m\dot{x}+bx^n\dot{x}+cx^p\dot{x}+\text{\&c.}$$

where m, n, p, &c. are constant numbers, then

$$y=\frac{ax^{m+1}}{m+1}+\frac{bx^{n+1}}{n+1}+\frac{cx^{p+1}}{p+1}+\text{\&c.}+C;$$

here C denotes a constant arbitrary quantity that may be considered as the sum of the constant quantities which ought to be added to the terms $\frac{ax^{m+1}}{m+1}$, $\frac{bx^{n+1}}{n+1}$, &c. each being regarded as a distinct fluent.

105. In general, since that when

$$y=at+bv+cu+\text{\&c.}+C,$$

where t, v, u, &c. denote any functions of a variable quantity, and C a constant quantity, we have (§ 35. and § 36.)

$$\dot{y}=a\dot{t}+b\dot{v}+c\dot{u}+\text{\&c.}$$

So on the contrary, if we have any fluxional equation of this last form, we may conclude that

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$$y=at+bv+cu+\text{\&c.}+C.$$

And since that when $u=vt+$C, where u, v and t denote any function of a variable quantity, and C a constant quantity, we have § 37, $\dot{u}=v\dot{t}+t\dot{v}$, so on the contrary, if

$$\dot{u}=v\dot{t}+t\dot{v},$$

we may conclude that

$$u=vt+C,$$

and in like manner if we have

$$\dot{u}=\frac{t\dot{v}-v\dot{t}}{t^2}=\frac{\dot{v}}{t}-\frac{v\dot{t}}{t^2},$$

we may infer from § 39. that

$$u=\frac{v}{t}+C.$$

106. It is often convenient to denote the fluent of a fluxional expression without actually exhibiting that fluent. For this purpose we shall employ the sign $\int$, putting it before the fluxion whose fluent we mean to denote. Thus, by the expression $\int ax^n\dot{x}$, is to be understood the fluent of $ax^n\dot{x}$; and as this fluent has been found to be $\frac{ax^{n+1}}{n+1}+$C, we may express this conclusion in symbols shortly thus,

$$\int ax^n\dot{x}=\frac{ax^{n+1}}{n+1}+C.$$

107. Suppose we have $\dot{y}=(ax+b)^m\dot{x}$, we may expand $(ax+b)^m$ into a series, and multiply the series by $\dot{x}$, and find the fluent of each term of the result. But we may also find the fluent of this expression without employing the developement of $(ax+b)^m$, by proceeding thus. Put $ax+b=z$, then $x=\frac{z-b}{a}$, and $\dot{x}=\frac{\dot{z}}{a}$. Substitute now these values of $ax+b$, and $\dot{x}$, in the expression for $\dot{y}$, and it becomes $\dot{y}=\frac{z^m\dot{z}}{a}$; hence we have (§ 101.) $y=\frac{z^{m+1}}{a(m+1)}+$C, and consequently, by substituting $(ax+b)$ for z,

$$y=\frac{(ax+b)^{m+1}}{a(m+1)}+C.$$

108. Suppose that $\dot{y}=(ax^n+b)^m x^{n-1}\dot{x}$. By putting as before $ax^n+b=z$, we have $nax^{n-1}\dot{x}=\dot{z}$, and $x^{n-1}\dot{x}=\frac{\dot{z}}{na}$; hence $\dot{y}=\frac{z^m\dot{z}}{na}$, and $y=\frac{z^{m+1}}{na(m+1)}+$C, and, substituting for z its value ax^n+b,

$y=$

$$y=\frac{(ax^n+b)^{m+1}}{na(m+1)}+C.$$

109. Let us now consider fractional functions, and to begin with a simple case, let us suppose that $\dot{y}=\frac{Ax^m\dot{x}}{(ax+b)^n}$. Put $ax+b=z$, then $x=\frac{z-b}{a}$, $\dot{x}=\frac{\dot{z}}{a}$, and consequently,

$$\dot{y}=\frac{A(z-b)^m\dot{z}}{a^{m+1}z^n};$$

We have now only to find the developement of $(z-b)^m$, to multiply each of its terms by $\dot{z}$ and divide it by z^n, and take the fluent of the result.

Let us take for example the case of $m=3$, and $n=2$, then

$$\dot{y}=\frac{A(z-b)^3\dot{z}}{a^4z^2}$$

$$=\frac{A}{a^4}\left\{z\dot{z}-3b\dot{z}+3b^2z^{-1}\dot{z}-b^3z^{-2}\dot{z}\right\}$$

Hence, taking the fluents of the several terms, as in § 105, we have

$$y=\frac{A}{a^4}\left\{\frac{z^2}{2}-3bz+3b^2\mathrm{l}.z+b^3z^{-1}\right\}+C.$$

Let us now restore the value of z, and then it appears, that when

$$\dot{y}=\frac{Ax^3\dot{x}}{(ax+b)^2},$$

$$y=\frac{A}{a^4}\cdot\left\{\begin{matrix}\frac{1}{2}(ax+b)^2-3b(ax+b)\\+3b^2\mathrm{l}.(ax+b)+b^3(ax+b)^{-1}\end{matrix}\right\}+C.$$

110. If we suppose that

$$\dot{y}=\frac{Ax^n\dot{x}+Bx^p\dot{x}+Cx^q\dot{x}+\text{\&c.}}{(a+bx)^m},$$

then, we may write the equation thus,

$$\dot{y}=\frac{Ax^n\dot{x}}{(a+bx)^m}+\frac{Bx^p\dot{x}}{(a+bx)^m}$$

$$+\frac{Cx^q\dot{x}}{(a+bx)^m}+\text{\&c.}$$

and take the fluent of each term, in the same manner as we have found the fluent of $\frac{Ax^3\dot{x}}{(ax+b)^2}$.

Of the Fluents of rational Fractions.

111. Every fluxion that is a rational fraction is comprehended under this general formula,

$$\frac{(Ax^m+Bx^n+Cx^p+\text{\&c.})\dot{x}}{A'x^{m'}+B'x^{n'}+C'x^{p'}+\text{\&c.}},$$

which, by putting U to denote the expression between the parentheses in the numerator, and V the denominator, may be represented by $\frac{U\dot{x}}{V}$. Now in the first place, we remark that the greatest exponent of the powers of x in the numerator may be supposed to be less than that of its powers in the denominator. For if it were not so, by dividing U by V, and calling Q the quotient, and R the remainder, we should have $\frac{U\dot{x}}{V}=Q\dot{x}+\frac{R\dot{x}}{V}$, and

$$\int\frac{U\dot{x}}{V}=\int Q\dot{x}+\int\frac{R\dot{x}}{V}.$$

Now, Q being a rational and integer function, $\int Q\dot{x}$ may be found, as in § 101, and it only remains to find $\int\frac{R\dot{x}}{V}$, an expression in which the highest exponent of the powers of x in R is less by unity than in V; so that the fraction $\frac{R\dot{x}}{V}$ may be generally expressed thus,

$$\frac{(Ax^{n-1}+Bx^{n-2}+Cx^{n-3}\ldots\ldots+T)\dot{x}}{x^n+A'x^{n-1}+B'x^{n-2}+C'x^{n-3}\ldots+T'}.$$

The general method of finding the fluent of a fractional expression of this form consists in decomposing it into a series of other fractions, the denominators of which are more simple. These fractions may be found by proceeding as follows: By putting the denominator of the proposed fraction equal to 0, we get this equation,

$$x^n+A'x^{n-1}+B'x^{n-2}\ldots+T'=0.$$

Suppose now that the roots of this equation are found, and that they are denoted by

$$-a,\ -a',\ -a'',\ -a''',\ \text{\&c.}$$

which quantities we shall suppose in the first place, are all unequal. Then the expression which has been assumed as equal to 0, may (ALGEBRA, Sect. X.) be considered as the product of n factors

$$x+a,\ x+a',\ x+a'',\ x+a''',\ \text{\&c.}$$

Let the proposed fraction $\frac{R}{V}$ be now assumed as equal to the sum of the simple fractions

$$\frac{N}{x+a},\ \frac{N'}{x+a'},\ \frac{N''}{x+a''},\ \text{\&c.}$$

having for their denominators the simple factors of the denominator of the proposed fraction, and for their numerators quantities which are constant, but as yet are indetermined.

That we may avoid complicated calculations, and present a determinate object to the mind, let us suppose that the fluxion of which we are to find the fluent is

$$\frac{(Ax^2+Bx+C)\dot{x}}{x^3+A'x^2+B'x+C'},$$

and that we have by the resolution of the cubic equation $x^3+A'x^2+B'x+C'=0$ found

$$x^3+A'x^2+B'x+C'=(x+a)(x+a')(x+a'').$$

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The fractions

$$\frac{N\dot{x}}{x+a},\ \frac{N'\dot{x}}{x+a'},\ \frac{N''\dot{x}}{x+a''},$$

when reduced to a common denominator are

$$\frac{N(x+a')(x+a'')\dot{x}}{(x+a)(x+a')(x+a'')},\ \frac{N'(x+a)(x+xa'')\dot{x}}{(x+a)(x+a')(x+a'')},$$
$$\frac{N''(x+a)(x+a')\dot{x}}{(x+a)(x+a')(x+a'')}.$$

The common denominator of these fractions is the same as that of the proposed fraction, and each of the numerators, as well as their sum, is a function of x of a degree lower than the denominator, that is, in the present case, it is a function of the second degree. By taking the actual products of the factors in the numerators, and adding the results, we find the sum of the fractions equal to

$$\frac{\dot{x}}{V}\left\{\begin{array}{l}(N+N'+N'')x^2\\ +\left\{N(a'+a'')+N'(a+a'')+N''(a+a')\right\}x\\ +Na'a''+N'aa''+N''aa'\end{array}\right\}$$

where V denotes the common denominator $(x+a)(x+a')(x+a'')=x^3+A'x^2+B'x+C'$. Setting aside the factor $\frac{\dot{x}}{V}$ of the above expression, we are now to compare that part of it which involves the three indeterminate quantities N, N′, N″, with Ax^2+Bx+C, the numerator of the proposed fraction, thus we obtain these three equations

$$N+N'+N''=A,$$
$$N(a'+a'')+N'(a+a'')+N''(a+a')=B,$$
$$Na'a''+N'aa''+N''aa'=C.$$

By these equations, which are all of the first degree, we may determine the values of N, N′ and N″, and thus we have the proposed fraction $\frac{(Ax^2+Bx+C)\dot{x}}{x^3+A'x^2+B'x+C'}$ equal to

$$\frac{N\dot{x}}{x+a}+\frac{N'\dot{x}}{x+a'}+\frac{N''\dot{x}}{x+a''},$$

where N, N′, N″, and a, a', a'', are constant and known quantities.

Put $x+a=z$, then $\dot{x}=\dot{z}$, and the fraction $\frac{N\dot{x}}{x+a}$ is transformed to $\frac{N\dot{z}}{z}$, of which the fluent is $N\,l.\,z=N\,l.\,(x+a)$ (§ 103). In like manner we find $\int\frac{N'\dot{x}}{x+a'}=N'\,l.\,(x+a')$, and $\int\frac{N''\dot{x}}{x+a''}=N''\,l.\,(x+a'')$, and consequently

$$\int\frac{(Ax^2+Bx+C)\dot{x}}{x^3+A'x^2+B'x+C'}$$
$$=N\,l.(x+a)+N'l.(x+a')+N''l.(x+a'')+const.$$
$$=l.\left\{(x+a)^N(x+a')^{N'}(x+a'')^{N''}\right\}+const.$$

where by *const.* is meant a constant quantity.

It is easy to extend this mode of proceeding to the general formula given at the beginning of this §; and it is obvious, that as often as the denominator of a rational fraction can be decomposed into real and unequal factors, the determination of the fluent of that fraction is attended with no other difficulty than this decomposition, which requires the numerical resolution of equations.

112. We have supposed that the factors of the denominator of the proposed fraction are unequal among themselves, and it is only when this is the case that the fraction can be decomposed into others, having all this form $\frac{N}{x+a}$. If we suppose that the denominator $x^n+A'x^{n-1}+B'x^{n-2}\ldots+T'$ has a factor of the form $(x+a)^p$, then the proposed fraction

$$\frac{(Ax^{n-1}+Bx^{n-2}+Cx^{n-3}\ldots+T)\dot{x}}{x^n+A'x^{n-1}+B'x^{n-2}+C'x^{n-3}\ldots+T}$$

must be assumed equal to

$$\frac{(Px^{p-1}+Qx^{p-2}+Rx^{p-3}\ldots+Y)\dot{x}}{(x+a)^p}$$
$$+\frac{N'\dot{x}}{x+a'}+\frac{N''\dot{x}}{x+a''}\ldots$$

where P, Q, R ... Y, N′, N″, &c. denotes indeterminate but constant quantities, and $x+a'$, $x+a''$, &c. are the remaining factors of the denominator of the proposed fraction. To determine the quantities P, Q, R ... Y, N′, N″, &c. we must now proceed in all respects as in last §, that is, we must reduce the fractions involving these quantities to a common denominator, which will be the same as the denominator of the proposed fraction; then we must add the numerators, and put the coefficient of each power of x in the sum equal to the coefficient of the same power in the numerator of the proposed fraction. Thus we shall have as many equations as indeterminate quantities, and by resolving these equations, the values of these quantities will be found.

Having thus determined all the quantities P, Q, R, ... Y, which enter into the fraction

$$\frac{(Px^{p-1}+Qx^{p-2}\ldots+Y)\dot{x}}{(x+a)^p}$$

its fluent may be found as shewn in § 109. But we may also assume it equal to

$$\frac{M\dot{x}}{(x+a)^p}+\frac{M'\dot{x}}{(x+a)^{p-1}}+\frac{M''\dot{x}}{(x+a)^{p-2}}$$
$$\ldots+\frac{M'''\cdots\dot{x}}{x+a}$$

and, it is easy to see, that by reducing these fractions to a

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a common denominator and adding them, the numerator of their sum will have the same form as that of the fraction whose fluent we are seeking; so that the values of the indeterminate quantities M, M′, &c. will be found by putting the coefficients of the same power of x in both numerators equal to each other. To find the fluent of $\frac{M\dot{x}}{x+a)^p}$ we may assume $x+a=z$, then $\dot{x}=\dot{z}$, and

$$\int\frac{M\dot{x}}{(x+a)^p}=\int\frac{M\dot{z}}{z^p}=\frac{Mz^{-p+1}}{1-p}$$
$$=\frac{M}{(1-p)(x+a)^{p-1}}.$$

In like manner

$$\int\frac{M'\dot{x}}{(x+a)^{p-1}}=\frac{M'}{(2-p)(x+a)^{p-2}}$$

and so on, all the fluents being algebraic, except the last $\int\frac{M'''\cdots\dot{x}}{x+a}$ which is $M'''\cdots \mathrm{l}.(x+a)$, a logarithmic function.

113. In resolving the equation

$$x^n+A'x^{n-1}+B'x^{n-2}\ldots+T=0,$$

it may happen that some of its roots $a, a'\, a''$, &c. are imaginary quantities, and then some of the simple factors $x+a$, $x+a'$, $x+a''$, &c. will be imaginary. These factors always occur in pairs (ALGEBRA, § 179.) and have this form

$$x+\alpha+\beta\sqrt{-1}, \qquad x+\alpha-\beta\sqrt{-1},$$

so that their product

$$x^2+2\alpha x+\alpha^2+\beta^2$$

is a real factor of the second degree. As every corresponding pair of imaginary simple factors may be united in this manner into a real factor of the second degree, if these factors are all unequal, we may avoid introducing imaginary quantities into the fluent of the proposed fraction by proceeding thus. Let $x+\alpha+\beta\sqrt{-1}$ and $x+\alpha-\beta\sqrt{-1}$, denote two corresponding imaginary simple factors of the denominator. Instead of the two simple fractions

$$\frac{N\dot{x}}{x+\alpha+\beta\sqrt{-1}}, \qquad \frac{N'\dot{x}}{x+\alpha-\beta\sqrt{-1}},$$

which would have been assumed if the factors had been real, assume a single fraction

$$\frac{(Kx+L)\dot{x}}{x^2+2\alpha x+\alpha^2+\beta^2}$$

the denominator of which is a real function of x of the second degree, viz. that which is the product of the two imaginary factors. Here K and L denote two constant but indeterminate coefficients, the values of which, as also those of the other indeterminate coefficients are to be found as before.

If the denominator of the proposed fraction have several equal factors of the second degree resulting from its imaginary simple factors, so that the product of those equal factors is

$$(x^2+2\alpha x+\alpha^2+\beta^2)^q;$$

then, corresponding to this product, we must, among the fractions having indeterminate coefficients, assume one of this form

$$\frac{(Q'x^{2q-1}+R'x^{2q-2}\ldots+Y')\dot{x}}{(x^2+2\alpha x+\alpha^2+\beta^2)^q},$$

where Q′, R′ ... Y′ denote constant and indeterminate coefficients, the values of which will be found in all respects as those of the others.

We are now to find the fluents of these two fluxional expressions, beginning with the first, viz.

$$\frac{(Kx+L)\dot{x}}{x^2+2\alpha x+\alpha^2+\beta^2}, \quad \text{or} \quad \frac{(Kx+L)\dot{x}}{(x+\alpha)^2+\beta^2}.$$

Put $x+\alpha=z$, then it becomes

$$\frac{(Kz+L-K\alpha)\dot{z}}{z^2+\beta^2};$$

and this again, by putting $L-K\alpha=M$, is resolved into these two fluxions

$$\frac{Kz\dot{z}}{z^2+\beta^2}+\frac{M\dot{z}}{z^2+\beta^2}.$$

We can immediately find the fluent of the first of these, by putting $z^2+\beta^2=v$, for then $z\dot{z}=\frac{\dot{v}}{2}$, and

$$\int\frac{Kz\dot{z}}{z^2+\beta^2}=\frac{K}{2}\int\frac{\dot{v}}{v}=K\tfrac{1}{2}\,\mathrm{l}.\,v, \text{ (§ 103.)},$$
$$=K\,\mathrm{l}.\sqrt{(z^2+\beta^2)}.$$

With respect to the other fluxion, if we put $z=\beta y$, we have

$$\frac{M\dot{z}}{z^2+\beta^2}=\frac{M}{\beta}\,\frac{\dot{y}}{1+y^2},$$

but we have seen (§ 60.) that $\frac{\dot{y}}{1+y^2}$ is the fluxion of an arch of which the tangent is y, therefore

$$\int\frac{M}{\beta}\,\frac{\dot{y}}{1+y^2}=\frac{M}{\beta}\text{ arc (tan.}=y)+\text{const.}$$
$$=\frac{M}{\beta}\text{ arc (tan.}=\frac{z}{\beta})+\text{const.}$$

It is proper to remark that if $\frac{z}{\beta}$ be the tangent of an arch, then the sine of that arch is $\frac{z}{\sqrt{(z^2+\beta^2)}}$, and its cosine is $\frac{\beta}{\sqrt{(z^2+\beta^2)}}$, thus we may express the fluent under

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under different forms, by introducing the sine or cosine of the arch instead of its tangent.

If instead of z we substitute in these two fluents $x+\alpha$ we find that the fluent of $\frac{(Kx+L)\dot{x}}{x^2+2\alpha x+\alpha^2+\beta^2}$ is

$$K\,l.\sqrt{(x^2+2\alpha x+\alpha^2+\beta^2)}$$
$$+\frac{L-K\alpha}{\beta}\text{arc }(\tan.=\frac{x}{\beta})+\text{const.}$$

114. To find the fluent of the expression

$$\frac{(Q'x^{2q-1}+R'x^{2q-2}\ldots+Y')\dot{x}}{(x^2+2\alpha x+\alpha^2+\beta^2)^q},$$

we first transform it to

$$\frac{(Kx+L)\dot{x}}{(x^2+2\alpha x+\alpha^2+\beta^2)^q}$$
$$+\frac{(K'x+L')\dot{x}}{(x^2+2\alpha x+\alpha^2+\beta^2)^{q-1}}$$
$$\ldots+\frac{(K'''\ldots x+L'''\ldots)\dot{x}}{x^2+2\alpha x+\alpha^2+\beta^2},$$

where K, L, K′, L′, &c. denote indeterminate but constant coefficients, which may be determined by reducing these fractions to a common denominator, and proceeding as in the two preceding §§. Then the whole difficulty is reduced to the finding of the fluxion of the expression

$$\frac{(Kx+L)\dot{x}}{(x^2+2\alpha x+\alpha^2+\beta^2)^q}=\frac{(Kx+L)\dot{x}}{((x+\alpha)^2+\beta^2)^q},$$

where q denotes some integer number. To simplify this expression put $x+\alpha=z$, and $L-K\,a=M$, then it becomes $\frac{(Kz+M)\dot{z}}{(z^2+\beta^2)^q}$, which we shall now shew may be reduced to $\int\frac{H\dot{z}}{(z^2+\beta^2)^{q-1}}$. To effect this reduction we decompose its fluent into two parts

$$\int\frac{Kz\dot{z}}{(z^2+\beta^2)^q}+\int\frac{M\dot{z}}{(z^2+\beta^2)^q}.$$

The fluent of the first part may be immediately found by putting $z^2+\beta^2=v$; for then $z\dot{z}=\frac{\dot{v}}{2}$ and

$$\int\frac{Kz\dot{z}}{(z^2+\beta^2)^q}=\int\frac{K\dot{v}}{2v^q}=\frac{K\,v^{-q+1}}{2(1-q)},$$

Let us now suppose that the fluent of the second part $\frac{M\dot{z}}{(z^2+\beta^2)^q}$ is equal to the sum of the algebraic function $\frac{Gz}{(z^2+\beta^2)^{q-1}}$, and another function, which is the fluent of $\frac{H\dot{z}}{(z^2+\beta^2)^{q-1}}$, that is, let us assume

$$\int\frac{M\dot{z}}{(z^2+\beta^2)^q}=\frac{Gz}{(z^2+\beta^2)^{q-1}}+\int\frac{H\dot{z}}{(z^2+\beta^2)^{q-1}},$$

where G and H are constant but indeterminate coefficients. To determine these let the fluxion of each side of this equation be taken (observing that the fluxion of a quantity having the sign $\int$ prefixed to it is the same quantity only without that sign); thus we have

$$\frac{M\dot{z}}{(z^2+\beta^2)^q}=\frac{G\dot{z}}{(z^2+\beta^2)^{q-1}}-\frac{2(q-1)Gz^2\dot{z}}{(z^2+\beta^2)^q}$$
$$+\frac{H\dot{z}}{(z^2+\beta^2)^{q-1}},$$

and from this equation, by rejecting what is common to each term, we find

$$M=G(z^2+\beta^2)-2(q-1)Gz^2+H(z^2+\beta^2),$$

and hence

$$M=G\beta^2+H\beta^2+(G-2(q-1)G+H)z^2;$$

Therefore by comparing together like terms we find

$$M=G\beta^2+H\beta^2,\qquad G-2(q-1)G+H=0;$$

and from these equations we get

$$G=\frac{M}{(2q-2)\beta^2},\qquad H=\frac{(2q-3)M}{(2q-2)\beta^2}.$$

Let these values of G and H be now substituted in our assumed equation, and it becomes

$$\int\frac{M\dot{z}}{(z^2+\beta^2)^q}=\frac{M}{(2q-2)\beta^2}\,\frac{z}{(z^2+\beta^2)^{q-1}}$$
$$+\frac{M(2q-3)}{(2q-2)\beta^2}\int\frac{\dot{z}}{(z^2+\beta^2)^{q-1}}.$$

Thus we have reduced the determination of the fluent of $\frac{M\dot{z}}{(z^2+\beta^2)^q}$ to that of $\frac{\dot{z}}{(z^2+\beta^2)^{q-1}}$, and by proceeding in the same manner with this last fluxion, its fluent may be made to depend on that of $\frac{\dot{z}}{(z^2+\beta^2)^{q-2}}$; but this will be more readily effected by simply substituting $q-1$ instead of q, and supposing $M=1$ in the preceding equation.

Thus

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Thus we shall obtain

$$\int\frac{\dot{z}}{(z^2+\beta^2)^{q-1}}=\frac{1}{(2q-4)\beta^2}\,\frac{z}{(z^2+\beta^2)^{q-2}}$$
$$+\frac{(2q-5)}{(2q-4)\beta^2}\int\frac{\dot{z}}{(z^2+\beta^2)^{q-2}}.$$

Substituting now this value of $\int\frac{\dot{z}}{(z^2+\beta^2)^{q-1}}$ in the former equation, we have $\int\frac{M\dot{z}}{(z^2+\beta^2)^{q}}$ equal to

$$\frac{M}{(2q-2)\beta^2}\,\frac{z}{(z^2+\beta^2)^{q-1}}$$
$$+\frac{(2q-3)M}{(2q-2)(2q-4)\beta^4}\,\frac{z}{(z^2+\beta^2)^{q-2}}$$
$$+\frac{(2q-3)(2q-5)M}{(2q-2)(2q-4)\beta^4}\int\frac{\dot{z}}{(z^2+\beta^2)^{q-2}}$$

It is easy to see, that like as we obtained an expression for the fluent of $\frac{\dot{z}}{(z^2+\beta^2)^{q-1}}$ by substituting $q-1$ for q, and supposing $M=1$, in the equation preceding the last; so by substituting $q-2$ for q, we shall obtain an expression for the fluent of $\frac{\dot{z}}{(z^2+\beta^2)^{q-2}}$, which expression will consist of two terms, one an algebraic function of z, and the other $\int\frac{\dot{z}}{(z^2+\beta^2)^{q-3}}$ multiplied by a constant and given coefficient. This value of $\frac{\dot{z}}{(z^2+\beta^2)^{q-2}}$ when substituted in the last equation will produce an expression for $\int\frac{M\dot{z}}{(z^2+\beta^2)^{q}}$ consisting of algebraic quantities and $\int\frac{\dot{z}}{(z^2+\beta^2)^{q-3}}$. By continuing this process it is evident that we shall at last have $\int\frac{M\dot{z}}{(z^2+\beta^2)^{q}}$ expressed by a series of algebraic quantities, and $\int\frac{\dot{z}}{z^2+\beta^2}$, and here we must stop, for if we repeat the process with a view to make the fluent depend on $\int\frac{\dot{z}}{(z^2+\beta^2)^{0}}$ that is on $\int\dot{z}$, or z, we shall find that the coefficient of this quantity becomes infinite. As to the fluent of $\frac{\dot{z}}{z^2+\beta^2}$ we have exhibited the expression for it in last §.

In comparing together the results which have been obtained in the preceding articles, it must appear that when a fluxion is expressed by a rational fraction, if we grant the resolution of equations, the fluent may always be assigned either algebraically, or by means of arches of a circle or logarithms; and that to prepare it for a solution, we must decompose the fraction into others, whose denominators may be either binomial or trinomial quantities. This decomposition may always be effected by the method of indeterminate coefficients. There are, however, several analytical artifices by which the labour of calculation may be greatly shortened. These we now proceed to explain.

115. Let us recur to the fraction $\frac{U}{V}$ and suppose that $x+a$ is one of the unequal factors of the denominator V, so that we have $V=(x+a)Q$; Let us now put $\frac{U}{V}=\frac{A}{x+a}+\frac{P}{Q}$, A being supposed a constant quantity, and P an indeterminate function of x, but such as not to be divisible by $x+a$. Then we have $U=AQ+P(x+a)$, and hence $P=\frac{U-AQ}{x+a}$. As P is an integer function with respect to x, it follows from this equation that $U-AQ$, which is also a rational and integer function of x, is divisible by $x+a$, and consequently has $x+a$ for a factor; therefore, the function $U-AQ$ will vanish when we substitute $-a$ in it instead of x, seeing that $-a$ is the value of x that makes the factor $x+a=0$. Let us denote by u and q, what U and Q become by this substitution, which however will not affect the indeterminate quantity A, because it is independent of x. We have therefore $u-Aq=0$, and consequently $A=\frac{u}{q}$.

This value of A requires that we should know the function Q given by the equation $V=(x+a)Q$, and we may always find it by dividing V by $a+x$. The direct method of fluxions affords also a very simple method of determining it. For by taking the fluxion of the above equation we have

$$\frac{\dot{V}}{\dot{x}}=Q+(x+a)\frac{\dot{Q}}{\dot{x}};$$

if in this result we make $x+a=0$, or $x=-a$, and denote by v what $\frac{\dot{V}}{\dot{x}}$ becomes by that substitution, we shall have $v=q$, and consequently $A=\frac{u}{v}$.

The expression $A=\frac{u}{q}$ has always a finite value, for the numerator and denominator can never become $=0$, because we suppose the fraction $\frac{U}{V}$ reduced to its lowest terms, and consequently, that the numerator U has not for a factor $x+a$, which is a factor of the denominator, but which being contained in it only once does not enter into Q.

116. Let us now consider how the numerators of the fractions, into which the proposed fraction $\frac{U}{V}$ is to be decomposed, are to be found in the case of the denominator

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nator V having equal factors of the first degree. In this case we have $V=Q(x+a)^n$, and we assume

$$\frac{U}{V}=\frac{A}{(x+a)^n}+\frac{B}{(x+a)^{n-1}}+\frac{C}{(x+a)^{n-2}} \dots+\frac{N}{x+a}+\frac{P}{Q}.$$

By reducing to a common denominator, we find U equal to

$$Q\left\{\begin{matrix}A+B(x+a)+C(x+a)^2\\ \dots+N(x+a)^{n-1}\end{matrix}\right\}+P(x+a)^n$$

and P equal to

$$\frac{U-Q\left(A+B(x+a)+C(x+a)^2\dots+N(x+a)^{n-1}\right)}{(x+a)^n}$$

and as P ought to be an integer function of x, the numerator of its value is necessarily divisible n times successively by $x+a$; therefore, that numerator ought to be equal to 0, when $-a$ is substituted in it instead of x. Now this substitution being made, each of the terms of the numerator which is multiplied by $x+a$ vanishes, so that there remains only $U-AQ$, but that this quantity may be divisible by $x+a$ it is necessary that $u-q\,A=0$, where u and q denote the same as in last §, hence $A=\frac{u}{q}$.

This value of A changes $U-QA$ into $U-\frac{u}{q}Q$, which must be divisible by $x+a$. Let us, with a view to abridge, put $U-\frac{u}{q}Q=U'(x+a)$, then, substituting this quantity in the value of P, and dividing both numerator and denominator by $x+a$, we have P equal to

$$\frac{U'-Q\left(B+C(x+a)\dots+N(x+a)^{n-2}\right)}{(x+a)^{n-1}}.$$

Now to obtain B we make $x+a=0$, then, putting u' to denote what U' becomes by substituting $-a$ in it in place of x, we have $u'-q\,B=0$, and $B=\frac{u'}{q}$.

Instead of B let its value be substituted in $U'-QB$, and this quantity becomes $U'-\frac{u'}{q}Q$, which vanishing when $x+a=0$, will have $x+a$ for a divisor; therefore, we may put $U'-\frac{u'}{q}Q=U''(x+a)$, then, substituting this last quantity instead of the former in the value of P, and dividing the numerator and denominator by $x+a$, we have P equal to

$$\frac{U''-Q(C+D(x+a)\dots+N(x+a)^{n-3})}{(x+a)^{n-2}}.$$

By continuing the same mode of reasoning, and the same notation, we find $u''-q\,C=0$, and $C=\frac{u''}{q}$. And so on with the remaining quantities.

The direct method of fluxions facilitates greatly the preceding operations. For the numerator of P being divisible by $(x+a)^n$ is necessarily of this form $X(a+x)^n$, X being an integer function of x, but which does not contain the factor $x+a$. Now agreeably to what has been shewn in § 88, the successive fluxions of this numerator, as far as the $n-1$ order inclusive, vanish when $x+a$ is supposed $=0$. By giving to the numerator the following form

$$Q\left(\frac{U}{Q}-A-B(x+a)-C(x+a)^2\dots\right)$$

and observing that the function Q does not contain the factor $x+a$, it is manifest that it is only the part of this expression between the parentheses which ought to be divisible by $(x+a)^n$. Let us put $\frac{U}{Q}=Z$, then the successive fluxions of that part are

$$\dot{Z}-B\dot{x}-2\,C(x+a)\dot{x}-3\,D(x+a)^2\dot{x}\dots$$

$$\ddot{Z}-2\,C\dot{x}^2-2\,.\,3\,D(x+a)\dot{x}^2\dots$$

$$\dddot{Z}-2\,.\,3\,D\dot{x}^3\dots$$

&c.

and these results ought all to vanish when we put $x+a=0$. Thus we have

$$Z-A=0, \text{ and } A=\frac{u}{q},$$

$$\dot{Z}-B\dot{x}=0,\quad B=\frac{\dot{Z}}{\dot{x}},$$

$$\ddot{Z}-2C\dot{x}^2=0,\quad C=\frac{\ddot{Z}}{2\dot{x}^2},$$

$$\dddot{Z}-2.3D\dot{x}^3=0,\quad D=\frac{\dddot{Z}}{2\,.\,3\,\dot{x}^3},$$

&c. &c.

observing that in each of these functions $\frac{\dot{Z}}{\dot{x}}$, $\frac{\ddot{Z}}{2\dot{x}^2}$, we must substitute $-a$ instead of x.

The most simple way to find the value of Q in this case is to divide V by $(x+a)^n$, but we may also find it by the direct method of fluxions, as in the preceding §; for, since $V=Q(x+a)^n$, if we take the fluxion of each side of this equation n times, and then make $x+a=0$, we shall find, § 88, the nth fluxion of V equal to $1\,.\,2\,.\,3\dots n\,Q\,\dot{x}^n$, and consequently

$$Q=\frac{n\text{th flux. of V}}{1\,.\,2\dots n\,\dot{x}^n}.$$

117. Let us now consider how we are to find the numerator of the fraction which forms a part of $\frac{U}{V}$ when it has this form

$$\frac{Ax+B}{x^2+2\alpha x+\alpha^2+\beta^2}.$$

Assume

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Assume

$$\frac{U}{V}=\frac{Ax+B}{x^2+2\alpha x+\alpha^2+\beta^2}+\frac{P}{Q};$$

then, reducing the latter part of this equation to a common denominator, we find

$$U=Q(Ax+B)+P(x^2+2\alpha x+\alpha^2+\beta^2).$$

Hence we deduce

$$P=\frac{U-Q(Ax+B)}{x^2+2\alpha x+\alpha^2+\beta^2}.$$

As P is supposed to be an integer function with respect to x, it follows that $U-Q(Ax+B)$ is divisible by $x^2+2\alpha x+\alpha^2+\beta^2$; therefore, the former of these two quantities must contain among its factors those of the latter, and the quantities, which, being substituted for x, cause the latter to vanish, must also make the former vanish. But the factors of $x^2+2\alpha x+\alpha^2+\beta^2$ are $x+\alpha+\beta\sqrt{-1}$, and $x+\alpha-\beta\sqrt{-1}$, and these, being put each $=0$, give us $x=-(\alpha+\beta\sqrt{-1})$, and $x=-(\alpha-\beta\sqrt{-1})$, therefore, each of these values of x being substituted in $U-Q(Ax+B)$ ought to make that quantity vanish. Let us denote by $u\pm u'\sqrt{-1}$, and by $q\pm q'\sqrt{-1}$ what U and Q respectively become when $-(\alpha\pm\beta\sqrt{-1})$ is substituted in each instead of x, then, after this transformation, we have

$$\left.\begin{matrix} u\pm u'\sqrt{-1} \\ -(q\pm q'\sqrt{-1})\left\{-A(\alpha\pm\beta\sqrt{-1})+B\right. \end{matrix}\right\}=0.$$

This equation is twofold, because of the sign $\pm$ with which several of its terms are affected, and it is equivalent to those which would be formed by putting the real part equal to 0, and the imaginary part $=0$; from this consideration we have

$$u+q\alpha A-q'\beta A-qB=0,$$

$$u'+q\beta A+q'\alpha A-q'B=0,$$

two equations which give us the values of A and B.

The function Q may be found as in § 115. For, if we take the fluxions of each side of the equation

$$Q(x^2+2\alpha x+\alpha^2+\beta^2)=V,$$

and afterwards make

$$x^2+2\alpha x+\alpha^2+\beta^2=0,$$

we find $Q(2x\dot{x}+2\alpha\dot{x})=\dot{V}$ and hence

$$Q=\frac{\dot{V}}{2x\dot{x}+2\alpha\dot{x}};$$

Let the two values of x, to wit $-(\alpha\pm\beta\sqrt{-1})$, be substituted instead of it in this equation, then, putting $v\pm v'\sqrt{-1}$ to denote what the xpression $\frac{\dot{V}}{\dot{x}}$ becomes by that substitution, and writing $q\pm q'\sqrt{-1}$ instead of Q, we have

$$q\pm q'\sqrt{-1}=\frac{v\pm v'\sqrt{-1}}{\mp 2\beta\sqrt{-1}},$$

which, by multiplying the terms of the fraction on the latter side of the equation by $\sqrt{-1}$, becomes

$$q\pm q'\sqrt{-1}=\frac{v\sqrt{-1}\mp v'}{\pm 2\beta}.$$

Hence, by putting the real part of each side of this equation equal to each other, and also the imaginary parts equal to each other, we find

$$q=-\frac{v'}{2\beta},\ q'=\frac{v}{2\beta}.$$

118. If the factor $x^2+2\alpha x+\alpha^2+\beta^2$ is found several times in the denominator of V, so that $V=Q(x^2+2ax+\alpha^2+\beta^2)^n$, then, § 113, we assume in this case $\frac{U}{V}$ equal to

$$\frac{Ax+B}{(x^2+2\alpha x+\alpha^2+\beta^2)^n}+\frac{A'x+B'}{(x^2+2\alpha x+\alpha^2+\beta^2)^{n-1}}$$
$$+\frac{A''x+B}{(x^2+2\alpha x+\alpha^2+\beta^2)^{n-2}}\cdots+\frac{P}{Q}$$

reducing this expression to a common denominator, and so ordering the equation as to bring P to stand alone on one side, we find P equal to

$$\frac{U-Q\left\{\begin{matrix}Ax+B+(A'x+B')(x^2+2\alpha x+\alpha^2+\beta^2) \\ +(A''x+B'')(x^2+2\alpha x+\alpha^2+\beta^2)^2\cdots\end{matrix}\right\}}{(x^2+2\alpha x+\alpha^2+\beta^2)^n}$$

By reasoning in this as in the preceding case, it may be concluded that the numerator of this expression ought to vanish when $-(\alpha\pm\beta\sqrt{-1}$ is substituted in it instead of x; therefore, putting $u\pm u'\sqrt{-1}$, and $q\pm q'\sqrt{-1}$ to denote the same things as before, we deduce from that substitution

$$\left.\begin{matrix} u\pm u'\sqrt{-1} \\ -(q\pm q'\sqrt{-1})(-A(\alpha\pm\beta\sqrt{-1})+B) \end{matrix}\right\}=0$$

the very same equation for the determination of A and B, as we have already found in last §.

Having found the values of these quantities, they may be substituted in the numerator of P, and the terms $U-Q(Ax+B)$ becoming divisible by $x^2+2\alpha x+\alpha^2+\beta^2$, the whole expression becomes divisible by the same quantity. Calling therefore U′ the quotient arising from the division of $U-Q(Ax+B)$ by $x^2+2\alpha x+\alpha^2+\beta^2$, we have P equal to

$$\frac{U'-Q[A'x+B'+(A''x+B'')(x^2+2\alpha x+\alpha^2+\beta^2)\ldots]}{(x^2+2\alpha x+\alpha^2+\beta^2)^{n-1}}$$

If in this numerator we substitute instead of x its values deduced from the equation $x^2+2\alpha x+a^2+\beta^2=0$, and put the result $=0$, we may determine A′ and B′ in the very same way that we have already determined A and B, and by proceeding in this manner we shall find the remaining coefficients A″, B″, &c.

This case is quite analogous to that which has been already treated in § 116, and the direct method of fluxions applies to it in the same manner as to the other. For since Q does not contain the factor $x^2+2\alpha x+\alpha^2+\beta^2$, if the numerator of P be divided by the function Q, the result, which may be denoted by r, ought to be of this form

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form $r=X(x^2+2\alpha x+\alpha^2+\beta^2)^n$ and consequently ought to vanish, as well as all its fluxions, from the first order to the $n-1$ order, inclusively, when $x^2+2\alpha x+a^2+\beta^2=0$; this being the case, we have these equations

$$r=0,\ \dot r=0,\ \ddot r=0,\ \ldots$$

and so on to the $n-1$ fluxion of r, which ought also to be $=0$; each of these equations becomes twofold when we substitute instead of x, the values of which it is susceptible in consequence of the equation $x^2+2\alpha x+\alpha^2+\beta^2=0$. By putting the real and the imaginary parts separately $=0$, we shall obtain as many equations as are sufficient to determine A, B, A′, B′, &c.

It may also be remarked, that from the equation

$$V=Q(x^2+2\alpha x+\alpha^2+\beta^2)^n$$

we find Q equal to the quotient arising from the division of the nth fluxion of V by the nth fluxion of $x^2+2\alpha x+\alpha^2+\beta^2$, observing to assume

$$x^2+2\alpha x+\alpha^2+\beta^2=0.$$

119. We shall now give some applications of what has been said relative to the fluents of rational fractions. Suppose the fraction to be

$$\frac{\dot x}{x^8+x^7-x^4-x^3};$$

The factors of its denominator are easily found, for it may be put under this form

$$x^3(x^5+x^4-x-1)=x^3(x+1)(x^4-1),$$

the factor x^4-1 may be decomposed into x^2-1 and x^2+1, or $x-1$, $x+1$, and x^2+1, thus we have the denominator equal to

$$x^3(x-1)(x+1)^2(x^2+1)$$

therefore (§ 111, § 112, and § 113.) the proposed fraction is to be decomposed as follows

$$\frac{A\dot x}{x-1}+\frac{B\dot x}{(x+1)^2}+\frac{C\dot x}{x+1}$$

$$+\frac{D\dot x}{x^3}+\frac{E\dot x}{x^2}+\frac{F\dot x}{x}+\frac{(Gx+H)\dot x}{1+x^2}$$

By reducing these fractions to a common denominator, and comparing the numerator of their sum with that of the proposed fraction, we might determine the unknown quantities A, B, C, &c. we shall, however, rather employ the methods that have just been explained.

By comparing this particular example $\frac{\dot x}{x^8+x^7-x^4-x^3}$ with the general expression $\frac{U\dot x}{V}$, it appears that $U=1$, and $V=x^8+x^7-x^4-x^3$. First let us investigate the numerator of the fraction $\frac{A}{x-1}$, and for this purpose we employ the formula $A=\frac{u}{v}$ (§ 115.). As we have $U=1$, it is evident that $u=1$; and since $V=x^8+x^7-x^4-x^3$, therefore $\frac{\dot V}{\dot x}=8x^7+7x^6-4x^3-3x^2$. If in this expression we substitute $+1$ instead of x (viz. the value of x deduced from the equation $x-1=0$) we find the result to be 8, therefore $v=8$. So that

$$A=\frac{u}{v}=\frac{1}{8},\ \text{and}\ \frac{A}{x-1}=\frac{1}{8}\,\frac{1}{x-1}.$$

Let us next investigate the values of B and C in the fractions $\frac{B}{(x+1)^2}$, and $\frac{C}{x+1}$, by means of the rule of § 116, and that we may make the symbols expressing the quantity under consideration agree with those employed in that formula, let us exchange the letters B and C for A and B, so that we are to consider $\frac{A}{(x+1)^2}+\frac{B}{x+1}$. In the first place we have

$$Q=\frac{x^8+x^7-x^4-x^3}{(x+1)^2}=x^6-x^5+x^4-x^3;$$

Put $x+1=0$, then $x=1$; substituting now this value of x in the value of Q, the result is $4=q$, therefore $A=\frac{u}{q}=\frac{1}{4}$. Let this value of A be substituted for A in the expression for U′ in the § above cited, and we have

$$U'=\frac{U-AQ}{x+1}=\frac{4-x^6+x^5-x^4+x^3}{4(x+1)}$$

$$=\frac{-x^5+2x^4-3x^3+4x^2-4x+4}{4}$$

Hence putting -1 instead of x in the expression for U′, we have $u'=\frac{9}{2}$ and $B=\frac{u'}{q}=\frac{9}{8}$. Thus the two fractions under consideration are found to be $\frac{1}{4}\cdot\frac{1}{(x+1)^2}$ and $\frac{9}{8}\cdot\frac{1}{x+1}$. We might have deduced the value of B from the formula $B=\frac{\dot z}{\dot x}$, § 116, where Z is put for $\frac{U}{Q}$ for we have

$$Z=\frac{U}{Q}=\frac{1}{x^6-x^5+x^4-x^3},$$

$$\text{and}\ \frac{\dot Z}{\dot x}=-\frac{6x^5-5x^4+4x^3-3x^2}{(x^6-x^5+x^4-x^3)^2}.$$

If in this expression we substitute -1 instead of x, it becomes $\frac{18}{16}=\frac{9}{8}$, the same value for B as before.

Let us now consider the fractions $\frac{D}{x^3}+\frac{E}{x^2}+\frac{F}{x}$, or exchanging the symbols D, E, F for A, B, C,

$$\frac{A}{x^3}+\frac{B}{x^2}+\frac{C}{x}.$$

The numerators A, B, C may all be found from these formulas of § 116.

A=

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$$A=\frac{U}{Q}=Z,\ B=\frac{\dot{Z}}{\dot{x}},\ C=\frac{\ddot{Z}}{1.2\dot{x}^2},$$

observing that in this case $Q=x^5+x^4-x-1$; and that we must substitute 0 instead of x in each formula, after taking the fluxions. Now we have

$$Z=\frac{U}{Q}=\frac{1}{x^5+x^4-x-1},$$

$$\frac{\dot{Z}}{\dot{x}}=-\frac{5x^4+4x^3-1}{(x^5+x^4-x-1)^2},$$

$$\frac{\ddot{Z}}{\dot{x}^2}=-\frac{20x^3+12x^2}{(x^5+x^4-x-1)^2}$$

$$+\frac{2(5x^4+4x^3-1)^2}{(x^5+x^4-x-1)^3};$$

Hence putting $x=0$, we find

$$A=-1,\ B=+1,\ C=-1,$$

so that

$$\frac{A}{x^3}+\frac{B}{x^2}+\frac{C}{x}=-\frac{1}{x^3}+\frac{1}{x^2}-\frac{1}{x}$$

There yet remains the fraction $\frac{Gx+H}{x^2+1}$, or $\frac{Ax+B}{x^2+1}$ to be considered. It may be found by subtracting the sum of all the others from the proposed fraction; we proceed however to find it directly by the formulas of § 117. In the first place we have $Q=x^6+x^5-x^4-x^3$; next, the factor x^2+1 being put $=0$ gives $x=\pm\sqrt{-1}$ $\alpha=0$, $\beta=0$. Hence we find

$$q\pm q'\sqrt{-1}=-2\pm 2\sqrt{-1},\ u=1, \text{ and } u'=0.$$

The equations which determine A and B thus become

$$1+2A+2B=0,\quad 2A-2B=0,$$

therefore $A=B=-\frac{1}{4}$, and

$$\frac{Ax+B}{x^2+1}=-\frac{1}{4}\cdot\frac{x+1}{x^2+1}$$

Thus upon the whole, the proposed fraction $\frac{\dot{x}}{x^8+x^7-x^4-x^3}$ is decomposed into the following

$$\frac{1}{8}\cdot\frac{\dot{x}}{x-1}+\frac{1}{4}\cdot\frac{\dot{x}}{(x+1)^2}+\frac{9}{8}\frac{\dot{x}}{x+1}$$

$$-\frac{\dot{x}}{x^3}+\frac{\dot{x}}{x^2}-\frac{\dot{x}}{x}-\frac{1}{4}\cdot\frac{(x+1)\dot{x}}{x^2+1}$$

The manner of finding the fluent of each of these has been already explained, and the result of taking all the fluents is

$$\left.\begin{array}{l}\frac{1}{8}\,\mathrm{l.}\,(x-1)-\frac{1}{4}\,\frac{1}{x+1}\\ +\frac{9}{8}\,\mathrm{l.}\,(x+1)+\frac{1}{2x^2}-\frac{1}{x}-\mathrm{l.}\,x\\ -\frac{1}{8}\,(x^2+1)-\frac{1}{4}\text{ arc }(\tan.=x)+\text{const.}\end{array}\right\}$$

The union of all the algebraic terms produces the fraction $\frac{2-2x-5x^2}{4x^2(1+x)}$, and that of the logarithmic quantities gives

$$\frac{1}{8}\,\mathrm{l.}\,(x-1)+\frac{1}{8}\,\mathrm{l.}\,(x+1)+\mathrm{l.}\,(x+1)$$

$$-\frac{1}{8}\mathrm{l.}\,(x^2+1)-\mathrm{l.}\,x$$

$$=\frac{1}{8}\,\mathrm{l.}\left(\frac{x^2-1}{x^2+1}\right)+\mathrm{l.}\left(\frac{x+1}{x}\right).$$

We have therefore upon the whole $\int\frac{\dot{x}}{x^8+x^7-x^4-x^3}$ equal to

$$\frac{2-2x-5x^2}{4x^2(1+x)}+\frac{1}{8}\,\mathrm{l.}\left(\frac{x^2-1}{x^2+1}\right)$$

$$+\mathrm{l.}\left(\frac{x+1}{x}\right)-\frac{1}{4}\text{ arc }(\tan.=x)+\text{const.}$$

120. When a fluxion is a rational fraction having either of these forms

$$\frac{x^m\dot{x}}{x^n\pm a^n},\quad \frac{x^m\dot{x}}{x^{2n}\pm 2p\,a^n x^n+a^n},$$

we can always, by the application of a particular theorem in analysis, resolve its denominator into real factors of the first and second degrees. The theorem to which we allude is this. Let n be any positive integer, and let z denote any arch of a circle, of which the radius is unity, then

$$(\text{cos. }z\pm\sqrt{-1}\text{ sin. }z)^n=\text{cos. }nz\pm\sqrt{-1}\text{ sin. }nz.$$

We proceed to prove this theorem. Because

$$(\text{cos. }z+\sqrt{-1}\text{ sin. }z)(\text{cos. }z-\sqrt{-1}\text{ sin. }z)$$

$$=\text{cos.}^2 z+\text{sin.}^2 z=1.$$

If we put $\text{cos. }z\pm\sqrt{-1}\text{ sin. }z=v$,

Then $\text{cos. }z\mp\sqrt{-1}\text{ sin. }z=\frac{1}{v}$;

Therefore taking the sum of these two equations,

$$2\text{ cos. }z=v+\frac{1}{v}.$$

Now by the arithmetic of sines (ALGEBRA, § 358.)

$$2\text{ cos. }2z=2(2\text{ cos. }z\times\text{cos. }z-1),$$

$$2\text{ cos. }3z=2(2\text{ cos. }z\times\text{cos. }2z-\text{cos. }z),$$

$$2\text{ cos. }4z=2(2\text{ cos. }z\times\text{cos. }3z-\text{cos. }2z),$$

$$2\text{ cos. }5z=2(2\text{ cos. }z\times\text{cos. }4z-\text{cos. }3z).$$

&c.

Therefore, substituting in the first of these equations $v+\frac{1}{v}$ instead of $2\text{ cos. }z$, we have

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$$2\cos. 2z = \left(v+\frac{1}{v}\right)\left(v+\frac{1}{v}\right)-2$$

$$= v^2 + \frac{1}{v^2}.$$

In like manner, substituting in the second equation, $v+\frac{1}{v}$ instead of $2\cos. z$, and $v^2+\frac{1}{v^2}$ instead of $2\cos. 2z$, we have

$$2\cos. 3z = \left(v+\frac{1}{v}\right)\left(v^2+\frac{1}{v^2}\right) - \left(v+\frac{1}{v}\right)$$

$$= v^3 + \frac{1}{v^3}.$$

Proceeding in the same way with the third and following equations, we find

$$2\cos. 4z = v^4 + \frac{1}{v^4},$$

$$2\cos. 5z = v^5 + \frac{1}{v^5};$$

so that we may conclude in general that

$$2\cos. nz = v^n + \frac{1}{v^n};$$

Hence we have this quadratic equation

$$v^{2n} - 2\cos. nz \times v^n + 1 = 0,$$

from which, by completing the square, we find

$$v^n = \cos. nz \pm \sqrt{(\cos.^2 nz - 1)};$$

therefore, by substituting for v the quantity it was put to represent, and observing that $\sqrt{(\cos.^2 nz - 1)} = \sqrt{(-\sin.^2 nz)} = \sqrt{-1}\sin. nz$, we have

$$(\cos. z \pm \sqrt{-1}\sin. z)^n = \cos. nz \pm \sqrt{-1}\sin. nz,$$

as was to be proved.

121. The function $x^n \pm a^n$ is transformed to $a^n(y^n \pm 1)$ by putting $x = ay$, and to discover its factors, we must resolve the equation

$$y^n \pm 1 = 0.$$

The expression $y = \cos. z + \sqrt{-1}\sin. z$ satisfies this equation, by a very simple determination of the arch z; for we have $y^n = (\cos. z + \sqrt{-1}\sin. z)^n = \cos. nz + \sqrt{-1}\sin. nz$, and as by putting π to denote half the circumference, and m any whole number, we have (ALGEBRA, § 352)

$$\sin. m\pi = 0, \cos. m\pi = \pm 1,$$

where the sign $+$ is to be taken, if m be an even number, but $-$ if it be odd, we have only to suppose $nz = m\pi$, in order to obtain $y^n = \pm 1$.

That we may distinguish the case in which m is even, from that in which it is odd, we shall write for the first $2m$, and for the second $2m+1$; we therefore make

$$nz = 2m\pi, \text{ and } nz = (2m+1)\pi.$$

By the first hypothesis, we find

$$y^n = +1, \; y = \cos. \frac{2m\pi}{n} + \sqrt{-1}\sin. \frac{2m\pi}{n},$$

and by the second

$$y^n = -1,$$

$$y = \cos. \frac{(2m+1)\pi}{n} + \sqrt{-1}\sin. \frac{(2m+1)\pi}{n}.$$

122. By means of the indeterminate number n, each of these expressions for y furnishes all the values of which this quantity is susceptible, for we may take successively

$$m=0, m=1, m=2, m=3, \&c.$$

The first formula gives

$$y = \cos. 0.\pi = 1$$

$$y = \cos. \frac{2\pi}{n} + \sqrt{-1}\sin. \frac{2\pi}{n},$$

$$y = \cos. \frac{4\pi}{n} + \sqrt{-1}\sin. \frac{4\pi}{n},$$

&c.

It is evident that we shall always have different results as far as $m = n-1$. If, however we suppose $m = n$; then we have $y = \cos. 2 = 1\pi$, which is the same as the first of the values already obtained, and if we suppose $m = n+1$, then (ALGEBRA, § 25.)

$$\text{Cos.} \frac{(2n+2)}{n}\pi = \cos. \left(2\pi + \frac{2\pi}{n}\right) = \cos. \frac{2\pi}{n},$$

$$\text{Sin.} \frac{(2n+2)\pi}{n} = \sin. \left(2\pi + \frac{2\pi}{n}\right) = \sin. \frac{2\pi}{n},$$

which is the same as the second value, and so on with respect to the others.

By this mode of proceeding we shall not only obtain the n roots of the equation $y^n = 1$, or $y^n - 1 = 0$, but, with a little attention, we shall discover that these roots may be arranged in pairs, by bringing together those that only differ in the sign of the radical $\sqrt{-1}$; for since

$$\text{Cos.} (2\pi - p) = \cos. p, \text{ and } \sin. (2\pi - p) = -\sin. p,$$

it follows that

$$y = \cos. \frac{(2n-2m)\pi}{n} + \sqrt{-1}\sin. \frac{(2n-2m)\pi}{n}$$

$$= \cos. \frac{2m\pi}{n} - \sqrt{-1}\sin. \frac{2m\pi}{n}.$$

Hence it appears that we may comprehend all the roots of the equation $y^n - 1 = 0$ in the single expressions

$y=$

$$y=\text{cos.}\frac{2m\pi}{n}\pm\sqrt{-1}\,\text{sin.}\frac{2m\pi}{n},$$

by giving to m only these values

$$0,\ 1,\ 2,\ \ldots\ \frac{n}{2},$$

if n is even, and these values

$$0,\ 1,\ 2,\ \ldots\ \frac{n-1}{2},$$

if n is odd; and it may be observed that in the former case the last value of y is

$$y=\text{cos.}\ \pi=-1,$$

because that then the equation $y^n-1=0$ has two real roots.

The two values comprehended in the formula,

$$y=\text{cos.}\frac{2m\pi}{n}+\sqrt{-1}\,\text{sin.}\,\frac{2m\pi}{n}$$

give for factors of the first degree of the quantity y^n-1, the two imaginary expressions

$$y-\left(\text{cos.}\frac{2m\pi}{n}+\sqrt{-1}\,\text{sin.}\frac{2m\pi}{n}\right),$$

$$y-\left(\text{cos.}\frac{2m\pi}{n}-\sqrt{-1}\,\text{sin.}\frac{2m\pi}{n}\right),$$

and the product of these is the expression

$$y^2-2\,y\,\text{cos.}\,\frac{2m\pi}{n}+1,$$

which comprehends all the real factors of the second degree.

As an example of the formula

$$y=\text{cos.}\,\frac{2m\pi}{n}\pm\sqrt{-1}\,\text{sin.}\frac{2m\pi}{n},$$

the simple factors, or those of the first degree, contained in the function y^6-1 will be

$$y-1,$$
$$y-\left(\text{cos.}\,\frac{2\pi}{6}\pm\sqrt{-1}\,\text{sin.}\frac{2\pi}{6}\right),$$
$$y-\left(\text{cos.}\,\frac{4\pi}{6}\pm\sqrt{-1}\,\text{sin.}\frac{4\pi}{6}\right),$$
$$y+1.$$

The formula

$$y^2-2y\,\text{cos.}\,\frac{2m\pi}{n}+1$$

gives as factors of the second degree

$$y^2-2y+1,$$
$$y^2-2y\,\text{cos.}\,\frac{2\pi}{6}+1,$$
$$y^2-2y\,\text{cos.}\,\frac{4\pi}{6}+1,$$
$$y^2+2y+1.$$

The first and the last of the factors of the second degree are the squares of $y-1$, and $y+1$, factors of the first degree each of which only enters once into the proposed function; it will therefore be necessary, when we employ the factors of the second degree, to reject the first and last, and take instead of them

$$(y-1)(y+1)=y^2-1.$$

The factors of the first degree of the function y^5-1 are

$$y-1,$$
$$y-\left(\text{cos.}\,\frac{2\pi}{5}\pm\sqrt{-1}\,\text{sin.}\,\frac{2\pi}{5}\right)$$
$$y-\left(\text{cos.}\,\frac{4\pi}{5}\pm\sqrt{-1}\,\text{sin.}\,\frac{4\pi}{5}\right)$$

Those of the second degree are

$$y^2-2y+1,$$
$$y^2-2y\,\text{cos.}\,\frac{2\pi}{5}+1,$$
$$y^2-2y\,\frac{\text{cos.}\,4\pi}{5}+1;$$

but it is to be observed that the first factor of the second degree is the square of $y-1$, which enters only once into the proposed function.

123. When the function to be decomposed into factors is y^n+1, the formula

$$y=\text{cos.}\,\frac{(2m+1)\pi}{n}+\sqrt{-1}\,\text{sin.}\frac{(2m+1)\pi}{n},$$

which corresponds to that case (§ 121.) is also susceptible of the double sign $\pm$, provided we stop at the value of m which gives

$$2m+1=n,\ \text{or}\ 2m+1=n-1,$$

according as n is odd or even; hence it follows that

$$m=\frac{n-1}{2},\quad m=\frac{n-2}{2};$$

the factors of the first degree are

$$y-\left(\text{cos.}\,\frac{(2m+1)\pi}{n}\pm\sqrt{-1}\,\text{sin.}\frac{(2m+1)\pi}{n}\right),$$

and those of the second

$$y^2-2y\,\text{cos.}\,\frac{(2m+1)\pi}{n}+1.$$

When among these last there is found some which are squares, we must take only one of their simple factors, in the same way as in the two preceding examples.

When the function is y^5+1, the factors of the first degree are

$$y-\left(\text{cos.}\,\frac{\pi}{5}\pm\sqrt{-1}\,\text{sin.}\frac{\pi}{5}\right),$$
$$y-\left(\text{cos.}\,\frac{3\pi}{5}\pm\sqrt{-1}\,\text{sin.}\,\frac{3\pi}{5}\right)$$
$$y+1;$$

and

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and those of the second,

$$y^2-2y\,\text{cos.}\,\frac{\pi}{5}+1,$$

$$y^2-2y\,\text{cos.}\,\frac{3\pi}{5}+1,$$

$$y^2+2y+1.$$

The function y^6+1 has for factors of the first degree

$$y-\left(\text{cos.}\,\frac{\pi}{6}\pm\sqrt{-1}\,\text{sin.}\,\frac{\pi}{6}\right),$$

$$y-\left(\text{cos.}\,\frac{3\pi}{6}\pm\sqrt{-1}\,\text{sin.}\,\frac{3\pi}{6}\right),$$

$$y-\left(\text{cos.}\,\frac{5\pi}{6}\pm\sqrt{-1}\,\text{sin.}\,\frac{5\pi}{6}\right),$$

and those of the second,

$$y^2-2y\,\text{cos.}\,\frac{\pi}{6}+1,$$

$$y^2-2y\,\text{cos.}\,\frac{3\pi}{6}+1,\ \text{or}\ y^2+1,$$

$$y^2-2y\,\text{cos.}\,\frac{5\pi}{6}+1.$$

124. Such functions as are of this form $x^{2n}+2px^n+q$ may be treated in the same manner as those which consist of only two terms. By putting the function $=0$, and resolving the equation which is thus produced, in the same manner as if it were of the second degree, we find the factors to be

$$x^n+(p\pm\sqrt{(p^2-q)});$$

if p^2 exceed q, the second term of these factors is real, and by making

$$\pm a^n=p\pm\sqrt{(p^2-q)},$$

we have functions of the form

$$x\ \pm a^n$$

to decompose into factors.

When $p^2\angle q$, then we put $p=a^n$, $q=b^{2n}$, $x=by$, and the function becomes

$$b^{2n}y^{2n}+2a^nb^ny^n+b^{2n}$$

$$=b^{2n}\left(y^{2n}+\frac{2a^n}{b^n}y^n+1\right);$$

but the condition $p^2\angle q$, or $a^{2n}\angle b^{2n}$, makes $a^n\angle b^n$, and $\frac{a^n}{b^n}\angle 1$, therefore $\frac{a^n}{b^n}$ may be represented by the cosine of a given arch δ, and the proposed function will be reduced to

$$b^{2n}(y^{2n}+2y^n\,\text{cos.}\,\delta+1),$$

we have then only to resolve the equation

$$y^{2n}+2y^n\,\text{cos.}\,\delta+1=0,$$

and we immediately find

$$y^n=-\text{cos.}\,\delta\pm\sqrt{-1}\,\text{sin.}\,\delta;$$

we now assume as in § 121,

$$y=\text{cos.}\,z\pm\sqrt{-1}\,\text{sin.}\,z;$$

then we find (§ 120),

$$y^n=\text{cos.}\,n\,z\pm\sqrt{-1}\,\text{sin.}\,n\,z.$$

which expression for y^n, being compared with its other value, gives

$$\text{cos.}\,n\,z=\text{cos.}\,\delta,\ \text{sin.}\,n\,z=\text{sin.}\,\delta.$$

These relations will be satisfied if we suppose $n\,z=2m+\delta$, m being any whole number whatever, for

$$\text{cos.}\,(2m\pi+\delta)=\text{cos.}\,\delta,\ \text{sin.}\,(2m\pi+\delta)=\text{sin.}\,\delta;$$

we have therefore

$$z=\frac{2m\pi+\delta}{n},$$

$$y=\text{cos.}\frac{2m\pi+\delta}{n}\pm\sqrt{-1}\,\text{sin.}\frac{2m\pi+\delta}{n}.$$

The factors of the first degree of the function

$$y^{2n}+2y^n\,\text{cos.}\,\delta+1$$

will consequently be comprehended in this formula

$$y-\left\{\text{cos.}\,\frac{2m\pi+\delta}{n}\pm\sqrt{-1}\,\text{sin.}\frac{2m\pi+\delta}{n}\right\}$$

If p the coefficient of the second term of the proposed function be negative, the only change necessary is to make $p=-a^n$, and to take the arch δ greater than a quadrant.

Of the Fluents of Irrational Functions.

125. When a fluxionary expression involves irrational functions, we must endeavour either to transform it into another that is rational, or to reduce it to a series of irrational terms of this form $Ax^{\frac{m}{n}}\dot{x}$, and then, in either case its fluent may be found by the rules already delivered.

Let us take for example the fluxion $\frac{(1+\sqrt{x}-\sqrt[3]{x^2})\dot{x}}{1+\sqrt[3]{x}}$. It is evident that by putting $x=z^6$, all the extractions indicated by the radical signs may be effected, and the fluxion may be transformed to $\frac{6z^5(1+z^3-z^4)\dot{z}}{1+z^2}$, which, by dividing the numerator by $1+z^2$, may be otherwise expressed thus,

$$-6\left(z^7\dot{z}-z^6\dot{z}-z^5\dot{z}+z^4\dot{z}-z^2\dot{z}+\dot{z}-\frac{\dot{z}}{1+z^2}\right)$$

The fluent of which is

$$-6\left\{\begin{matrix}\frac{z^8}{8}-\frac{z^7}{7}-\frac{z^6}{6}+\frac{z^5}{5}-\frac{z^3}{3}\\+z-\text{arc}\ (\text{tan.}=z)\end{matrix}\right\}+\mathit{const.}$$

126.

126. We shall first consider such fluxions as contain the irrational function $\sqrt{(A+Bx+Cx^2)}$, and which have necessarily one or other of these forms

$$X\dot{x}\sqrt{(A+Bx+Cx^2)},\quad \frac{X\dot{x}}{\sqrt{(A+Bx+Cx^2)}},$$

X being put for any rational function of x; and it may be remarked, that the latter form comprehends the former, which may be written thus

$$\frac{X\dot{x}\sqrt{(A+Bx+Cx^2)}\times\sqrt{(A+Bx+Cx^2)}}{\sqrt{(A+Bx+Cx^2)}}$$
$$=\frac{X(A+Bx+Cx^2)\dot{x}}{\sqrt{(A+Bx+Cx^2)}};$$

and here the numerator of the fluxion is a rational function of x.

Before we transform the expression $\sqrt{(A+Bx+Cx^2)}$ into another that is rational with respect to the variable quantity it contains, we shall put the quantity $A+Bx+Cx^2$ under this form

$$C\left(\frac{A}{C}+\frac{B}{C}x+x^2\right);$$

and, in order to abridge, we shall put

$$C=c^2,\ \frac{A}{C}=a,\ \frac{B}{C}=b,$$

then we have

$$\sqrt{(A+Bx+Cx^2)}=c\sqrt{(a+bx+x^2)},$$

Let us now assume $\sqrt{(a+bx+x^2)}=x+z$, then, squaring both sides of the equation, we find $a+bx=2xz+z^2$, hence we get $x=\frac{a-z^2}{2z-b}$, and consequently

$$\sqrt{(A+Bx+Cx^2)}=c(x+z)=c\left(\frac{a-bz+z^2}{2z-b}\right)$$
$$\dot{x}=-\frac{2(a-bz+z^2)\dot{z}}{(2z-b)^2}.$$

By means of these values the fluxion $\frac{X\dot{x}}{\sqrt{(A+Bx+Cx^2)}}$ is transformed into another fluxion $Z\dot{z}$, where Z denotes a rational function of z, which is real when C or c^2 is positive; but as when C is negative c becomes imaginary, the fluxion $Z\dot{z}$ which involves c becomes also imaginary.

In this case we have to consider $\sqrt{(A+Bx-Cx^2)}$, and making

$$C=c^2,\ \frac{A}{C}=a,\ \frac{B}{C}=b,$$

it becomes $c\sqrt{(a+bx-x^2)}$. The quantity x^2-bx-a may always be decomposed into real factors of the first degree; let us represent these factors by $x-\alpha$, and $x-\alpha'$, then it is evident that

$$a+bx-x^2=-(x^2-bx-a)$$
$$=(x-\alpha)(\alpha'-x).$$

Let us now assume

$$\sqrt{(x-\alpha)(\alpha'-x)}=(x-\alpha)z,$$

then, squaring both sides of the equation it becomes divisible by $x-\alpha$, and we have $\alpha'-x=(x-\alpha)z^2$, from which we find

$$x=\frac{\alpha z^2+\alpha'}{z^2+1},\ (x-\alpha)z=\frac{(\alpha'-\alpha)z}{z^2+1},$$
$$\dot{x}=\frac{2(\alpha-\alpha')z\dot{z}}{(z^2+1)^2},$$

values which render the proposed fluxion $\frac{X\dot{x}}{\sqrt{(A+Bx-Cx^2)}}$ rational.

127. Let us now take for example the fluxion $\frac{\dot{x}}{\sqrt{(A+Bx+Cx^2)}}$; by applying to it the first of the preceding transformations it becomes $\frac{-2\dot{z}}{c(2z-b)}$, the fluent of which is $-\frac{1}{c}\,\text{l.}\,(2z-b)+\textit{const.}$ Substituting now for z its value $-x+\sqrt{(a+bx+x^2)}$, and for a, b, and c, the quantities they severally represent, the fluent becomes

$$\frac{-1}{\sqrt{C}}\,\text{l.}\left\{\frac{1}{\sqrt{C}}\left(-\frac{B}{\sqrt{C}}-2x\sqrt{C}+2\sqrt{(A+Bx+Cx^2)}\right)\right\}+\textit{const.}$$

a result to which we may also give this form

$$\frac{-1}{\sqrt{C}}\,\text{l.}\left\{\frac{-B}{2\sqrt{C}}-x\sqrt{C}+\sqrt{(A+Bx+Cx^2)}\right\}$$
$$+\,\text{l.}\,\frac{2}{\sqrt{C}}+\textit{const.}$$

By uniting the constant quantities into one, and observing that the radical quantity $\sqrt{C}$ may have the sign $\pm$ prefixed to it, we have at last

$$\int\frac{\dot{x}}{\sqrt{(A+Bx+Cx^2)}}\ \text{equal to}$$
$$\frac{1}{\sqrt{C}}\,\text{l.}\left\{+\frac{B}{2\sqrt{C}}+x\sqrt{C}+\sqrt{(A+Bx+Cx^2)}\right\}+\text{const.}$$

128. Let us take for the second example $\frac{\dot{x}}{\sqrt{(A+Bx-Cx^2)}}$. By employing the latter transformation of § 126 we have $\frac{-2\dot{z}}{c(z^2+1)}$, of which the fluent is

$$-\frac{2}{c}\,\text{arc}\ (\text{tan.}=z)+\textit{const.}$$

Substituting now instead of z its value $\frac{\sqrt{(\alpha'-x)}}{\sqrt{(x-\alpha)}}$ deduced from the equation $\alpha'-x=(x-\alpha)z^2$, and

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and putting $\sqrt{C}$ for c, we get $\int \frac{\dot{x}}{\sqrt{(A+Bx-Cx^2)}}$ equal to

$$-\frac{2}{\sqrt{C}}\text{ arc }\left(\tan.=\frac{\sqrt{(\alpha'-x)}}{\sqrt{(x-\alpha)}}\right)+const.$$

α and α' being the roots of the equation

$$x^2-\frac{B}{C}x-\frac{A}{C}=0.$$

Let us suppose that $A=C=1$ and $B=0$, then the proposed fluxion becomes in this particular case $\frac{\dot{x}}{\sqrt{(1-x^2)}}$, and the preceding formula gives for its fluent -2 arc. $\left(\tan.=\frac{\sqrt{(1-x)}}{\sqrt{(1+x)}}\right)+const.$ for α and α' being the roots of the equation $x^2-1=0$, we must take $\alpha=-1$, and $\alpha'=1$.

We may, however, give this fluent another form by proceeding thus; Let v be the arch whose tan. $=\frac{\sqrt{(1-x)}}{\sqrt{(1+x)}}$, then $\tan.^2 v=\frac{1-x}{1+x}$, and $x=\frac{1-\tan.^2 v}{1+\tan.^2 v}$ $=\frac{2}{1+\tan.^2 v}-1=\frac{2}{\sec.^2 v}-1=2\cos.^2 v-1$, but $2\cos.^2 v-1=\cos.\ 2v$ (ALGEBRA, § 358.) therefore, $x=\cos.\ 2v$. Put s for the arch whose sine is x, and π for half the circumference, then $x=\cos.\ (\frac{1}{2}\pi-s)$, therefore $2v=\frac{1}{2}\pi-s$, and since it has been shewn that $\int\frac{\dot{x}}{\sqrt{(1-x^2)}}=-2v+const.$ therefore $\int\frac{\dot{x}}{\sqrt{(1-x^2)}}$ $=s-\frac{1}{2}\pi+const.$ or, by including the arch $\frac{1}{2}\pi$ in the constant quantity, $\int\frac{\dot{x}}{\sqrt{(1-x^2)}}=s+const.$ This conclusion agrees with what has been shewn in § 59.

Instead of finding the fluent of

$$\frac{\dot{x}}{\sqrt{(A+Bx-Cx^2)}}=\frac{\dot{x}}{c\sqrt{(a+bx-x^2)}}$$

by first transforming it to a rational expression, we may reduce it directly to an arch of a circle by proceeding as follows. Put $x-\frac{b}{2}=z$, then $\dot{x}=\dot{z}$, and the fluxion is transformed to $\frac{\dot{z}}{c\sqrt{(a+\frac{1}{4}b^2-z^2)}}$; again, put $a+\frac{1}{4}b^2$ $=g^2$, and $z=g\,u$, then $\dot{z}=g\,\dot{u}$, and this last fluxion is transformed to $\frac{\dot{u}}{c\sqrt{(1-u^2)}}$, the fluent of which is $\frac{1}{c}$ arc $(\sin.=u)+const.$

Of the Fluents of Binomial Fluxions.

129. Let us now consider such fluxions as have this form

$$x^{m-1}\dot{x}\,(a+bx^n)^{\frac{p}{q}},$$

and which are sometimes called *binomial* fluxions. We may here suppose m and n to be whole numbers, without affecting the generality of the expression. For if we had $x^{\frac{1}{3}}\dot{x}\,(a+bx^{\frac{1}{2}})^{\frac{p}{q}}$, we may assume $x=z^6$, then $\dot{x}=6z^5\dot{z}$, and the fluxion becomes $6z^7\dot{z}$ $(a+bz^3)^{\frac{p}{q}}$. We may also suppose n to be positive, for if it were negative, so that the fluxion were $x^{m-1}\dot{x}$ $(a+bx^{-n})^{\frac{p}{q}}$ we have only to assume $x=\frac{1}{z}$, and the fluxion is transformed to $-z^{-m-1}\dot{z}\,(a+bz^n)^{\frac{p}{q}}$.

Let us inquire in what case the fluxion $x^{m-1}\dot{x}$ $(a+bx^n)^{\frac{p}{q}}$ may become rational. Assume $a+bx^n=z^q$, then $(a+bx^n)^{\frac{p}{q}}=z^p$, $x^n=\frac{z^q-a}{b}$, $x^m=\left(\frac{z^q-a}{b}\right)^{\frac{m}{n}}$, and $x^{m-1}\dot{x}=\frac{q}{nb}z^{q-1}\left(\frac{z^q-a}{b}\right)^{\frac{m}{n}-1}\dot{z}$; hence the proposed fluxion is transformed to

$$\frac{q}{nb}z^{p+q-1}\dot{z}\left(\frac{z^q-a}{b}\right)^{\frac{m}{n}-1};$$

this expression is evidently rational as often as $\frac{m}{n}$ is a whole number.

There are yet other cases in which the fluxion may become rational, and which may be determined by assuming $a+bx^n=x^n u^q$, thus we have

$$x=\frac{a}{u^q-b},\ x^m=\frac{a^{\frac{m}{n}}}{(u^q-b)^{\frac{m}{n}}},\ldots\ldots$$

$x^{m-1}\dot{x}=\frac{-q\,a^{\frac{m}{n}}u^{q-1}\dot{u}}{n\,(u^q-b)^{\frac{m}{n}+1}}$, and because that $(a+bx^n)^{\frac{p}{q}}$ $=\frac{a^{\frac{p}{q}}u^p}{(u^q-b)^{\frac{p}{q}}}$ the fluxion $x^{m-1}\dot{x}(a+bx^n)^{\frac{p}{q}}$ is transformed to

$$\frac{-q\,a^{\frac{m}{n}+\frac{p}{q}}u^{p+q-1}\dot{u}}{n\,(u^q-b)^{\frac{m}{n}+\frac{p}{q}+1}},$$

an expression which is rational if $\frac{m}{n}+\frac{p}{q}$ is a whole number.

130. As it is not possible, in every case, to express in finite terms the formula $\int x^{m-1}\dot{x}\,(a+bx^n)^{\frac{p}{q}}$, we may try to reduce it to its most simple case, as we have done

done with respect to $\int \frac{\dot{z}}{(z^2+\beta^2)^q}$ in § 114, which we have succeeded in reducing to $\int \frac{\dot{z}}{z^2+\beta^2}$. To effect this reduction, we remark, that, since when u and v denote any functions of a variable quantity, the fluxion of $u\,v$ is $u\,\dot{v}+v\,\dot{u}$, (§ 37.) therefore $\int u\,\dot{v}=u\,v-\int v\,\dot{u}$. Now if we can decompose the expression $x^{m-1}\,\dot{x}\,(a+b\,x^n)^{\frac{p}{q}}$ into two factors such, that we can find the fluent of one of them, then, denoting that factor by $\dot{v}$, and the other by u, the fluent of the proposed fluxion will be made to depend on that of $v\,\dot{u}$, which in some cases will be more simple than the proposed fluxion. That we may abridge a little the results, we shall write p instead of $\frac{p}{q}$, so that p will represent any fraction; the proposed fluxion thus simplified in its form is

$$x^{m-1}\,\dot{x}\,(a+b\,x^n)^p.$$

Among the different ways of resolving this fluxion into two factors, we shall choose that which diminishes the exponent of x without the parentheses, we therefore write the fluxion thus

$$x^{m-n}\times x^{n-1}\,\dot{x}\,(a+b\,x^n)^p,$$

now the fluent of the factor $x^{n-1}\,\dot{x}\,(a+b\,x^n)^p$ may always be determined, whatever be the value of p, by § 108; let us denote this factor by $\dot{v}$, then

$$v=\frac{(a+b\,x^n)^{p+1}}{(p+1)\,n\,b},\text{ and } u=x^{m-n},$$

thus the formula $\int u\,\dot{v}=u\,v-\int v\,\dot{u}$ gives us $\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p$ equal to

$$\frac{x^{m-n}\,(a+b\,x^n)^{p+1}}{(p+1)\,n\,b}$$

$$-\frac{m-n}{(p+1)\,n\,b}\int x^{m-n-1}\,\dot{x}\,(a+b\,x^n)^{p+1}.$$

But $\int x^{m-n-1}\,\dot{x}\,(a+b\,x^n)^{p+1}=$

$$\int x^{m-n-1}\,\dot{x}\,(a+b\,x^n)^p(a+b\,x^n)=$$

$$a\int x^{m-n-1}\,\dot{x}\,(a+b\,x^n)^p$$

$$+b\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p;$$

Substituting now this last value in the preceding equation, and collecting into one the terms involving the fluent $\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p$, we find

$$\left(1+\frac{m-n}{(p+1)\,n}\right)\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p=$$

$$\frac{1}{(p+1)\,n\,b}\left\{\begin{array}{l} x^{m-n}\,(a+b\,x^n)^{p+1} \\ -a\,(m-n)\int x^{m-n-1}\,\dot{x}(a+b\,x^n)^p \end{array}\right\}$$

hence at last we get

(A)

$$\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p=$$

$$\frac{1}{b(p\,n+m)}\left\{\begin{array}{l} x^{m-n}\,(a+b\,x^n)^{p+1} \\ -a\,(m-n)\int x^{m-n-1}\,\dot{x}(a+b\,x^n)^p \end{array}\right\}$$

It is easy to see that, as we have, by this formula, reduced the determination of the fluent of $x^{m-1}\,\dot{x}\,(a+b\,x^n)^p$ to that of $x^{m-n-1}\dot{x}\,(a+b\,x^n)^p$ we may reduce this last to that of $x^{m-2n-1}\,\dot{x}\,(a+b\,x^n)^p$ by writing $m-n$ in place of m in equation (A), then by changing m into $m-2\,n$ we may reduce the fluent of $x^{m-2n-1}\,\dot{x}\,(a+b\,x^n)^p$ to that of $x^{m-3n-1}\,\dot{x}\,(a+b\,x^n)^p$, and so on.

In general, if r denote the number of reductions, we shall at last come to

$\int x^{m-rn-1}\,\dot{x}\,(a+b\,x^n)^p$, and the last formula will be

$$\int x^{m-(r-1)n-1}\,\dot{x}\,(a+b\,x^n)^p=$$

$$\frac{x^{m-rn}\,(a+b\,x^n)^{p+1}}{b(p\,n+m-(r-1)\,n)}$$

$$-\frac{a\,(m-r\,n)\int x^{m-rn-1}\,\dot{x}\,(a+b\,x^n)^p}{b\,(p\,n+m-(r-1)\,n)}.$$

It appears by this last formula, that if m is a multiple of n, then $\int x^{m-1}\,\dot{x}(a+b\,x^n)^p$ will be an algebraic quantity, for in that case the coefficient $m-r\,n$ will be $=0$, and therefore the term containing $\int x^{m-rn-1}\,\dot{x}\,(a+b\,x^n)^p$ will vanish. This result coincides with what we have already found, § 129.

131. We may also obtain a reduction, by which the exponent p shall be diminished by unity. For this purpose it is sufficient to observe that $\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^p$ is equal to

$$\int x^{m-1}\,\dot{x}\,(a+b\,x^n)^{p-1}(a+b\,x^n)=$$

$$a\int x^{m-1}\,\dot{x}(a+b\,x^n)^{p-1}$$

$$+b\int x^{m+n-1}\,\dot{x}\,(a+b\,x^n)^{p-1},$$

and that the formula (A) by changing m into $m+n$, and p into $p-1$ gives

$\int$ x

Inverse Method.

$$\int x^{m+n-1}\dot{x}(a+bx^n)^{p-1}=$$

$$\frac{x^m(a+bx^n)^p-am\int x^{m-1}\dot{x}(a+bx^n)^{p-1}}{b(pn+m)}.$$

Substitute now this value in the preceding equation, we have

(B)

$$\int x^{m-1}\dot{x}(a+bx^n)^p=$$

$$\frac{x^m(a+bx^n)^p+pna\int x^{m-1}\dot{x}(a+bx^n)^{p-1}}{pn+m}.$$

By means of this general formula we may take away successively from p as many units as it contains, and by the application of this formula, and formula (A), we may cause the fluent $\int x^{m-1}\dot{x}(a+bx^n)^p$ to depend on $\int x^{m-rn-1}\dot{x}(a+bx^n)^{p-s}$, rn being the greatest multiple of r contained in $m-1$, and s the greatest whole number contained in p.

The fluent $\int x^7\dot{x}(a+bx^3)^{\frac{5}{2}}$, for example, may, by the application of formula (A) be reduced successively to

$$\int x^4\dot{x}(a+bx^3)^{\frac{5}{2}}, \text{ and } \int x\dot{x}(a+bx^3)^{\frac{5}{2}},$$

and by formula (B) $\int x\dot{x}(a+bx^3)^{\frac{5}{2}}$ is reduced successively to

$$\int \dot{x}x(a+bx^3)^{\frac{3}{2}}, \;\&\; \int \dot{x}x(a+bx^3)^{\frac{1}{2}}.$$

132. It is evident, that if m and n were negative, the formulas (A) and (B) would not answer the purpose for which they have been investigated, because, in that case they would increase the exponents instead of diminishing them. If, however, we reverse them, we shall find that they then apply to the case under consideration.

From formula (A) we get

$$\int x^{m-n-1}\dot{x}(a+bx^n)^p=$$

$$\frac{x^{m-n}(a+bx^n)^{p+1}}{a(m-n)}$$

$$-\frac{b(m+np)\int x^{m-1}\dot{x}(a+bx^n)^p}{a(m-n)};$$

Substitute now $m+n$ in place of m, and it becomes

(C)

$$\int x^{m-1}\dot{x}(a+bx^n)^p=$$

$$\frac{x^m(a+bx^n)^{p+1}}{am}$$

$$-\frac{b(m+n+np)\int x^{m+n-1}\dot{x}(a+bx^n)^p}{am}.$$

This formula diminishes the exponents without the parentheses, because $m+n-1$ becomes $-m+n-1$, when $-m$ is substituted instead of m.

To reverse formula (B) we first take

$$\int x^{m-1}\dot{x}(a+bx^n)^{p-1}=$$

$$\frac{-x^m(a+bx^n)^p}{pna}$$

$$+\frac{(m+np)\int x^{m-1}\dot{x}(a+bx^n)^p}{pna};$$

Then, writing $p+1$ instead of p, we find

(D)

$$\int x^{m-1}\dot{x}(a+bx^n)^p=$$

$$-\frac{x^m(a+bx^n)^{p+1}}{(p+1)na}$$

$$+\frac{(m+n+np)\int x^{m-1}\dot{x}(a+bx^n)^{p+1}}{(p+1)na}.$$

This formula answers the purpose we have in view, because $p+1$ becomes $-p+1$ when p is negative.

These formulas (A), (B), (C), (D) are inapplicable when their denominators vanish. This is the case with formula (A); for example, when $m=-np$; but, in every such case the proposed fluxion may have its fluent determined either algebraically or by logarithms.

133. Let the fluent be $\int\frac{x^{m-1}\dot{x}}{\sqrt{(1-x^2)}}$, m being a whole positive number. Formula (A) immediately applies to this case, so that by putting $a=1$, $b=-1$, $n=2$, $p=-\frac{1}{2}$ we have

$$\int\frac{x^{m-1}\dot{x}}{\sqrt{(1-x^2)}}=\begin{cases}-\dfrac{x^{m-2}\sqrt{(1-x^2)}}{m-1}\\[2ex] +\dfrac{m-2}{m-1}\displaystyle\int\frac{x^{m-3}\dot{x}}{\sqrt{(1-x^2)}}\end{cases}$$

or, substituting m in place of $m-1$,

$$\int\frac{x^m\dot{x}}{\sqrt{(1-x^2)}}=\begin{cases}-\dfrac{x^{m-1}\sqrt{(1-x^2)}}{m}\\[2ex] +\dfrac{m-1}{m}\displaystyle\int\frac{x^{m-2}\dot{x}}{\sqrt{(1-x^2)}}\end{cases}$$

Let us suppose, for example, that $m=1$, then

$$\int\frac{x\dot{x}}{\sqrt{(1-x^2)}}=-\sqrt{(1-x^2)}+const.$$

Let us next suppose that $m=3$, then

$$\int\frac{x^3\dot{x}}{\sqrt{(1-x^2)}}=\begin{cases}-\frac{1}{3}x^2\sqrt{(1-x^2)}\\+\frac{2}{3}\int\frac{x\dot{x}}{\sqrt{(1-x^2)}}\end{cases}$$

or, substituting for $\int\frac{x\dot{x}}{\sqrt{(1-x^2)}}$ its value,

$$\int\frac{x\dot{x}}{\sqrt{(1-x^2)}}=-\left(\frac{1}{3}x^2+\frac{2}{3}\right)\sqrt{(1-x^2)}+const.$$

If we suppose $m=2$, then

$$\int\frac{x^2\dot{x}}{\sqrt{(1-x^2)}}=\begin{cases}-\frac{1}{2}x\sqrt{(1-x^2)}\\+\frac{1}{2}\int\frac{\dot{x}}{\sqrt{(1-x^2)}}\end{cases}$$

But we have already found, § 128. that

$$\int\frac{\dot{x}}{\sqrt{(1-x^2)}}=\text{arc (fin.}=x),$$

therefore, putting A for arc (fin. $=x$),

$$\int\frac{x^2\dot{x}}{\sqrt{(1-x^2)}}=-\tfrac{1}{2}x\sqrt{(1-x^2)}+\tfrac{1}{2}A+const.$$

In the very same way we find that

$$\int\frac{x^4\dot{x}}{\sqrt{(1-x^2)}}\text{ is equal to}$$

$$-\left(\frac{1}{4}x^3+\frac{3}{8}x\right)\sqrt{(1-x^2)}+\frac{3}{8}A+const.$$

134. In the case of m, a negative number, we must have recourse to formula (C), from which we find

$$\int\frac{x^{-m-1}\dot{x}}{\sqrt{(1-x^2)}}=\begin{cases}-\frac{x^{-m}\sqrt{(1-x^2)}}{m}\\+\frac{m-1}{m}\int\frac{x^{-m+1}\dot{x}}{\sqrt{(1-x^2)}}\end{cases}$$

which formula, by writing $-m$ instead of $-m-1$ becomes

$$\int\frac{\dot{x}}{x^m\sqrt{(1-x^2)}}=\begin{cases}-\frac{\sqrt{(1-x^2)}}{(m-1)x^{m-1}}\\+\frac{m-2}{m-1}\int\frac{\dot{x}}{x^{m-2}\sqrt{(1-x^2)}}\end{cases}$$

We cannot here suppose $m=1$, for that value would render the denominator $=0$; therefore, before we can apply this formula, it is necessary to investigate the fluent of $\frac{\dot{x}}{x\sqrt{(1-x^2)}}$. We may easily find it from § 126, or otherwise thus, put $1-x^2=z^2$, then

$$x=\sqrt{(1-z^2)},\ \dot{x}=\frac{-z\dot{z}}{\sqrt{(1-z^2)}}$$

Therefore

$$\frac{\dot{x}}{x\sqrt{(1-x^2)}}=\frac{-\dot{z}}{1-z^2}=\frac{-\frac{1}{2}\dot{z}}{1+z}-\frac{\frac{1}{2}\dot{z}}{1-z}.$$

The fluent of the right hand side of this equation is evidently (§ 103.)

$$-\tfrac{1}{2}\text{l.}(1+z)+\tfrac{1}{2}\text{l.}(1-z)=-\tfrac{1}{2}\text{l.}\left(\frac{1+z}{1-z}\right);$$

or, since $\frac{1+z}{1-z}=\frac{(1+z)^2}{1-z^2}$, the same fluent may be expressed thus

$$-\tfrac{1}{2}\text{l.}\frac{(1+z)^2}{1-z^2}=-\text{l.}\frac{1+z}{\sqrt{(1-z^2)}}.$$

therefore, by substituting $\sqrt{(1-x^2)}$ for z, and x for $\sqrt{(1-z^2)}$ we have

$$\int\frac{\dot{x}}{x\sqrt{(1-x^2)}}=-\text{l.}\left(\frac{1+\sqrt{(1-x^2)}}{x}\right)+const.$$

If we suppose $m=2$, the formula becomes

$$\int\frac{\dot{x}}{x^2\sqrt{(1-x^2)}}=-\frac{\sqrt{(1-x^2)}}{x}+const.$$

If we suppose $m=3$, then

$$\int\frac{\dot{x}}{x^3\sqrt{(1-x^2)}}=\begin{cases}-\frac{\sqrt{(1-x^2)}}{2x^2}\\+\frac{1}{2}\int\frac{\dot{x}}{x\sqrt{(1-x^2)}}\end{cases}$$

which expression, by substituting for

$$\int\frac{\dot{x}}{x\sqrt{(1-x^2)}}\text{ its value, becomes}$$

$$\int\frac{\dot{x}}{x^3\sqrt{(1-x^2)}}=\begin{cases}-\frac{\sqrt{(1-x^2)}}{2x^2}\\-\frac{1}{2}\text{l.}\left(\frac{1+\sqrt{(1-x^2)}}{x}\right)\\+const.\end{cases}$$

Of Finding Fluents by Series.

135. We can always easily find an expression for the fluent $\int X\dot{x}$, where X denotes any function of x; when that function is expanded into a series, each term of which is some power of x multiplied by a constant quantity; thus suppose

$$X=Ax^m+Bx^{m+n}+Cx^{m+2n}+\&c.$$

then $X\dot{x}$ is equal to

A x^m

$$A x^m \dot{x} + B x^{m+n} \dot{x} + C x^{m+2n} \dot{x} + \text{\&c.}$$

and taking the fluent of each term by § 101,

$$\int X\dot{x} = \frac{A x^{m+1}}{m+1} + \frac{B x^{m+n+1}}{m+n+1}$$

$$+ \frac{C x^{m+2n+1}}{m+2n+1} + \text{\&c.} + \textit{const.}$$

If in the developement of $\dot{x}$ there be any term of this form $\frac{A}{x}$, the fluent corresponding to that term will be $A\,\text{l}.\,x$ (§ 103).

136. The most simple function of x that can be expanded into a series is $\frac{1}{a+x}$, which becomes,

$$\frac{1}{a} - \frac{x}{a^2} + \frac{x^2}{a^3} - \frac{x^3}{a^4} + \text{\&c.}$$

Hence we find

$$\frac{\dot{x}}{a+x} = \frac{\dot{x}}{a} - \frac{x\dot{x}}{a^2} + \frac{x^2\dot{x}}{a^3} - \frac{x^3\dot{x}}{a^4} + \text{\&c.}$$

and taking the fluents

$$\int \frac{\dot{x}}{a+x} = \frac{x}{a} - \frac{x^2}{2a^2} + \frac{x^3}{3a^3} - \frac{x^4}{4a^4} + \text{\&c.} + \textit{const.}$$

Now we know that $\int \frac{\dot{x}}{a+x} = \text{l}.\,(a+x)$ (§ 57.) therefore

$$\text{l}.\,(a+x) = \frac{x}{a} - \frac{x^2}{2a^2} + \frac{x^3}{3a^3} - \frac{x^4}{4a^4} + \text{\&c.} + \textit{const.}$$

To find the value of the constant quantity we have only to make $x=0$, for then the equation becomes $\text{l}.\,a = \textit{const.}$ therefore

$$\text{l}.\,(a+x) = \text{l}.\,a + \frac{x}{a} - \frac{x^2}{2a^2} + \frac{x^3}{3a^3} - \text{\&c.}$$

hence, if we subtract $\text{l}.\,a$ from each side, and observe that $\text{l}.\,(x+a) - \text{l}.\,a = \text{l}.\left(\frac{x+a}{a}\right) = \text{l}.\left(1+\frac{x}{a}\right)$ we get

$$\text{l}.\left(1+\frac{x}{a}\right) = \frac{x}{a} - \frac{x^2}{2a^2} + \frac{x^3}{3a^3} - \frac{x^4}{4a^4} + \text{\&c.}$$

From this conclusion we may deduce rules for computing the logarithms of numbers.

137. Let the fluxion be $\frac{a\dot{x}}{a^2+x^2}$, which may be put under this form $\frac{\frac{\dot{x}}{a}}{1+\frac{x^2}{a^2}}$, and which consequently belongs to the arch of which the tangent $=\frac{x}{a}$ (§ 60). By reducing $\frac{a}{a^2+x^2}$ into a series, we find

$$\frac{a}{a^2+x^2} = \frac{1}{a} - \frac{x^2}{a^3} + \frac{x^4}{a^5} - \frac{x^6}{a^7} + \text{\&c.}$$

Hence, multiply both sides by $\dot{x}$, and taking the fluent of each term, we get

$$\int \frac{a\dot{x}}{a^2+x^2} = \text{arc}\left(\text{tan.} = \frac{x}{a}\right) + \textit{const.} =$$

$$\frac{x}{a} - \frac{x^3}{3a^3} + \frac{x^5}{5a^5} - \frac{x^7}{7a^7} + \text{\&c.} + \textit{const.}$$

If we wish to deduce from this equation, the value of the least arch whose tangent is $\frac{x}{a}$ it is necessary to suppress the arbitrary constant quantity, for when that arch $=0$, then $x=0$, thus we have the arch whose tangent is $\frac{x}{a}$ expressed by the infinite series

$$\frac{x}{a} - \frac{x^3}{3a^3} + \frac{x^5}{5a^5} - \frac{x^7}{7a^7} + \text{\&c.}$$

Let π denote the circumference of a circle whose diameter is unity, or half the circumference of a circle whose radius is unity, then, as the sine of 30 degrees, or $\frac{1}{6}\pi$, is $\frac{1}{2}$, and its cosine $\sqrt{(1-\frac{1}{4})} = \frac{1}{2}\sqrt{3}$, we have $\text{tan.}\,\frac{\pi}{6} = \frac{\text{sin.}\,\frac{1}{6}\pi}{\text{cos.}\,\frac{1}{6}\pi} = \sqrt{\frac{1}{3}}$. Let $\sqrt{\frac{1}{3}}$ be substituted instead of x in the above series, and a be supposed $=1$, thus we get

$$\frac{\pi}{6} = \sqrt{\tfrac{1}{3}} \times \left(1 - \frac{1}{3\cdot3} + \frac{1}{5\cdot3^2} - \frac{1}{7\cdot3^3} + \text{\&c.}\right)$$

and therefore

$$\pi = \sqrt{12} \times \left(1 - \frac{1}{3\cdot3} + \frac{1}{5\cdot3^2} - \frac{1}{7\cdot3^3} + \text{\&c}\right);$$

by taking the sum of about fifteen terms of this series, we shall find $\pi = 3.1415927$. The determination of this number is of great importance in every branch of mathematics.

138. By proceeding with the fluxion $\frac{x^m\dot{x}}{a^n+x^n}$, in the same manner as we have done with $\frac{a\dot{x}}{a^2+x^2}$, we get

$$\int \frac{x^m\dot{x}}{a^n+x^n} = \frac{x^{m+1}}{(m+1)a^n} - \frac{x^{m+n+1}}{(m+n+1)a^{2n}}$$

$$+ \frac{x^{m+2n+1}}{(m+2n+1)a^{3n}} - \text{\&c.}$$

This series proceeds by the positive powers of x, or is an ascending series, but we may also expand $\frac{1}{a^n+x^n}$ into a series proceeding by the negative powers of x, and which will therefore be called a *descending* series. Thus because

$\frac{1}{x^n+a^n}$

$$\frac{1}{x^n+a^n}=\frac{1}{x^n}-\frac{a^n}{x^{2n}}+\frac{a^{2n}}{x^{3n}}-\frac{a^{3n}}{x^{4n}}+\&c.$$

we have, after multiplying both sides by $x^m \dot{x}$ and taking the fluents

$$\int\frac{x^m\dot{x}}{x^n+a^n}=-\frac{1}{(n-m-1)x^{n-m-1}}$$

$$+\frac{a^n}{(2n-m-1)x^{2n-m-1}}-\frac{a^{2n}}{(3n-m-1)x^{3n-m-1}}+\&c.+\mathit{const.}$$

This last series will be convergent when x is greater than a, and at the same time $m<n$, and $n>1$. But besides, that it may contain algebraic terms only, it is necessary that none of the divisors $n-m-1$, $2n-m-1$, $3n-m-1$, &c. become $=0$; this circumstance will take place as often as $m+1$ is a multiple of n, and in which case

the series $\frac{\dot{x}}{x^{n-m}}-\frac{a^n\dot{x}}{x^{2n-m}}+$ &c. which is the developement of the fluxion will contain a term of this form $\frac{a^{rn}\dot{x}}{x}$, the fluent of which is $a^{rn}\,\mathrm{l}.x$.

If in this result we put $m=0$, $n=2$, and $a=1$ we get

$$\int\frac{\dot{x}}{1+x^2}=-\frac{1}{x}+\frac{1}{3x^3}-\frac{1}{5x^5}+\&c.+\mathit{const.}$$

But although the expression $\frac{\dot{x}}{1+x^2}$ is the fluxion of the arch having x for its tangent, we must not conclude that this series is the developement of that arch, for x being supposed $=0$, each of the terms of the series becomes infinite.

The consideration of the constant quantity added to the fluent will remove this apparent difficulty, if we remark, that to know the true value of a series, it is always necessary to begin with the case in which it is convergent. Now the series

$$-\frac{1}{x}+\frac{1}{3x^3}-\frac{1}{5x^5}+\&c.$$

converges so much the faster as x is greater, and it vanishes when x is infinite; but in this extreme case the equation

$$\text{arc }(\tan.=x)=-\frac{1}{x}+\frac{1}{3x^3}-\frac{1}{5x^5}+\&c.+\mathit{const.}$$

becomes simply arc $\frac{\pi}{2}=$ *const.* where π denotes half the circumference of the circle; therefore, substituting this value of the constant quantity, we have

$$\text{arc }(\tan.=x)=\pi-\frac{1}{x}+\frac{1}{5x^3}-\frac{1}{5x^5}+\&c.$$

We may easily find an expression for the fluent of the rational fraction $\frac{\mathrm{U}\dot{x}}{\mathrm{V}}$ (§ 111.) by expanding the quantity $\frac{\mathrm{U}}{\mathrm{V}}$ into a series, but the result thus obtained is in general very complicated, and seldom convergent; besides, this manner of finding the fluent is hardly of any use, since it may be expressed by means of arches of a circle and logarithms, both of which are readily obtained from the common trigonometrical tables.

139. The fluent of $x^{m-1}\dot{x}(a+bx^n)^{\frac{p}{q}}$ is easily obtained by first expanding the quantity $(a+bx^n)^{\frac{p}{q}}$ into a series by the binomial theorem, then multiplying each term of that series by $x^{m-1}\dot{x}$, and taking the fluents of the results by § 101. Thus we have $\int x^{m-1}\dot{x}(a+bx^n)^{\frac{p}{q}}=$

$$a^{\frac{p}{q}}\left\{\frac{x^m}{m}+\frac{pb}{qa}\frac{x^{m+n}}{m+n}+\frac{p(p-q)b^2}{1.2\,q^2a^2}\frac{x^{m+2n}}{m+2n}\right.$$

$$\left.+\frac{p(p-q)(p-2q)b^3}{1.2.3\,q^3a^3}\frac{x^{m+3n}}{m+3n}+\&c.\right\}+\mathit{const.}$$

This is an ascending series, but to get a descending series we must divide $(a+bx^n)^{\frac{p}{q}}$ by $x^{\frac{np}{q}}$ and multiply $x^{m-1}\dot{x}$, the remaining part of the fluxional expression by the same quantity, thus the fluxion is transformed to

$$x^{m+\frac{np}{q}-1}\dot{x}\,(b+ax^{-n})^{\frac{p}{q}}$$

the fluent of which, by proceeding as in the former case, is

$$b^{\frac{p}{q}}\left\{\frac{qx^{m+\frac{pn}{q}}}{mq+np}-\frac{pa}{qb}\frac{qx^{m+\frac{(p-q)n}{q}}}{mq+(p-q)n}-\right.$$

$$\left.\frac{p(p-q)a^2}{1.2q^2b^2}\frac{qx^{m+\frac{(p-2q)n}{q}}}{mq+(p-2q)n}-=\&c.\right\}+\mathit{const.}$$

either of these series may be employed if a and b are both positive, or q an odd number, but if q be an even number, the first formula becomes imaginary on account of the factor $a^{\frac{p}{q}}$ if a^p be negative, and the same thing happens to the second formula if a^p be negative.

140. Let it be required to express by a series the fluent of $\frac{\dot{x}}{\sqrt{(1-x^2)}}$. That we may develope the radical quantity $\frac{1}{\sqrt{(1-x^2)}}$ we put it under this form

$(1-x^2)$

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$(1-x^2)^{-\frac{1}{2}}$, an expression which when expanded by the binomial theorem is

$$1+\frac{1}{2}x^2+\frac{1.3}{2.4}x^4+\frac{1.3.5}{2.4.6}x^6+\&c.$$

therefore, multiplying each term of this series by $\dot{x}$, and taking the fluent, we get

$$\int\frac{\dot{x}}{\sqrt{(1-x^2)}}=x+\frac{1.x^3}{2.3}+\frac{1.3.x^5}{2.4.5}$$
$$+\frac{1.3.5.x^7}{2.4.6.7}+\mathit{const.}$$

If we suppose x to denote the sine of an arch, then $\sqrt{(1-x^2)}$ is its cosine, and $\frac{\dot{x}}{\sqrt{(1-x^2)}}$ is the fluxion of the arch itself (§ 59.); therefore the series which we have just found, expresses the length of the arch of a circle, radius being unity, and the sine of the arch x. If we suppose the series to express the smallest arch that corresponds to the sine x, then, as when the sine of that arch $=0$, the arch itself $=0$, the series expressing the arch must vanish when $x=0$, therefore we must suppress the constant quantity added to complete the fluent; or suppose it $=0$. The same series has already been found by the direct method of fluxions in § 72.

Let π denote the same as in § 137, then, as the sine of 30 degrees, or of $\frac{1}{6}\pi$, is $\frac{1}{2}$, we have, by substituting $\frac{1}{2}$ instead of x in the preceding series, and multiplying both sides by 6,

$$\pi=3\left(1+\frac{1}{2.3.2^2}+\frac{1.3}{2.4.5.2^4}+\frac{1.3.5}{2.4.6.7.2^6}+\&c.\right)$$

by means of this series, which involves only rational numbers, we may compute (but with more labour), the value of π as before.

Suppose the fluxion to be $\dot{x}\sqrt{(ax-x^2)}$, which may be otherwise expressed thus, $\dot{x}a^{\frac{1}{2}}x^{\frac{1}{2}}(1-\frac{x}{a})^{\frac{1}{2}}$. By the binomial theorem $(1-\frac{x}{a})^{\frac{1}{2}}=$

$$1-\frac{x}{2a}-\frac{1.1x^2}{2.4a^2}-\frac{1.1.3x^3}{2.4.6a^3}-\&c.$$

Let each term of this series be multiplied by $a^{\frac{1}{2}}x^{\frac{1}{2}}\dot{x}$, and the fluent taken by § 101, thus we get $\int\dot{x}\sqrt{(ax-x^2)}=$

$$a^{\frac{1}{2}}\left(\frac{2x^{\frac{3}{2}}}{3}-\frac{1}{2}\frac{2x^{\frac{5}{2}}}{5a}-\frac{1.1}{2.4}\frac{2x^{\frac{7}{2}}}{7a^2}\right.$$
$$\left.-\frac{1.1.3}{2.4.6}\frac{2x^{\frac{9}{2}}}{9a^3}-\&c.\right)+\mathit{const.}$$

141. By resolving a fluxion into an infinite series, the the object in view is to transform it into a series of other fluxions, each of which may have its fluent determined by known methods; but it is not always necessary that the terms of the series should be each simply a power of x multiplied by $\dot{x}$ and constant quantities.

If for example we have this fluxion

$$\frac{\dot{x}\sqrt{(1-e^2x^2)}}{\sqrt{(1-x^2)}},$$

in which e is supposed to denote a small constant quantity, we may expand $\sqrt{(1-e^2x^2)}$ or $(1-e^2x^2)^{\frac{1}{2}}$ into a series, which will thus become

$$1-\frac{1}{2}e^2x^2-\frac{1.1}{2.4}e^4x^4-\frac{1.1.3}{2.4.6}e^6x^6-\&c.$$

and the fluxion $\frac{\dot{x}\sqrt{(1-e^2x^2)}}{\sqrt{(1-x^2)}}$ will be transformed to

$$\frac{\dot{x}}{\sqrt{(1-x^2)}}\left\{1-\frac{1}{2}e^2x^2-\frac{1.1}{2.4}e^4x^4\right.$$
$$\left.-\frac{1.1.3}{2.4.6}e^6x^6-\&c.\right\}$$

the series will converge very fast when e is small, for that $\sqrt{(1-x^2)}$ may be a real quantity, x^2 must be less than 1. We must now multiply each term of the series by the common factor $\frac{\dot{x}}{\sqrt{(1-x^2)}}$ and take the fluents, which being all contained in the general expression $\int\frac{x^m\dot{x}}{\sqrt{(1-x^2)}}$, will be found by § 133. Thus, putting A to denote an arch of which x is the sine, we have

$$\int\frac{\dot{x}\sqrt{(1-e^2x^2)}}{\sqrt{(1-x^2)}}=$$

$$\mathrm{A}$$
$$+\frac{1}{2}e^2\left\{\frac{1}{2}x\sqrt{(1-x^2)}-\frac{1}{2}\mathrm{A}\right\}$$
$$+\frac{1.1}{2.4}e^4\left\{\left(\frac{1}{4}x^3+\frac{1.3}{2.4}x\right)\sqrt{(1-x^2)}-\frac{1.3}{2.4}\mathrm{A}\right\}$$
$$+\frac{1.1.3}{2.4.6}e^6\left\{\begin{array}{l}\left(\frac{1}{6}x^5+\frac{1.5}{4.6}x^3+\frac{1.3.5}{2.4.6}x\right)\sqrt{(1-x^2)}\\ -\frac{1.3.5}{2.4.6}\mathrm{A}\end{array}\right\}$$
$$+\&c.\quad+\mathit{const.}$$

Of the Fluents of such Fluxions as involve Logarithmic and Exponential functions.

142. Let it be required to find the fluent of $x^m\dot{x}(\mathrm{l}.x)$, where $\mathrm{l}.x$ denotes the Napierean logarithm of x. In this case, as well as in some following examples, we shall have recourse to the principle already employed in § 130, namely, that if v and z denote any functions of a variable quantity x, then

$$\int z\dot{v}=vz-\int v\dot{z}.$$

Let us therefore assume $x^m\dot{x}=\dot{v}$, and $\mathrm{l}.x=z$, then, (§ 101.), $\frac{x^{m+1}}{m+1}=v$, and (§ 57.), $\frac{\dot{x}}{x}=\dot{z}$, therefore, substituting

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substituting these values of $v, z, \dot{v}, \dot{z}$ in the formula it becomes

$$\int x^m \dot{x}\,(\mathrm{l}.\,x) = \frac{x^{m+1}\,\mathrm{l}.\,x}{m+1} - \int \frac{x^m \dot{x}}{m+1},$$

or, since $\int \frac{x^m \dot{x}}{m+1} = \frac{x^{m+1}}{(m+1)^2} + const.$

$$\int x^m \dot{x}(\mathrm{l}.\,x) = x^{m+1} \left\{ \frac{\mathrm{l}.\,x}{m+1} - \frac{1}{(m+1)^2} \right\} + const.$$

Let us next suppose that the proposed fluxion is $x^m \dot{x}\,(\mathrm{l}.x)^n$. Put $x^m\dot{x} = \dot{v}$, and $(\mathrm{l}.\,x)^n = z$, then (§ 101.) $\frac{x^{m+1}}{m+1} = v$, and (§ 57.) $\frac{n\dot{x}\,(\mathrm{l}.\,x)^{n-1}}{x} = \dot{z}$, therefore, substituting as before these values in the formula $\int z\dot{v} = vz - \int v\dot{z}$, we get

$$\int x^m \dot{x}(\mathrm{l}.\,x)^n = \frac{x^{m+1}\,(\mathrm{l}.\,x)^n}{m+1} - \int \frac{n\,x^m\dot{x}\,(\mathrm{l}.\,x)^{n-1}}{m+1}$$

It is evident that by this formula the determination of the fluent of $x^m\dot{x}\,(\mathrm{l}.\,x)^2$ is reduced to that of $x^m\dot{x}\,(\mathrm{l}.\,x)$ which we have already found, and in like manner that the determination of the fluent of $x^m\dot{x}\,(\mathrm{l}.\,x)^3$ is reduced to that of $x^m\dot{x}\,(\mathrm{l}.\,x)^2$, and so on, from which it appears that the fluent of $x^m\dot{x}(\mathrm{l}.\,x)^n$ is expressible in finite terms when n is a whole positive number. The formula however will not apply when $m = -1$, because of the denominator $m+1 = -1+1 = 0$. But in this case we have

$$\int \frac{\dot{x}}{x}(\mathrm{l}.\,x)^n = \frac{1}{n+1}\,(\mathrm{l}.\,x)^{n+1} + const.$$

If n be negative or fractional the fluent of $x^m\dot{x}\,(\mathrm{l}.\,x)^n$ can only be expressed by an infinite series.

143. As an example of an exponential function, let it be required to find the fluent of $a^x x^n \dot{x}$. Here we may put $\dot{v}$ for $x^n\dot{x}$, and z for a^x, then we have $v = \frac{x^{n+1}}{n+1}$, § 101, and $\dot{z} = (\mathrm{l}.\,a)a^x\dot{x}$, (§ 56.) therefore, substituting these values of $v, z, \dot{v}, \dot{z}$ in the formula $\int z\dot{v} = vz - \int v\dot{z}$ we get

$$\int a^x x^n \dot{x} = \frac{a^x x^{n+1}}{n+1} - \int \frac{(\mathrm{l}.\,a)\,a^x x^{n+1}\dot{x}}{n+1}$$

therefore, substituting $n-1$ every where instead of n,

$$\int a^x x^{n-1}\dot{x} = \frac{a^x x^n}{n} - \int \frac{(\mathrm{l}.\,a)\,a^x x^n \dot{x}}{n};$$

hence, bringing $\int a^x x^n \dot{x}$ to stand alone one side of the equation

$$\int a^x x^n \dot{x} = \frac{a^x x^n}{\mathrm{l}.\,a} - \frac{n}{\mathrm{l}.\,a}\int a^x x^{n-1}\dot{x}.$$

If we suppose $n=1$, then, observing that $\int a^x\dot{x} = \frac{a^x}{\mathrm{l}.\,a}$ (§ 56.),

$$\int a^x x\dot{x} = \frac{a^x x}{\mathrm{l}.\,a} - \frac{a^x}{(\mathrm{l}.\,a)^2} + const.$$

If $n=2$, then

$$\int a^x x^2 \dot{x} = \frac{a^x x^2}{\mathrm{l}.\,a} - \frac{2}{\mathrm{l}.\,a}\int a^x x\dot{x}.$$

In this expression we substitute the value of $\int a^x x\dot{x}$ just found, thus it becomes

$$\int a^x x^2 \dot{x} = a^x \left\{ \frac{x^2}{\mathrm{l}.\,a} - \frac{2x}{(\mathrm{l}.\,a)^2} + \frac{2}{(\mathrm{l}.\,a)^3} \right\} + const.$$

Proceeding in this way we may find the fluent when $n=3$, or when $n=4$, or in general, when n is any integer number whatever, the number of terms in the fluent being in this case always finite; it is not so however when n is either negative or fractional.

Of the Fluents of such Fluxions as contain functions related to a circle.

144. Let us suppose that z is an arch whose sine is x, and that it is required to find the fluent of $z\,x^n\dot{x}$. Put $x^n\dot{x} = \dot{v}$, then

$$\int z\,x^n\dot{x} = \int z\dot{v} = zv - \int v\dot{z};$$

but since $\dot{v} = x^n\dot{x}$, we have $v = \frac{x^{n+1}}{n+1}$, § 101, and since $x = \text{fin.}\,z$, we have $\dot{x} = \dot{z}\,\text{cof.}\,z = \dot{z}\sqrt{(1-x^2)}$ (§ 59.), and therefore $\dot{z} = \frac{\dot{x}}{\sqrt{(1-x^2)}}$; thus we have

$$\int z\,x^n\dot{x} = \frac{z x^{n+1}}{n+1} - \frac{1}{n+1}\int \frac{x^{n+1}\dot{x}}{\sqrt{(1-x^2)}};$$

hence the determination of the proposed fluent is reduced to $\int \frac{x^{n+1}\dot{x}}{\sqrt{(1-x^2)}}$ which we have already considered in § 133. By the same mode of reasoning we may determine the fluent when x denotes the cosine of the arch z.

145. It appears from § 59. that $n\,z$ being put to denote any arch of a circle to radius unity, the fluxion of the sine of that arch is $n\dot{z}\,\text{cof.}\,n\,z$; therefore on the contrary,

$$\int \dot{z}\,\text{cof.}\,n\,z = \frac{1}{n}\,\text{fin.}\,n\,z + const.$$

In like manner from the formulas of § 59. and § 60. we find

$\int \dot{z}$ fin.

$$\int \dot{z} \text{ sin. } nz = \frac{-1}{n} \text{ cos. } nz + const.$$

$$\int \frac{\dot{z}}{\text{cos.}^2 nz} = \frac{1}{n} \text{ tan. } nz + const.$$

$$\int \frac{\dot{z}}{\text{sin.}^2 nz} = \frac{-1}{n} \text{ cot. } nz + const.$$

$$\int \frac{\dot{z} \text{ sin. } nz}{\text{cos.}^2 nz} = \frac{1}{n} \text{ sec. } nz + const.$$

$$\int \frac{\dot{z} \text{ cos. } nz}{\text{sin.}^2 nz} = \frac{-1}{n} \text{ cosec. } nz + const.$$

146. By the second of these expressions we find the fluent of

$$\dot{z}\,(A + B \text{ sin. } z + C \text{ sin. } 2z + \&c.)$$

to be

$$Az - B \text{ cos. } z - \tfrac{1}{2} C \text{ cos. } 2z - \&c. + const.$$

and from the first expression we find the fluent of

$$\dot{z}\,(A + B \text{ cos. } z + C \text{ cos. } 2z + \&c.)$$

to be

$$Az + B \text{ sin. } z + \tfrac{1}{2} C \text{ sin. } 2z + \&c. + const.$$

147. It has been shewn in the Arithmetic of sines, (see ALGEBRA, § 356.) that

$$\text{sin.}^2 z = \tfrac{1}{2}(-\text{cos. } 2z + 1),$$

therefore, by what has been shewn in § 145.

$$\int \dot{z} \text{ sin.}^2 z = \tfrac{1}{2} \int (-\dot{z} \text{ cos. } 2z + \dot{z})$$

$$= \tfrac{1}{2}(-\tfrac{1}{2} \text{ sin. } 2z + z) + const.$$

It has also been shewn that

$$\text{sin.}^3 z = \tfrac{1}{4}(-\text{sin. } 3z + 3 \text{ sin. } z),$$

therefore, multiplying each term of this expression by $\dot{z}$, and taking the fluents,

$$\int \dot{z} \text{ sin.}^3 z = \tfrac{1}{4}(\tfrac{1}{3} \text{ cos. } 3z - 3 \text{ cos. } z) + const.$$

In the same manner may the fluent of $\dot{z}$ sin.$^n z$ be found, n being any positive integer number whatever.

Again, it has been shewn (ALGEBRA, § 356.), that

$$\text{cos.}^2 z = \tfrac{1}{2}(\text{cos. } 2z + 1)$$

therefore

$$\int \dot{z} \text{ cos.}^2 z = \tfrac{1}{2} \int (\dot{z} \text{ cos. } 2z + \dot{z})$$

$$= \tfrac{1}{2}(\tfrac{1}{2} \text{ sin. } 2z + z) + const.$$

and because

$$\text{cos.}^3 z = \tfrac{1}{4}(\text{cos. } 3z + 3 \text{ cos. } z)$$

therefore, multiplying by $\dot{z}$, and taking the fluents,

$$\int \dot{z} \text{ cos.}^3 z = \tfrac{1}{4}(\tfrac{1}{3} \text{ sin. } 3z + 3 \text{ sin. } z) + const.$$

and proceeding in this way we may find the fluents of $\dot{z}$ cos.$^n z$, n being any positive integer number.

148. The fluents of $\dot{z}$ sin.$^n z$, and $\dot{z}$ cos.$^n z$ may be expressed under another form, by proceeding as in § 142. Thus, beginning with $\dot{z}$ sin.$^n z$, and resolving it into $\dot{z}$ sin. $z \times$ sin.$^{n-1} z$, if we put $\dot{z}$ sin. $z = \dot{v}$, and sin.$^{n-1} z = t$, we have by § 145, $v = -$ cos. z, and (by § 26 and § 59) $\dot{t} = (n-1)\,\dot{z}$ cos. z sin.$^{n-2} z$, therefore, substituting in the formula $\int t\,\dot{v} = v\,t - \int v\,\dot{t}$ we have

$$\int \dot{z} \text{ sin.}^n z = -\text{cos. } z \text{ sin.}^{n-1} z$$

$$+ (n-1) \int \dot{z} \text{ cos.}^2 z \text{ sin.}^{n-2} z;$$

but cos.$^2 z = 1 -$ sin.$^2 z$, therefore $\int \dot{z}$ sin.$^n z$ is equal to

$$-\text{cos. } z \text{ sin.}^{n-1} z + (n-1) \int \dot{z} \text{ sin.}^{n-2} z$$

$$-(n-1) \int \dot{z} \text{ sin.}^n z$$

which expression, by bringing together the terms containing $\int \dot{z}$ sin.$^n z$ becomes

$$\int \dot{z} \text{ sin.}^n z = -\frac{1}{n} \text{ cos. } z.\ \text{sin.}^{n-1} z,$$

$$+ \frac{n-1}{n} \int \dot{z} \text{ sin.}^{n-2} z,$$

By giving particular values to n we have

$$\int \dot{z} \text{ sin.}^2 z = -\frac{1}{2} \text{ cos. } z \text{ sin. } z + \frac{1}{2} \int \dot{z}$$

$$= -\frac{1}{2} \text{ cos. } z.\ \text{sin. } z + \frac{1}{2} z + const.$$

$$\int \dot{z} \text{ sin.}^3 z = -\frac{1}{3} \text{ cos. } z \text{ sin.}^2 z + \frac{2}{3} \int \dot{z} \text{ sin. } z$$

$$= -\frac{1}{3} \text{ cos. } z \text{ sin.}^2 z - \frac{2}{3} \text{ cos. } z + const.$$

We may proceed in this way as far as we please, deducing the fluent of $\dot{z}$ sin.$^4 z$ from that of $\dot{z}$ sin.$^2 z$, and the fluent of $\dot{z}$ sin.$^5 z$ from that of $\dot{z}$ sin.$^3 z$, and so on.

If in the general formula we substitute every where $2-n$ instead of n, it becomes

$$\int \dot{z} \text{ sin.}^{2-n} z = \frac{1}{n-2} \text{ cos. } z \text{ sin.}^{1-n} z$$

$$+ \frac{n-1}{n-2} \int \dot{z} \text{ sin.}^{-n} z$$

an

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an expression which, by bringing $\int \dot{z} \sin.^{-n} z$ or $\int \frac{\dot{z}}{\sin.^n z}$ to stand on one side of the equation, becomes

$$\int \frac{\dot{z}}{\sin.^n z} = -\frac{1}{(n-1)}\frac{\cos. z}{\sin.^{n-1} z} + \frac{n-2}{n-1}\int\frac{\dot{z}}{\sin.^{n-2} z}.$$

This formula is not applicable to the case of $n=1$, because then each of the terms of the fluent is divided by $n-1=0$, and therefore becomes infinite. In order to obtain the expression for the fluent in this particular case, we proceed thus. It is evident that $\frac{1}{\sin.^2 z} = \frac{1}{1-\cos.^2 z}$, but $\frac{1}{1-\cos.^2 z} = \frac{1}{2(1-\cos. z)} + \frac{1}{2(1+\cos. z)}$ as will be found by reducing the fractions to a common denominator, therefore $\frac{1}{\sin. z} = \frac{\sin. z}{2(1-\cos. z)} + \frac{\sin. z}{2(1+\cos. z)}$ and consequently,

$$\int\frac{\dot{z}}{\sin. z} = \frac{1}{2}\int\frac{\dot{z} \sin. z}{1-\cos. z} + \frac{1}{2}\int\frac{\dot{z}\sin. z}{1+\cos. z};$$

but if it be considered that the fluxion of $\cos. z$ is $-\dot{z} \sin. z$ (§ 59.) it will appear by § 103 that $\int\frac{\dot{z} \sin. z}{1-\cos. z} = \mathrm{l.}\,(1-\cos. z)$, and that $\int \frac{\dot{z}\sin. z}{1+\cos. z} = -\mathrm{l.}\,(1+\cos. z)$, therefore

$$\int\frac{\dot{z}}{\sin. z} = \frac{1}{2} \mathrm{l.}\,(1-\cos. z) - \frac{1}{2} \mathrm{l.}\,(1+\cos. z) + const.$$

$$= \frac{1}{2} \mathrm{l.}\left(\frac{1-\cos. z}{1+\cos. z}\right) + const.$$

$$= \mathrm{l.}\,\frac{\sqrt{(1-\cos. z)}}{\sqrt{(1+\cos. z)}} + const.$$

If in the general formula for $\int\frac{\dot{z}}{\sin.^n z}$ we suppose $n=2$ we have $\int\frac{\dot{z}}{\sin.^2 z} = -\frac{\cos. z}{\sin. z} = -\mathrm{cotan.}\, z + const.$ which agrees with what has been already observed (§ 145.), and if we suppose $n=3$, then

$$\int\frac{\dot{z}}{\sin.^3 z} = -\frac{\cos. z}{2\sin.^2 z} + \frac{1}{2}\int\frac{\dot{z}}{\sin. z}$$

$$= -\frac{\cos. z}{2\sin.^2 z} + \frac{1}{4} \mathrm{l.}\left(\frac{1-\cos. z}{1+\cos. z}\right) + const.$$

In this way we proceed as far as we please, deducing $\int\frac{\dot{z}}{\sin.^4 z}$ from $\int\frac{\dot{z}}{\sin.^2 z}$, and so on.

149. If in the general formulas for $\int\dot{z}\sin.^n z$ and $\int\frac{\dot{z}}{\sin.^n z}$ we substitute $\frac{1}{2}\pi - z$ instead of z, (where $\frac{1}{2}\pi$ denotes a quadrant), and observe that

$$\sin.\,(\tfrac{1}{2}\pi - z) = \cos. z, \quad \cos.\,(\tfrac{1}{2}\pi-z)=\sin. z,$$

and that the fluxion of $(\frac{1}{2}\pi - z)$ is $-\dot{z}$ we shall immediately obtain

$$\int\dot{z}\cos.^n z = \frac{1}{n} \sin. z\cos.^{n-1} z + \frac{n-1}{n}\int\dot{z}\cos.^{n-2} z$$

$$\int\frac{\dot{z}}{\cos.^n z} = \frac{1}{n-1}\,\frac{\sin. z}{\cos.^{n-1} z} + \frac{n-2}{n-1}\int\frac{\dot{z}}{\cos.^{n-2} z}$$

and in like manner from the formula expressing the fluent of $\frac{\dot{z}}{\sin. z}$ we deduce

$$\int\frac{\dot{z}}{\cos. z} = \frac{1}{2} \mathrm{l.}\left(\frac{1+\sin. z}{1-\sin. z}\right) + const.$$

$$= \mathrm{l.}\,\frac{\sqrt{(1+\sin. z)}}{\sqrt{(1-\sin. z)}} + const.$$

150. It has been shewn in ALGEBRA, § 357, that $16 \cos.^2 z \sin.^3 = -\sin. 5z + \sin. 3z + 2 \sin. z$, therefore

$$\int\dot{z}\cos.^2 z\sin.^3 z = \frac{1}{16}\left(\frac{1}{5}\cos. 5z - \frac{1}{3}\cos. 3z - 2\cos. z\right) + const.$$

The same mode of finding the fluent will apply to any fluxion of this form $\dot{z}\sin.^m z\cos.^n z$; or by resolving the fluxion into two parts, the determination of its fluent may be reduced to that of a fluxion in which the exponents m and n are less than in the proposed fluxion, by the method of proceeding already employed in § 148.

151. Let us now denote $\sin. z$ by x, then $\cos. z = \sqrt{(1-x^2)}$ and since $\dot{z} \cos. z = \dot{x}$ (§ 59.) therefore $\dot{z} = \frac{\dot{x}}{\sqrt{(1-x^2)}}$; these values being substituted in any function involving $\dot{z}$, $\sin. z$ and $\cos. z$ will immediately reduce it to an algebraic form. Thus for example, we shall have $\dot{z} \sin.^m z \cos.^n z$ transformed to

$$\dot{x}\, x^m\, (1-x^2)^{\frac{n-1}{2}}$$

an expression which may have its fluent determined by the formulas of § 133 and § 134.

SECT. II. *Application of the Inverse Method of Fluxions to the Resolution of Problems.*

To find the Areas of Curves.

152. It has been shewn in § 61, that if the abscissa of a curve be denoted by x, the ordinate by y, and the area

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area by s, then $\dot{s}=y\dot{x}$. Therefore the general formula expreſſing the area of any curve will be

$$s=\int y\dot{x}.$$

Hence, to find the area of any curve, we muſt either find from the equation of the curve the value of y in terms of x, or elſe the value of $\dot{x}$ in terms of $\dot{y}$, and y, and either the one or the other of theſe being ſubſtituted the above formula, and the fluent found by the methods already explained, we ſhall have a general expreſſion for the curvilineal area as required.

Fig. 19. N° 1. *Ex.* 1. Let it be required to find the area of any curve of the parabolic kind, of which, putting the abſciſſa AB$=x$, and the ordinate BP$=y$, the equation is $y^n=ax^m$.

Then we have $y=a^{\frac{1}{n}}x^{\frac{m}{n}}$, and

$$s=\int y\dot{x}=a^{\frac{1}{n}}\int x^{\frac{m}{n}}\dot{x}$$

$$=\frac{na^{\frac{1}{n}}}{m+n}x^{\frac{m+n}{n}}+\text{C},$$

where C denotes the conſtant quantity that may be required to complete the fluent. As in the preſent caſe, it is required to find the area of the portion of the curve next its vertex, ſo that when $s=0$, then $x=0$, therefore, alſo C$=0$, and the area is ſimply $\frac{na^{\frac{1}{n}}}{m+n}x^{\frac{m+n}{n}}$.

If it be required to find the area comprehended between two ordinates PB, pb, put AB$=d$, then when $s=0$, we have $x=d$, therefore the general expreſſion $s=\frac{na^{\frac{1}{n}}}{m+n}x^{\frac{m+n}{n}}+\text{C}$ becomes in this caſe $o=\frac{na^{\frac{1}{n}}}{m+n}d^{\frac{m+n}{n}}$

$+\text{C}$, hence $\text{C}=-\frac{na^{\frac{1}{n}}}{m+n}d^{\frac{m+n}{n}}$,

and conſequently the area BPpb, or s, is equal to

$$\frac{na^{\frac{1}{n}}}{m+n}\left\{x^{\frac{m+n}{n}}-d^{\frac{m+n}{n}}\right\}.$$

When n is an even number, the expreſſion for the area, viz. $\frac{na^{\frac{1}{n}}}{m+n}x^{\frac{m+n}{n}}$ may be conſidered as negative as well as poſitive, on account of the radical quantity $x^{\frac{m+n}{n}}$, or $\sqrt[n]{x^{m+n}}$, which has then a twofold value, it it may therefore have the ſign $\pm$ prefixed to it; but in this caſe the ſame abſciſſa AB belongs to two branches of the curve APp and AP$'p'$ as in fig. 19. N° 1, therefore the two values of the expreſſion $\pm\frac{na^{\frac{1}{n}}}{m+n}x^{\frac{m+n}{n}}$ may be conſidered as indicating the two areas APB, AP$'$B,

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on each ſide of the axis, correſponding the one to the poſitive, and the other to the negative ordinates.

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When the exponents m and n are both odd numbers, the quantity $x^{\frac{m+n}{n}}$ has only one ſign and remains always poſitive whatever be the ſign of x, but in this caſe one of the two branches of the curve has its abſciſſas and its ordinates negative at the ſame time (as in fig. 19. N° 2.) it follows therefore that the areas correſponding to the negative abſciſſas and ordinates ought to be regarded as poſitive.

If n alone is odd, then the quantity $x^{\frac{m+n}{n}}$ becomes negative at the ſame time as x, but in this caſe the two branches of the curve are on the ſame ſide of the line in which the abſciſſas are taken (as in fig. 19. N° 3.) and the ordinates remain always poſitive.

Upon the whole it may be concluded, *that the area of a curve is poſitive when the abſciſſas and the ordinates have the ſame ſign, and negative when they have contrary ſigns.*

If we ſuppoſe $m=1$, and $n=2$, then the curve is the common parabola, the area of which from the general formula is found to be $\frac{2}{3}a^{\frac{1}{2}}x^{\frac{3}{2}}=\frac{2}{3}xy$; hence it appears that the parabola is $\frac{2}{3}$ of its circumſcribing parallelogram.

Ex. 2. Suppoſe the curve to be a circle. Put AB$=x$, BP$=y$, the diameter AD$=a$, the area ABP$=s$. From the nature of the circle $y^2=ax-x^2$, therefore $y=\sqrt{(ax-x^2)}$, and Fig. 20.

$$s=\int y\dot{x}=\int\dot{x}\sqrt{(ax-x^2)};$$

In this caſe the fluxion is not of ſuch a form as to admit of an algebraic fluent in finite terms, we muſt therefore have recourſe to the method of ſeries, but we have already found the fluent in this way in § 140, therefore, from the ſeries there brought out we have

$$s=\sqrt{ax}\left(\frac{2x}{3}-\frac{1}{2}\,\frac{2x^2}{5a}-\frac{1.1}{2.4}\,\frac{2x^3}{7a^2}\right.$$

$$\left.-\frac{1.1.3}{2.4.6}\,\frac{2x^4}{9a^3}-\&\text{c.}\right)$$

this expreſſion does not require a conſtant quantity to be added to it, becauſe when $x=0$ we muſt alſo have $s=0$.

If we ſuppoſe the arch AP to be $\frac{1}{3}$ of the quadrant AE, then it is known that PB$=\frac{1}{2}$ the rad. AC$=\frac{1}{2}a$, therefore, if we ſuppoſe the radius $=1$, we have in this caſe BC$=\frac{1}{2}\sqrt{3}$, and AB$=1-\frac{1}{2}\sqrt{3}=0{\cdot}1339746$ nearly. If this number be ſubſtituted inſtead of x, and a few terms of the ſeries computed, we ſhall find the area ABP $={\cdot}0452931$; to this add the triangle CBP$=\frac{1}{4}\times\sqrt{\frac{3}{4}}=0{\cdot}2165063$, and we have the ſector ACP$={\cdot}2617994$, which number when multiplied by 3 gives ${\cdot}7853982$ for the area of the quadrant. This number alſo expreſſes the area of a circle of which the diameter is 1.

Ex. 3. Suppoſe the curve to be an ellipſe. Put Plate fig. 21.

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the transverse axis AD$=a$, the conjugate axis 2CE$=b$, also AB$=x$, BP$=y$; then by the nature of the curve $y=\frac{b}{a}\sqrt{(ax-x^2)}$, and $\dot{s}=y\dot{x}=\frac{b\dot{x}}{a}\sqrt{(ax-x^2)}$; but if a circle be described on AD as a diameter, and BP the ordinate of the ellipse be produced to meet the circle, it appears from last example that $\dot{x}\sqrt{(ax-x^2)}$ is the fluxion of AQB the segment of the circle corresponding to the elliptic area APB or s; therefore, putting v for the segment AQB, we have $\dot{s}=\frac{b\dot{v}}{a}$, and $s=\frac{bv}{a}$, here the constant quantity c must be suppressed because s and v must vanish together. Hence it appears that the area of any segment of an ellipse is to the area of the corresponding segment of its circumscribing circle as the lesser axis of the ellipse is to the greater; therefore the whole ellipse must be to the whole circle in the same ratio.

Fig. 22. *Ex.* 4. Let the curve be a hyperbola, of which C is the centre. Put the semi-transverse axis CA$=a$, the the semiconjugate axis $=b$, CB$=x$, BP$=y$, the area APB$=s$. From the nature of the curve $y=\frac{b}{a}\sqrt{(x^2-a^2)}$, therefore

$$s=\int y\dot{x}=\frac{b}{a}\int\dot{x}\sqrt{(x^2-a^2)}.$$

But it appears from formula B (§ 131.) that

$$\int\dot{x}\sqrt{(x^2-a^2)}=\tfrac{1}{2}x\sqrt{(x^2-a^2)}-\tfrac{1}{2}a^2\int\frac{\dot{x}}{\sqrt{(x^2-a^2)}}$$

and again by § 127,

$$\int\frac{\dot{x}}{\sqrt{(x^2-a^2)}}=\text{l.}\left\{x+\sqrt{(x^2-a^2)}\right\}+c,$$

therefore

$$s=\frac{b}{2a}x\sqrt{(x^2-a^2)}-\frac{ab}{2}\text{l.}\left\{x+\sqrt{(x^2-a^2)}\right\}+c.$$

To discover the value of the constant quantity c we must consider that when $x=a$, then $s=0$, and in this extreme case the general equation just found becomes

$$0=-\frac{ab}{2}\text{l.}\,a+c$$

hence $c=\frac{ab}{2}\text{l.}\,a$, and consequently, observing that

$$-\frac{ab}{2}\text{l.}\left\{x+\sqrt{(x^2-a^2)}\right\}+\frac{ab}{2}\text{l.}\,a$$

$$=-\frac{ab}{2}\text{l.}\left\{\frac{x+\sqrt{(x^2-a^2)}}{a}\right\}$$

we get

$$s=\frac{b}{2a}x\sqrt{(x^2-a^2)}-\frac{ab}{2}\text{l.}\left\{\frac{x+\sqrt{(x^2-a^2)}}{a}\right\}$$

It immediately follows from this formula that

$$\frac{b}{2a}x\sqrt{(x^2-a^2)}-s=\frac{ab}{2}\text{l.}\left\{\frac{x+\sqrt{(x^2-a^2)}}{a}\right\}$$

but if a straight line be drawn from C to P so as form the triangle CBP, it is manifest that $\frac{b}{2a}x\sqrt{(x^2-a^2)}$ is equal to $\frac{1}{2}$CB$\times$BP, that is to the triangle CBP, therefore the excess of the triangle CBP above the area s, that is the hyperbolic sector CAP is equal to the logarithmic function

$$\frac{ab}{2}\text{l.}\left\{\frac{x+\sqrt{(x^2-a^2)}}{a}\right\}.$$

Ex. 5. Suppose the curve to be an equilateral hyperbola, that is a hyperbola whose axes are equal, and that it is required to find the curvilinear area DCBP comprehended between DC, a perpendicular from D (a given point in the curve) to one of the asymptotes, and PB, a perpendicular from any other point in the curve to the same asymptote. Fig. 23.

Let A be the centre, put AC$=a$, CD$=b$, AB$=x$, BP$=y$, the area DCBP$=s$. From the property of the asymptotes we have $xy=ab$, and therefore $y=\frac{ab}{x}$, hence (§ 103.)

$$s=\int y\dot{x}=\int\frac{ab\dot{x}}{x}=ab\,\text{l.}\,x+c.$$

To find the value of c, let us suppose $x=a$, then $s=0$ and the general formula becomes in this case

$$0=ab\,\text{l.}\,a+c,\text{ and hence }c=-ab\,\text{l.}\,a,$$

therefore

$$s=ab\,\text{l.}\,x-ab\,\text{l.}\,a=ab\,\text{l.}\,\frac{x}{a}.$$

If we suppose $a=b=1$, then $s=\text{l.}x$, from which it appears that in this case the hyperbolic area DCBP represents the Napierean logarithm of the number x; it was from the consideration of this property that the logarithms originally invented by *Napier* were called *hyperbolic* logarithms.

But the logarithms of any other system may also be represented by areas of the same hyperbola; for this purpose it is only necessary to determine the magnitudes of a, and b, so that $\frac{b}{a}=$M, where M denotes the *modulus* of the system, thus we shall have $ab=a^2$ M, and $s=a^2$ M l. $\frac{x}{a}$, or, putting $a=1$, $s=$M l. x, an expression for the logarithm of x according to any system whatever of which the *modulus* is M (ALGEBRA, § 287.).

Ex. 6. Let the curve be the cycloid of which AE is the axis and A the vertex, let a semicircle be described on AE as a diameter, draw AG perpendicular to the axis, and from any point in the curve draw PB perpendicular to AG and PD perpendicular to AE, meeting the circle in Q, and draw QC to C the centre of the circle. Put AC$=a$, AB$=x$, BP$=y$, the area ABP$=s$, and put v for the angle ACQ, that is for the arch of a circle which measures ACQ, the radius of Fig. 24.

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of that circle being unity, then AD$=a(1-\text{cof.}\ v)$, DQ$=a\ \text{fin.}v$, and arch AQ$=av$, and since from the nature of the curve, PD$=$ arch AQ$+$DQ, therefore PD$=av+a\ \text{fin.}\ v=a(v+\text{fin.}\ v)$; hence

$$x=a(v+\text{fin.}\ v),\ \dot{x}=a\dot{v}(1+\text{cof.}\ v),\ (\S\ 59.)$$

$$y=a(1-\text{cof.}\ v)$$

$$s=\int \dot{x}y=\int a^2\dot{v}(1-\text{cof.}^2\ v)$$

$$=a^2\int \dot{v}\ \text{fin.}^2\ v=\tfrac{1}{2}a^2v-\tfrac{1}{2}a^2\ \text{fin.}\ v\ \text{cof.}\ v\ (\S\ 148.)$$

$$=\tfrac{1}{2}\text{AC}\times \text{arch AQ}-\tfrac{1}{2}\text{CD}\times\text{DQ};$$

and here no constant quantity is wanted to complete the fluent; because upon the supposition that AQ$=0$ both sides of the equation vanish as they ought to do; now it is obvious that $\frac{1}{2}$AC$\times$AQ$=$ area of sector ACQ, and $\frac{1}{2}$CD$\times$DQ$=$ area of triangle DCQ, therefore

$$s= \text{area of circ. seg. ADQ.}$$

Let AG be the greatest value of x; complete the parallelogram AGFE, then from the general expression for the cycloidal area, it follows that the whole cycloidal space APFG is equal to the semicircle AQE; but from the nature of the curve, EF is equal to AQE, half the circumference, therefore the rectangle EG is equal to four times the semicircle AQE; from these equals take away the external cycloidal space AGF, and the semicircle AQE, which have been shewn to be equal, and the remainders, viz. the internal cycloidal space APFE, and three times the semicircle AQE are equal to each other.

153. In some cases it is more convenient to refer a curve line to a fixed point than to an axis. Thus instead of expressing the nature of the circle by the equation $y^2=ax-x^2$, where y denotes a perpendicular from any point of the curve upon a the diameter, and x the distance of that perpendicular from one end of the diameter, we may otherwise express it by the equation $z=rv$, where z denotes a variable arch of the circle reckoned from one end of its diameter, r its radius, and v the angle contained by a line drawn from the centre of the circle through the extremity of z, which angle is measured by an arch of a circle having its radius unity.

Fig. 25. The nature of the different conic sections may be defined in the same manner. Let P be any point in a conic section, of which F is one focus, and FA a part of the axis; let DC the directrix of the section meet FA in C, join PF, and draw PB perpendicular to the axis, and PD to the directrix; then from the nature of the curve (Conic Sections) PF has a given ratio to PD, that is to FC—FB; put FC$=a$, FP$=r$, the angle PFC$=v$, and suppose PF : PD : : n : 1, then PF$=n$.PD$=n$.FC$-n$.FB, hence, observing that FB$=$FP $\times$cof. v, we get $r=an-nr$ cof. v, and $r=\dfrac{an}{1+n\ \text{cof.}\ v}$ which equation expresses generally the nature of a conic section.

154. The formula which we have found for the fluxion of a curvilinear area, in § 61, is not immediately applicable when the nature of a curve is expressed in this way, we shall therefore investigate another formula suited to this particular manner of considering curves.

Let us suppose that APR is a curve the position of any point P of which is determined by PF, its distance from a given point F, and the angle which PF makes with AF a line given by position. Let a circle be described on F as a centre with a rad.$=1$, then FP, as also the area FAP may be considered as functions of BD the arch of that circle which measures the angle PFA. From F draw FP′ to any other point P′ of the curve meeting the circle BD in D′. Put FP$=r$, the area FAP$=s$, the angle AFP, or the arch BD$=v$, then the area PFP′, and the arch DD′ will be the corresponding increments of s and v, therefore § 21, Fig. 26.

$$\frac{\dot{s}}{\dot{v}}=\text{limit of}\ \frac{\text{area FPP}'}{\text{DD}'\times\text{FD}},$$

here DD′ the increment of v is multiplied by FD$=1$, to render the terms of the ratio homogeneous. On F as a centre, with FP as a radius, describe an arch of a circle meeting FP′ in Q, then, as the sectors FDD′, FPQ are similar, we have

$$\text{FD}^2 : \text{FP}^2 :: \text{FD}\times\text{DD}' : \text{FP}\times\text{PQ}=2\ \text{sect. FPQ},$$

$$\text{hence DD}'\times\text{FD}=\frac{2\,\text{FD}^2}{\text{FP}^2}\ \text{sect. FPQ}=\frac{2}{r^2}\text{sect. FPQ}$$

$$\text{and}\ \frac{\dot{s}}{\dot{v}}=\frac{r^2}{2}\times \text{lim.}\frac{\text{area FP}'\text{P}}{\text{sect. FPQ}};$$

but the point P′ being supposed to approach continually to P, it is manifest that the limit of $\dfrac{\text{area FPP}'}{\text{sect. FPQ}}$ is unity, or 1, therefore

$$\frac{\dot{s}}{\dot{v}}=\frac{r^2}{2},\ \text{and}\ \dot{s}=\frac{1}{2}r^2\dot{v}.$$

155. By means of this formula we may find the areas of that class of curves called *spirals*. Let us take for example the spiral of Archimedes, which may be defined thus. Conceive a straight line FR to revolve about F the centre of a given circle, departing from a given position FB; conceive also a point P to move in the revolving line, so that PF its distance from the centre may be to BD the arch of the circle passed over by the revolving line, as m to n, then the point P will generate the spiral. Fig. 27.

Put BF$=a$, the angle BFR$=v$, the line FP$=r$, and the area generated by the line FP$=s$, then the arch BD$=av$, and since from the nature of the curve $r : av :: m : n$, therefore $v=\dfrac{nr}{am}$, and $\dot{v}=\dfrac{n\dot{r}}{am}$, hence the general formula $\dot{s}=\dfrac{1}{2}r^2\dot{v}$ becomes $\dot{s}=\dfrac{nr^2\dot{r}}{2am}$, therefore,

$$s=\int\frac{nr^2\dot{r}}{2am}=\frac{nr^3}{6am}$$

this fluent does not require a constant quantity to be added,

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added, as both s and r evidently vanish at the same time.

Fig. 28. 156. As the general expression for a curvilineal area BCPD is $\int y\dot{x}$, where $x=AB$ the abscissa reckoned from a given point A in the axis and $y=BC$ the ordinate, it follows that X being put to denote any function of a variable quantity x, the fluent of $X\dot{x}$ may always be exhibited by means of a curvilineal area. Thus let CPp be a curve of such a nature that AD and DP the co-ordinates being denoted by x and y, the equation of of the curve is $y=X$, then, assuming any ordinate BC as given by position, we have evidently

$$\int X\dot{x} = \text{area CBDP}.$$

As the ordinate BC (which is assumed as given by position) may be taken any where, the fluxion of the area being the same wherever it is taken, it appears, as has been already observed (§. 101) that the function $\int X\dot{x}$ may be considered as indeterminate, for it admits of innumerable values corresponding to any particular value of x, and in this respect it differs from an algebraic function, which for a given value of x has always a determinate number of values. If however x be supposed to increase from any determinate magnitude a, to any other determinate magnitude a', then, taking the abscissa AD $=a$, and A $d=a'$, and drawing the ordinates DP, dp, we have

$$\text{when } x=a, \int X\dot{x} = \text{area CBDP},$$

$$\text{and when } x=a', \int X\dot{x} = \text{area CB}dp,$$

therefore, while x increases from a to a', or receives the increment $a'-a$, the function $\int X\dot{x}$ increases from area CBDP to area CBdp, and thus receives the increment area PDdp, which is of a determinate magnitude as the ordinates PD, pd have both a determinate position. Hence it appears that in assigning the fluent of $X\dot{x}$, we only determine the change that takes place in the value of the function $\int X\dot{x}$ while x passes from one particular value to another particular value.

157. As there are general and known methods by which an approximate value of any curvilineal area may be found, when a fluent is expressed by such an area, those methods may be applied to find an approximate value of the fluent. Let PDdp be a curvilineal area,

Fig. 29. supposed to represent the fluent $\int X\dot{x}$ between the limits of $x=AD$ and $x=Ad$. Conceive Dd to be divided into a number of equal parts DD′, D′D″, Dd, and the ordinates P′D′, P″D″ drawn, and the two sets of parallelograms DE, D′E′, D″E″ and D′e, D″e', de'' to be completed, the former constituting a rectilineal figure circumscribed about the curvilineal space DPP′P″pd, and the latter a rectilineal figure inscribed in that space; then as the circumscribed figure must necessarily be greater than the curvilineal space, that is, greater than $\int X\dot{x}$ taken between the limits of $x=AD$ and $x=Aa$, and the inscribed figure must be less, it follows that if we compute the areas of the circumscribed and inscribed figures we shall obtain two limits, the one greater, and the other less than $\int X\dot{x}$. And as by increasing the number of equal parts into which Dd is divided we may bring the circumscribed and inscribed rectilineal figures as near to a ratio of equality as we please, it is always possible to find two limits which shall differ from each other, and consequently from $\int X\dot{x}$ (which lies between them) by less than any assignable quantity.

158. If we join P, P′, P″, p, the tops of the ordinates, the rectilineal space formed by the trapeziums DPP′D′, D′P′P″D″, D″P″pd will be more nearly equal to the curvilineal area, than the circumscribed rectilineal figure formed by the parallelograms DE, D′E′, D″E″; therefore the sum of those trapeziums being found, it will be equal to the fluent $\int X\dot{x}$ nearly.

Suppose, for example, that it is required to find the value of $\int\frac{\dot{x}}{1+x^2}$ between the limits of $x=0$, and $x=1$. In this case $X=\frac{1}{1+x^2}$, so that the equation of the curve Pp is $y=\frac{1}{1+x^2}$; let us suppose Dd the distance between the extreme ordinates to be divided into ten equal parts, then putting 0, ·1, ·2, &c. to 1 instead of x in the formula $y=\frac{1}{1+x^2}$, we obtain eleven successive values of y, or eleven equidistant ordinates, the numeral values of which will be as follows,

The first = 1·00000	the 7th = ·73529
the 2d = ·99010	the 8th = ·67114
the 3d = ·96154	the 9th = ·60975
the 4th = ·91743	the 10th = ·55249
the 5th = ·86207	the 11th = ·50000
the 6th = ·80000	

By the elements of geometry the area of the rectilineal figure formed by the trapeziums is found by adding together all the ordinates except the first and last, and half the sum of the first and last, and multiplying that sum by the breadth of one of the trapeziums; now the sum of the ordinates, with the exception of the first and last, together with half the sum of the first and last, is 7·84981, and the common breadth of the trapeziums is ·1, therefore $\int\frac{\dot{x}}{1+x^2}=7.84981\times$ ·1=·785 nearly, as required. It is evident from § 137, that $\int\frac{\dot{x}}{1+x^2}$ taken between the limits of $x=0$, and $x=1$, is accurately equal to an arch of 45°, radius being unity, which arch being $\frac{1}{4}\pi$ will be found = ·7854 nearly.

If we recur to the series which has been found to express the above fluent in § 137, and put $a=1$, and $x=1$, we shall have $\int\frac{\dot{x}}{1+x^2}$ taken between the prescribed limits equal to

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$1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \&c.$

It is impossible however to compute the fluent simply by the addition of the terms of this series, on account of the slowness of its convergency.

159. As the curvilineal area DPpd is the limit of the sum of the parallelograms DP′, D′P″, &c. which constitute the rectilineal figure inscribed in that area; as also the limit of the sum of the parallelograms DE, D′E′, &c. which constitute the circumscribed figure, the number of parts into which D d is divided being in either case conceived to be increased indefinitely, so that each may be continually diminished (and this being the case it is of no consequence whether those parts be conceived as all equal or as unequal) so from analogy we may conclude that if $x', x'', x''', \ldots x^{(n)}$ be put to denote successive values of a variable quantity x, and X', $X'', X''', \ldots X^{(n)}$ the corresponding values of X any function of x, the limit of the sum of the products $X(x'-x)$, $X'(x''-x')$, $X''(x'''-x'')$, &c. when the number of successive values of x and X is continually increased, so that the difference between any two of them immediately following each other may be continually diminished, is equal to $\int X\dot{x}$, the fluent to be taken between the two extreme values of x.

160. It was in this manner that the first writers on the differential calculus conceived a fluent; as the difference between any two of its succeeding values is the product of the function X by $x'-x$ the increment of x, they called that product (when $x'-x$ was conceived to be infinitely diminished) the *Differential* of the fluent; and as the fluent is the sum of all the products, or differentials, instead of calling it a fluent they called it an *Integral;* the process by which an integral is found from its differential or fluxion they called *Integration.* The terms *Integral* and *Integration* are sometimes employed by writers in applying the method of fluxions to mathematical enquiries.

To find the Lengths of Curves.

161. It has been shewn in § 63, that if the abscissa of a curve be denoted by x, the ordinate by y, and the curve line by z, then $\dot{z} = \sqrt{(\dot{x}^2 + \dot{y}^2)}$, hence the general formula for finding the length of a curve is

$$z = \int \sqrt{(\dot{x}^2 + \dot{y}^2)}.$$

Therefore, if from the equation expressing the nature of a curve we find the value of $\dot{y}$ in terms of $\dot{x}$ and x, or else the value of $\dot{x}$ in terms of $\dot{y}$ and y, and substitute the one or the other in the above general formula, we shall obtain a fluxion the fluent of which will be the length of the curve.

Fig. 19. *Ex.* 1. Suppose the curve to be a parabola, and that AB$=x$, BP$=y$, the arch AP$=z$, the parameter $=a$, then the equation of the curve being $ax=y^2$, we have $\dot{x} = \frac{2y\dot{y}}{a}$, and

$$z = \int \sqrt{(\dot{x}^2 + \dot{y}^2)} = \int \sqrt{\left(\frac{4y^2\dot{y}^2}{a^2} + \dot{y}^2\right)}$$

$$= \frac{1}{a}\int \dot{y}\sqrt{(a^2 + 4y^2)}.$$

By comparing this expression with formula (B) in § 131, we find

$$\int \dot{y}\sqrt{(a^2+4y^2)} = \tfrac{1}{2}y\sqrt{(a^2+4y^2)}$$

$$+ \tfrac{1}{2}a^2 \int \frac{\dot{y}}{\sqrt{(a^2+4y^2)}};$$

again by § 127,

$$\int \frac{\dot{y}}{\sqrt{(a^2+4y^2)}} = \tfrac{1}{2}\,\mathrm{l.}\left\{2y + \sqrt{(a^2+4y^2)}\right\}$$

therefore

$$z = \frac{y\sqrt{(a^2+4y^2)}}{2a}$$

$$+ \frac{a}{4}\,\mathrm{l.}\left\{2y + \sqrt{(a^2+4y^2)}\right\} + \mathrm{C}.$$

To determine the value of C, we must consider that when $y=0$, then $z=0$, so that then the general formula will become simply

$$0 = \frac{a}{4}\,\mathrm{l.}\,a + \mathrm{C}, \text{ and hence } \mathrm{C} = -\frac{a}{4}\,\mathrm{l.}\,a,$$

therefore, substituting the value of C, and bringing together the logarithmic quantities,

$$z = \frac{y\sqrt{(a^2+4y^2)}}{2a}$$

$$+ \frac{a}{4}\,\mathrm{l.}\left\{\frac{2y+\sqrt{(a^2+4y^2)}}{a}\right\}.$$

Ex. 2. Suppose the curve to be a circle, and that C is its centre, and AE a quadrant of the circle. Put CB$=x$, BP$=y$, the arch EP$=z$, the radius of the circle $=a$, then $x^2+y^2=a^2$, and $y=\sqrt{(a^2-x^2)}$, and $\dot{y} = \frac{-x\dot{x}}{\sqrt{(a^2-x^2)}}$, hence Fig. 20.

$$z = \int \sqrt{(\dot{x}^2+\dot{y}^2)} = \int \sqrt{\left(\dot{x}^2 + \frac{x^2\dot{x}^2}{a^2-x^2}\right)}$$

$$= \int \frac{a\dot{x}}{\sqrt{(a^2-x^2)}}.$$

This fluent can only be expressed by an infinite series, under which form it has been already exhibited in § 140, the radius being there supposed unity.

Ex. 3. Let the curve be an ellipse, and let it be required to find the length of the curve between E the vertex of the lesser axis, and P any point in the curve. To simplify the calculation, let us suppose that the semitransverse axis AC$=1$; put the semi-conjugate axis CE$=b$, the excentricity (that is $\sqrt{(1-b^2)})=e$, the abscissa CB$=x$, the ordinate PB$=y$, the arch EP$=z$; then, the equation of the curve being $y^2=b^2(1-x^2)$, we have Fig. 21.

Inverse Method.

have $y=b\sqrt{(1-x^2)}$, and $\dot{y}=\frac{-bx\dot{x}}{\sqrt{(1-x^2)}}$, and therefore

$$z=\int\sqrt{(\dot{x}^2+\dot{y}^2)}=\int\sqrt{(\dot{x}^2+\frac{b^2x^2\dot{x}^2}{1-x^2})}$$

$$=\int\frac{\dot{x}\sqrt{(1-e^2x^2)}}{\sqrt{(1-x^2)}}.$$

This fluent can only be expressed by means of an infinite series, and it has been already given in this form in § 141.

If we take $x=1$, then all the quantities in that series which are multiplied by $\sqrt{(1-x^2)}$ will vanish, but in this particular case z is the elliptic quadrant EA, and A is a quadrant of the circumscribing circle, or $\frac{1}{2}\pi$, therefore the elliptic quadrant is equal to

$$\tfrac{1}{2}\pi(1-\frac{1}{2.2}e^2-\frac{1.1.3}{2.2.4.4}e^4-\frac{1.1.3.3.5}{2.2.4.4.6.6}e^6-\&c.)$$

This series converges very fast if e be a small fraction.

Fig. 11. *Ex.* 4. Suppose the curve to be a cycloid. Let a circle be described on its axis meeting the ordinate PB in Q, and draw CQ to the centre of the circle. Put $AB=x$, $BP=y$, the cycloidal arch $AP=z$, the radius $AC=a$, the angle $ACQ=v$, then $AB=a(1-\text{cos}.\,v)$, $BQ=a\,\text{sin}.\,v$, the circ. arch $AQ=a\,v$, so that $x=a(1-\text{cos}.\,v)$, and from the nature of the curve $y=a(v+\text{sin}.\,v)$, therefore (§ 59)

$$\dot{x}=a\dot{v}\,\text{sin}.\,v,\quad \dot{y}=a\dot{v}(1+\text{cos}.\,v),$$

$$\dot{x}^2+\dot{y}^2=a^2\dot{v}^2\left\{\text{sin}.^2\,v+(1+\text{cos}.\,v)^2\right\}$$

$$=a^2\dot{v}^2(2+2\,\text{cos}.\,v)$$

but $2+2\,\text{cos}.\,v=4\,\text{cos}.^2\tfrac{1}{2}v$ (ALGEBRA, § 356.), therefore

$$z=\int\sqrt{(\dot{x}^2+\dot{y}^2)}=2a\int\dot{v}\,\text{cos}.\,\tfrac{1}{2}v$$

$$=4a\,\text{sin}.\,\tfrac{1}{2}v+C,\ (\S\ 145.)$$

but as when $v=0$, then $z=0$, therefore $C=0$, and $z=4a\,\text{sin}.\,\frac{1}{2}v$; but if the chord AQ be drawn, $2a\,\text{sin}.\,\frac{1}{2}v$ = chord AQ, therefore $z=2$ chord AQ.

162. The formula $z=\int\sqrt{(\dot{x}^2+\dot{y}^2)}$ not being applicable in its present form to curves of the spiral kind, we shall here investigate another suited to that particular class of curves.

Fig. 30. Let APR be a curve of such a nature that the position of any point P in the curve is determined by PF, its distance from a given point F, and by the angle which PF makes with AF a line given in position. We shall employ the same construction and notation here as in § 154, with the addition of drawing the chords DD′, PQ, PP′, and putting the arch $AP=z$; then it is manifest that the simultaneous increments of v, z, and r will be the arches DD′, PP′, and the straight line P′Q respectively. Hence

$$\frac{\dot{z}}{\dot{v}}=\text{limit of}\ \frac{\text{arch PP}'}{\text{arch DD}'}$$

but it is evident from § 62, that the limiting ratio of those arches must be the same as that of their chords, therefore,

$$\frac{\dot{z}}{\dot{v}}=\text{limit of}\ \frac{\text{chord PP}'}{\text{chord DD}'};$$

now the limit of the angle PQD being evidently a right angle, we have

$$\text{lim.}\ \frac{PP'}{DD'}=\text{lim.}\ \frac{\sqrt{(PQ^2+QP'^2)}}{DD'}$$

$$=\text{lim.}\sqrt{\left\{\frac{PQ^2}{DD'^2}+\frac{P'Q^2}{DD'^2}\right\}}$$

but $\frac{PQ^2}{DD'^2}=\frac{FP^2}{FD^2}=r^2$, and lim. $\frac{P'Q^2}{DD'^2}=\frac{\dot{r}^2}{\dot{v}^2}$, therefore

$$\frac{\dot{z}}{\dot{v}}=\sqrt{\left(r^2+\frac{\dot{r}^2}{\dot{v}^2}\right)},\ \text{and}\ \dot{z}=\sqrt{\left(r^2\dot{v}^2+\dot{r}^2\right)}.$$

Let us apply this formula to the spiral of Archimedes, Fig. 27. the equation of which (§ 155.) is $amv=nr$, and therefore

$$v=\frac{nr}{am},\ \text{and}\ \dot{v}^2=\frac{n^2\dot{r}^2}{a^2m^2};\ \text{hence}$$

$$z=\int\sqrt{(\dot{r}^2+r^2\dot{v}^2)}=\frac{1}{a}\int\dot{r}\sqrt{(a^2+\frac{n^2}{m^2}r^2)}$$

This fluent may be found by formula B, § 131, and it is worthy of remark that the fluxion has the same form as that which we have found in § 161 for an arch of a parabola; thus the length of any portion of the spiral of Archimedes may be exhibited by means of an arch of a parabola.

To find the Content of Solids.

163. If AD the abscissa of a curve be denoted by x, Fig. 4. and PD the ordinate by y, and the solid generated by the revolution of the curve APD about AD as an axis by s, it has been shewn, in § 64, that $\dot{s}=\pi y^2\dot{x}$, therefore the general formula for finding the content of a solid is

$$s=\pi\int y^2\dot{x}.$$

Ex. 1. Suppose the solid to be a paraboloid, or that which is generated by the revolution of a parabola about its axis; in this case $y^2=ax$, and taking the fluent so that when $x=0$, then $s=0$,

$$s=\pi\int y^2\dot{x}=\pi a\int x\dot{x}=\tfrac{1}{2}\pi ax^2.$$

or $s=\frac{1}{2}\pi xy^2$; but πxy^2 is the content of a cylinder having y for the radius of its base and x for its altitude, therefore the content of a paraboloid is half that of a cylinder having the same base and altitude.

Ex. 2. Suppose the solid to be a parabolic spindle, Fig. 31. which is generated by the revolution of APB an arch of a parabola about AC an ordinate to its axis. In this case let $AD=x$, $DP=y$, $AB=b$, the parameter of the axis

Inverse Method.

axis $=a$, then from the nature of the parabola $AD\times DB=a\times PD$, that is $x(b-x)=a\,y$, hence $y=\frac{(b-x)x}{a}$, and taking the fluent, so that s and x may vanish together;

$$s=\pi\int y^2\dot{x}=\frac{\pi}{a^2}\int x^2(b-x)^2\dot{x}$$

$$=\frac{\pi}{a^2}\int(b^2x^2\dot{x}-2bx^3\dot{x}+x^4\dot{x})$$

$$=\frac{\pi}{a^2}\left(\frac{b^2x^3}{3}-\frac{bx^4}{2}+\frac{x^5}{5}\right)$$

or, since $a^2=\frac{(b-x)^2x^2}{y^2}$,

$$s=\frac{\pi y^2}{(b-x)^2}\left\{\frac{b^2x}{3}-\frac{bx^2}{2}+\frac{x^3}{5}\right\},$$

which expression (by supposing $x=AC=\frac{1}{2}b$, and putting d for CE, the greatest value of y) gives $\frac{4\pi d^2b}{15}$ or the content of half the solid generated by the curve AEB, therefore the entire spindle is $\frac{8\pi a^2b}{15}$, or (by observing that πd^2b is the content of a cylinder having d for the radius of its base and b for its length) it is $\frac{8}{15}$ of the circumscribing cylinder.

Fig. 32. and 33. *Ex.* 3. Suppose the solid to be a spheroid produced by the revolution of an ellipse about either of its axes; put a for $\frac{1}{2}$AB the axis round which the curve revolves, b for $\frac{1}{2}$ E F the other axis, x for AD the height of any segment made by a plane perpendicular to the axis of the solid, y for PD the radius of its base, and s for its content. Then, from the nature of the curve $y^2=\frac{b^2}{a^2}(2ax-x^2)$, therefore, taking the fluent upon the supposition that s and x vanish together,

$$s=\pi\int y^2\dot{x}=\frac{\pi b^2}{a^2}\int(2ax\dot{x}-x^2\dot{x})$$

$$=\frac{\pi b^2}{a^2}\left(ax^2-\frac{x^3}{3}\right).$$

To find the content of the whole spheroid we have only to take $x=2a$, thus the formula becomes $s=\frac{4\pi b^2a}{3}$, and as $2\pi b^2a$ expresses the content of a cylinder having $2b$ for the diameter of its base, and $2a$ for its height, it follows that the content of a spheroid is $\frac{2}{3}$ that of its circumscribing cylinder.

It is obvious that what has been found for the spheroid will apply also to the sphere, by supposing the axes equal, or $a=b$.

Fig. 4. 164. If instead of supposing the solid APQp to be formed by the revolution of a curve round its axis (in which case it is called a solid of *revolution*) we had supposed it to have any figure whatever, then by referring the solid to some straight line AC, given by position, as an axis, and in which A is a given point, and supposing PQp to be a section of the solid made by a plane perpendicular to that axis, meeting it in D, and putting $AD=x$, and the variable solid APQp (considered as a function of x) $=s$, by proceeding as in § 64, we would have found the limit of $\frac{\text{increment of } s}{\text{increment of } x}$, and consequently $\frac{\dot{s}}{\dot{x}}$, equal to the area of the section of the solid made by the plane PQp; therefore, putting V for that function of x which expresses the area of the section, we have $\dot{s}=V\dot{x}$, and $s=\int V\dot{x}$. Inverse Method.

Let us suppose for example that AEFG is a solid bounded by any plane figure EFG as a base, and by the surface which will be generated if we suppose a straight line drawn from A any given point above that plane to revolve in the circumference of the base. Fig. 34.

Let AC be a perpendicular drawn from the vertex of the figure to its base, and let PQp be a section of the solid by a plane parallel to the base, meeting the perpendicular in D. Put $a=$ the area of the base of the solid, $V=$ the area of the section PQp, $b=AC$ the altitude of the whole solid, $x=AD$ the altitude of the part cut off by the plane PQp, and $s=$ the content of that part; then, as from the nature of the solid it is pretty evident that the part of it cut off by the plane PQp is similar to the whole, and as the bases of similar solids are as the squares of their altitudes, we have $a:V::b^2:x^2$, hence $V=\frac{ax^2}{b^2}$, and

$$s=\int V\dot{x}=\frac{a}{b^2}\int x^2\dot{x}=\frac{ax^3}{3b^2},$$

this expression for s does not require the addition of any constant quantity, for by putting $x=0$, we have $s=0$ as it ought to be. Suppose now $x=b$, then $s=\frac{ab^3}{3b^2}=\frac{1}{3}ab$, from which it appears that the content of the whole solid is $\frac{1}{3}$ of the product of the base by the perpendicular. It is evident that pyramids and cones are solids of the kind we have been considering.

To find the Surfaces of Solids.

165. The altitude AD of a solid, generated by revolution of a curve about AD as an axis, being as before denoted by x, and PD the radius of its base by y, let us now put s to denote the curved surface of the solid, then, as it has been shewn, § 65, that $\dot{s}=2\pi y.\sqrt{(\dot{x}^2+\dot{y}^2)}$, we have Fig. 5.

$$s=2\pi\int y\sqrt{(\dot{x}^2+\dot{y}^2)}$$

as a general formula for the surface of a solid.

Ex. 1. Suppose the solid to be a sphere, generated by the revolution of a circle about its diameter AB, put the radius of the sphere $=a$, then, AD being denoted by x, and PD by y, we have from the nature of the curve $y^2=2ax-x^2$, therefore Fig. 35.

$$y=\sqrt{(2ax-x^2)},\text{ and }\dot{y}=\frac{(a-x)\dot{x}}{\sqrt{(2ax-x^2)}},\text{ and}$$

$\dot{x}^2$

$$\dot{x}^2+\dot{y}^2=\dot{x}^2\left(1+\frac{(a-x)^2}{2ax-x^2}\right)$$

$$=\frac{a^2\dot{x}^2}{2ax-x^2}=\frac{a^2\dot{x}^2}{y^2},$$

therefore, $y\sqrt{(\dot{x}^2+\dot{y}^2)}=a\dot{x}$, and taking the fluent, so that when $x=0$, then $s=0$,

$$s=2\pi\int y\sqrt{(\dot{x}^2+\dot{y}^2)}=2\pi a x;$$

now if it be considered that $2\pi a$ is the circumference of a great circle of the sphere, it will immediately appear that the surface of a segment of a sphere is equal to the circumference of a great circle of the sphere multiplied into the height of the segment. Hence it follows that the whole surface of the sphere is equal to four times the area of one of its great circles.

Fig. 5. *Ex.* 2. Suppose the curve to be a parabola, then putting $AD=x$, $DP=y$, the parameter of the axis $=a$, we have (§ 161. example 1.)

$$\sqrt{(\dot{x}^2+\dot{y}^2)}=\frac{1}{a}\dot{y}\sqrt{(a^2+4y^2)}, \text{ therefore}$$

$$s=2\pi\int y\sqrt{(\dot{x}^2+\dot{y}^2)}$$

$$=\frac{2\pi}{a}\int y\dot{y}\sqrt{(a^2+4y^2)}$$

$$=\frac{\pi}{6a}(a^2+4y^2)^{\frac{3}{2}}+C, \text{ by § 108.}$$

To discover the value of the constant quantity C, we must observe that when $x=0$, then $y=0$, and $s=0$, therefore, putting 0 instead of s and y, the above equation becomes $0=\frac{\pi a^3}{6}+C$, hence $C=-\frac{\pi a^3}{6}$, and

$$s=\pi\left\{\frac{(a^2+4y^2)^{\frac{3}{2}}-a^3}{6a}\right\}.$$

To find the Centre of Gravity of any Line, Surface, or Solid.

166. It belongs to the theory of MECHANICS to explain what is meant by the centre of gravity, and to demonstrate its general properties, and here it is only necessary to shew how the method of fluxions may be applied to deduce from some one of those properties rules for finding that centre in any proposed case.

The property of centres of gravity which we shall employ as the foundation of the application of the method of fluxions to its determination may be enunciated shortly thus.

Fig. 36. Let C be the centre of gravity of a mass of matter denoted by M, and c the centre of gravity of another mass m, and D the centre of gravity of the two masses M and m, from these points let perpendiculars CA, ca, DE be drawn to any straight line PQ, then

$$M\times CA+m\times ca=(M+m)\times DE.$$

Fig. 37. 167. Let us now suppose that AP is any curve line (having weight,) of which the centre of gravity is required, and that PB, PD are co-ordinates drawn from any point in the curve perpendicular to AB, AD two axes at right angles to each other; let the arch AP receive any increment Pp, let C be the centre of gravity of AP, G the centre of gravity of Pp, and C′ the centre of gravity of APp. From C and G draw CE, CF, GH, GK perpendicular to the axes AB, AD. Put $PD=x$, $PB=y$, $CF=X$, $CE=Y$, $AP=z$, also let the arch $APp=z'$, and let the distances of C′ its centre of gravity from the axes AD, AB be denoted by X', and Y' respectively; then, observing that the arch $Pp=z'-z$, by the proposition in last §,

$$zX+(z'-z)\times GK=z'X'$$

$$\text{hence } \frac{z'X'-zX}{z'-z}=GK;$$

If we now suppose the arch Pp to be continually diminished, and observe that $z'X'-zX$, and $z'-z$ are the simultaneous increments of zX and z, it will appear (§ 23.) that

$$\frac{\text{flux. of }(zX)}{\dot{z}}=\text{limit of GK.}$$

By the very same way of reasoning we find

$$\frac{\text{flux. of }(zY)}{\dot{z}}=\text{limit of GH},$$

but the point p approaching to P, it is manifest that the point G will also approach to P, so that the limit of GK is PD or x, and the limit of GH is PB or y, hence

$$\frac{\text{flux.}(zX)}{\dot{z}}=x,\quad \frac{\text{flux.}(zY)}{\dot{z}}=y,$$

$$\text{flux.}(zX)=x\dot{z}\quad \text{flux.}(zY)=y\dot{z}$$

Taking now the fluents of each side of these equations, and dividing by z,

$$X=\frac{\int x\dot{z}}{z},\quad Y=\frac{\int y\dot{z}}{z};$$

It is evident that by these two equations the position of C the centre of gravity is determined.

168. Let us next suppose that it is required to find C the centre of gravity of the plane area APB. As the arch AP was in last § supposed to receive the increment Pp, so let the area APB now receive the increment $BPpb$, and let C, C′ and G (which in the former case were supposed to be the centres of gravity of the arches AP, APp, and Pp respectively) now be supposed to be the centres of gravity of the areas APB, Apb, and $BPpb$; put the area $APB=s$, the area $Apb=s'$, and let X, Y, X′, Y′ denote as before, Then, reasoning exactly as in last case, we have (by § 166.), Fig. 37.

$$sX+(s'-s)\times GK=s'X'.$$

$$sY+(s'-s)\times GH=s'Y'$$

hence

Inverſe Method.

hence

$$\frac{s'X'-sX}{s'-s}=GK,\quad \frac{s'Y'-sY}{s'-s}=GH;$$

and the point p being ſuppoſed to approach to P, ſo that $s'X'-sX$, $s'Y'-sY$, and $s'-s$, the ſimultaneous increments of X, Y and s, may be continually diminiſhed,

$$\frac{\text{flux.}\,(sX)}{\dot{s}}=\text{lim. GK},\quad \frac{\text{flux.}\,(sY)}{\dot{s}}=\text{lim. GH};$$

but as the ordinate pb approaches to PB, it is manifeſt that the ultimate poſition of G the centre of gravity of the area BPpb will be the middle of PB, therefore the limit of GK is x, and the limit of GH is $\frac{1}{2}y$, thus we have

$$\frac{\text{flux.}\,(sX)}{\dot{s}}=x,\quad \frac{\text{flux.}\,(sY)}{\dot{s}}=\tfrac{1}{2}y,$$

and conſequently,

$$X=\frac{\int x\dot{s}}{s},\quad Y=\frac{\int y\dot{s}}{2s},$$

or ſince $\dot{s}=y\dot{x}$, and $s=\int y\dot{x}$ (§ 61.),

$$X=\frac{\int yx\dot{x}}{\int y\dot{x}},\quad Y=\frac{\int y^2\dot{x}}{2\int y\dot{x}}.$$

Fig. 37. 169. Let it next be required to find the centre of gravity of the ſurface of a ſolid generated by the revolution of the curve AP about AB as an axis. Let the ſurface of the ſolid be conceived to receive an increment generated by Pp an arch of the curve. In this caſe it is evident that the centres of gravity of the ſurface generated by the curve AP, the ſurface generated by the curve APp, and the ſurface generated by the arch Pp, will each be in AB, the axis of the ſolid; ſuppoſe them to be at E, E′ and H reſpectively. Put AE$=$X, AE′$=$X′, alſo put s for the ſurface generated by AP, and s' for the ſurface generated by APp, then as before (from § 166.) we have

$$sX+(s'-s)\,AH=s'X',$$

$$\text{hence}\quad \frac{s'X'-sX}{s'-s}=AH,$$

$$\text{and}\quad \frac{\text{flux.}\,(sX)}{\dot{s}}=\text{lim. AH}.$$

but the point p approaching to P, the limit of AH is manifeſtly AB or x, therefore

$$\frac{\text{flux.}\,(sX)}{\dot{s}}=x,\ \text{and}\ X=\frac{\int x\dot{s}}{s},$$

or ſince $\dot{s}=2\pi y\dot{z}$ (§ 65.),

$$X=\frac{2\pi\int xy\dot{z}}{2\pi\int y\dot{z}}=\frac{\int xy\dot{z}}{\int y\dot{z}}.$$

170. If inſtead of the centre of gravity of the ſurface generated by AP, the centre of gravity of the ſolid generated by the revolution of the plane figure APB about AB as an axis be required, the reaſoning will be the very ſame as in laſt §, ſubſtituting the ſolid generated by the plane figure inſtead of the ſurface generated by the curve line; ſo that putting s for the content of the ſolid, and X for AE the diſtance of its centre of gravity from the vertex, we have alſo

$$X=\frac{\int x\dot{s}}{s},$$

but in this caſe $\dot{s}=\pi y^2\dot{x}$ (§ 64.), therefore

$$X=\frac{\pi\int y^2x\dot{x}}{\pi\int y^2\dot{x}}=\frac{\int y^2x\dot{x}}{\int y^2\dot{x}}.$$

171. We ſhall now apply theſe formulas to ſome examples.

Example. 1. Let it be required to find the centre of gravity of AP an arch of a circle. Suppoſe AB to be a part of the diameter, and in addition to the notation of § 167. put a for the radius of the circle, then from the nature of the curve, $y^2=2ax-x^2$, hence (proceeding as in § 165. Ex. 1.) we have $\dot{z}=\frac{a\dot{x}}{y}$ and therefore $\dot{z}y=a\dot{x}$, and $\dot{z}x=\frac{ax\dot{x}}{y}$, but from the equation $y^2=2ax-x^2$, by taking the fluxions we get $y\dot{y}=a\dot{x}-x\dot{x}$, and hence $\frac{x\dot{x}}{y}=\frac{a\dot{x}}{y}-\dot{y}=\dot{z}-\dot{y}$, therefore $\dot{z}x=a(\dot{z}-\dot{y})$; ſubſtituting now the values of $\dot{z}x$ and $\dot{z}y$ in the formula of § 167 we have Fig. 37.

$$X=\frac{\int x\dot{z}}{z}=\frac{a}{z}\int(\dot{z}-\dot{y})$$

$$=\frac{a}{z}(z-y+c)$$

$$Y=\frac{\int y\dot{z}}{z}=\frac{a}{z}\int\dot{x}$$

$$=\frac{a}{z}(x+c').$$

To diſcover the values of the conſtant quantities c, c', we have from the equations in which they occur,

$$ac=Xz-az+ay,\quad ac'=Yz-ax;$$

but when $z=0$, then x, y, X and Y are each $=0$, therefore $c=0$, and $c'=0$, thus we have ſimply

$$X=\frac{a(z-y)}{z},\quad Y=\frac{ax}{z}.$$

Inverse Method.

Fig. 37. *Ex.* 2. Let it be required to find the centre of gravity of APB an area bounded by AP an arch of a circle and PB, BA its sine and versed sine. Let a denote the radius, and let the remaining notation be as in § 168. Then, because $\dot{s}=y\dot{x}$ we have $x\dot{s}=yx\dot{x}$, but from the equation $y^2=2ax-x^2$ (which expresses the nature of the curve), we find

$$x\dot{x}=a\dot{x}-y\dot{y}, \text{ therefore}$$

$$x\dot{s}=ay\dot{x}-y^2\dot{y}=a\dot{s}-y^2\dot{y}.$$

We have also $y\dot{s}=y^2\dot{x}=(2ax-x^2)\dot{x}$, therefore,

$$X=\frac{\int x\dot{s}}{s}=\frac{\int(a\dot{s}-y^2\dot{y})}{s}$$

$$=\frac{1}{s}(as-\tfrac{1}{3}y^3+c)$$

$$Y=\frac{\int y\dot{s}}{2s}=\frac{\int(2ax-x^2)\dot{x}}{2s}$$

$$=\frac{1}{2s}(ax^2-\tfrac{1}{3}x^3+c')$$

By proceeding as in the last example we find c and c' each $=0$, thus we have

$$X=a-\frac{y^3}{3s}, \quad Y=\frac{3ax^2-x^3}{6s}.$$

Fig. 37. *Ex.* 3. Suppose now the figure to be the surface generated by the revolution of AP an arch of a circle about the diameter AB, and that the centre of gravity of the generated surface is required. Then because from the nature of the circle $\dot{z}=\dfrac{a\dot{x}}{y}$ we have $y\dot{z}=a\dot{x}$, and $xy\dot{z}=ax\dot{x}$, therefore, substituting these values in the formula of § 169 it becomes

$$X=\frac{\int xy\dot{z}}{\int y\dot{z}}=\frac{\int x\dot{x}}{a\int\dot{x}}$$

$$=\frac{\frac{1}{2}x^2+c}{x+c'}.$$

To find the values of the constant quantities c, c', we have

$$c=X(x+c')-\tfrac{1}{2}x^2,$$

$$c'=\frac{\frac{1}{2}x^2+c}{X}-x,$$

but as when $x=0$, then $X=0$, it is manifest that c and c' are each $=0$, thus we have

$$X=\tfrac{1}{2}x.$$

Fig. 37. *Ex.* 4. Let us now suppose that it is required to find the centre of gravity of the solid generated by the revolution of AP an arch of a circle about the diameter. In this case, because $y^2=2ax-x^2$, we have from § 170,

$$X=\frac{\int y^2x\dot{x}}{\int y^2\dot{x}}=\frac{\int\dot{x}(2ax^2-x^3)}{\int\dot{x}(2ax-x^2)}$$

$$=\frac{\frac{2}{3}ax^3-\frac{1}{4}x^4+c}{ax^2-\frac{1}{3}x^3+c'},$$

and reasoning as in the last example, we find $c=0$, and $c'=0$, and therefore

$$X=\frac{8ax-3x^2}{12a-4x}.$$

If the segment be a hemisphere, in which case $x=a$, then $X=\frac{5}{8}a$.

Sect. III. *Of Fluxional Equations.*

172. It has been shewn, (§ 49.) how, from an equation being given, expressing the relation between x a variable quantity, and y a function of that quantity, we may deduce the equation that expresses the relation of their fluxions. We are now to show how from the latter, or *fluxional equation*, we may return to the equation of the fluents, which, relatively to the other, may be called its *primitive equation*.

173. As any primitive equation and the fluxional equation derived from it both hold true at the same time, and as the constant quantities which enter into the former retain the same values in the latter, it follows that by means of the two equations we may exterminate any one of the constant quantities, and thus from any proposed primitive equation deduce a fluxional equation, in which one of the constant quantities contained in that primitive shall not at all be found.

For example let the primitive equation be $y+ax+b=0$, by taking the fluxions we have $\dot{y}+a\dot{x}=0$, a fluxional equation in which b is not found; if however it be required to find an equation in which a shall be wanting, we have only to eliminate a by applying the common rules of algebra (Algebra, Sect. vii.) to the two equations

$$y+ax+b=0, \quad \dot{y}+a\dot{x}=0,$$

and hence we have $y\dot{x}-x\dot{y}+b\dot{x}=0$, thus it appears that from the primitive equation $y+ax+b=0$ we may deduce a fluxional equation which may be expressed under either of these forms

$$\dot{y}+a\dot{x}=0, \quad y\dot{x}-x\dot{y}+b\dot{x}=0;$$

these hold true at the same time as the primitive equation, they are alike related to it, and any two of the three being given the other necessarily follows from them.

As a second example, suppose the primitive equation to be $x^2-2ay-a^2-b=0$, by passing to the fluxions we immediately find $x\dot{x}-a\dot{y}=0$ an equation in which b is not found. If, however, it be required that the fluxional equation shall want a, we have only to apply the common rules of elimination to the two equations; thus from the second we get $a=\dfrac{x\dot{x}}{\dot{y}}$, and this being substituted in the first it becomes

x^2,

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$$x^2 - \frac{2xy\dot{x}}{\dot{y}} - \frac{x^2\dot{x}^2}{\dot{y}^2} - b = 0$$

from which we have

$$(x^2-b)\dot{y}^2 - 2xy\dot{y}\dot{x} - x^2\dot{x}^2 = 0$$

and taking the square root, having previously reduced the equation to a proper form,

$$\dot{y}\sqrt{(x^2+y^2-b)} - y\dot{y} - x\dot{x} = 0.$$

174. It is evident that by proceeding in this manner we shall, in some cases, arrive at a fluxional equation involving the second and higher powers of $\frac{\dot{y}}{\dot{x}}$, and when this happens we can only find the value of $\frac{\dot{y}}{\dot{x}}$ by the resolution of an equation; but this may be avoided by preparing the primitive equation in such a manner, that the constant quantity to be eliminated may be entirely separated from the variable quantities, so as to form one of the terms of the equation, then, upon taking the fluxions, this term being constant will vanish, and thus we shall obtain an equation entirely free from the constant quantity contained in that term. Thus the primitive equation $y+ax+b=0$ has already such a form that by taking the fluxions we get $\dot{y}+a\dot{x}=0$ an equation in which b is not found. If it be required, that upon taking the fluxions, a shall vanish; we must put the equation under this form $\frac{y+b}{x}+a=0$, and then taking the fluxion, we find immediately

$$\frac{x\dot{y}-(y+b)\dot{x}}{x^2}=0,$$

an expression in which a is not found, and which by rejecting the divisor x^2 becomes $y\dot{x}-x\dot{y}+b\dot{x}=0$, and these two forms of the fluxional equation are the very same as have been found in the last §. In the second example, viz. $x^2-2ay-a^2-b=0$, the equation has already the form suited to the elimination of b, for the fluxional equation is $x\dot{x}-a\dot{y}=0$, but in order that a may vanish, we must resolve the equation with respect to a, so as to give it this form

$$y-\sqrt{(x^2+y^2-b)}+a=0;$$

passing now to the fluxional equation, a disappears, and we have

$$\frac{\dot{y}\sqrt{(x^2+y^2-b)}-y\dot{y}-x\dot{x}}{\sqrt{(x^2+y^2-b)}}=0$$

It is evident that we have only to reject the denominator to give the equation this form

$$\dot{y}\sqrt{(x^2+y^2-b)}-y\dot{y}-x\dot{x}=0$$

the same as was found in the conclusion of last §.

175. From what has been now shewn we may infer that as from any proposed primitive equation we can deduce a fluxional equation that shall contain one constant quantity less than the primitive contains, so on the contrary any fluxional equation being given, its primitive equation may contain one constant quantity more than the fluxional equation, but it can contain only one, for no more than one constant quantity can be made to disappear by returning from the primitive to its fluxional equation.

176. The fluxional equation expressing the value of $\frac{\dot{y}}{\dot{x}}$, which is derived from any primitive equation involving x, and y a function of x, may be called a fluxional equation of the *first order*; and as from this equation considered as a primitive, we may in like manner derive an equation that shall involve $\frac{\ddot{y}}{\dot{x}^2}$ (§ 50.), this last may be called a fluxional equation of the *second order*, and the fluxional equation from which it is derived may be called its primitive equation of the *first order*, to distinguish it from the absolute primitive equation, from which all the others are conceived to be derived. A similar mode of definition is to be applied to the higher orders.

177. As any primitive equation and the fluxional equations of the first and second orders derived from it must all hold true at the same time, it is evident, that by means of the three equations, we may exterminate any two of the constant quantities contained in them that we please, and thus produce a fluxional equation of the second order that contains two constant quantities less than the primitive equation. There are however two other ways by which we may arrive at the very same fluxional equation of the second order. For as from the given primitive equation we may deduce two different fluxional equations of the first order, one of which shall contain one only of the two quantities to be eliminated, and the other shall contain the other quantity only, we may consider each of these equations in its turn as a primitive, and, by proceeding in the manner explained in § 173 and § 174, derive from it a fluxional equation, in which that particular constant quantity which remained in its primitive, but which was to be finally eliminated, shall not be found; thus, from each of these primitives we shall deduce the very same fluxional equation of the second order, that shall be freed from two of the constant quantities contained in the absolute primitive equation.

Let us take for example the equation

$$x^2-2ay+b^2=0;$$

by proceeding as explained in § 173, or § 174, we find these two fluxional equations of the first order,

$$x\dot{x}-a\dot{y}=0, \quad (x^2+b^2)\dot{y}-2xy\dot{x}=0,$$

in the one of these, the constant quantity a is wanting, and in the other b is wanting. Taking the first equation $x\dot{x}-a\dot{y}=0$, and proceeding as in § 50 (observing that $\dot{x}$ is constant) we find $\dot{x}^2-a\ddot{y}=0$, if from this equation we now eliminate a by putting instead of it $\frac{x\dot{x}}{\dot{y}}$ (deduced from the equation $x\dot{x}-a\dot{y}=0$) we find after proper reduction

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$$\ddot{y}x - \dot{x}\dot{y} = 0,$$

a fluxional equation of the second order, in which both a and b are wanting, and having $x^2 - 2ay + b^2$ for its absolute primitive equation.

Let us now take the other fluxional equation of the first order which involves b, viz. $(x^2+b^2)\dot{y} - 2xy\dot{x} = 0$; by proceeding with this as with the former we find $(x^2+b^2)\ddot{y} - 2y\dot{x}^2 = 0$; from the first of these equations we find $x^2+b^2 = \frac{2xy\dot{x}}{\dot{y}}$, and from the second $x^2+b^2 = \frac{2y\dot{x}^2}{\ddot{y}}$; therefore, $\frac{2xy\dot{x}}{\dot{y}} = \frac{2y\dot{x}^2}{\ddot{y}}$, and hence we have

$$\ddot{y}x - \dot{x}\dot{y} = 0$$

the same equation as before; and as we have arrived at the very same conclusion by considering each of these equations

$$x\dot{x} - a\dot{y} = 0, \quad (x^2+b^2)\dot{y} - 2xy\dot{x} = 0$$

as a primitive, it follows that both these are to be considered as primitive equations of the first order of the fluxional equation $\ddot{y}x - \dot{x}\dot{y}$.

178. In general, every fluxional equation of the second order has two primitive equations of the first order, and all three may be considered as originating from one and the same absolute primitive equation; and as a fluxional equation of the second order may contain two constant quantities less than its absolute primitive equation, and one less than either of its primitive equations of the first order; so, on the contrary, a primitive equation of the first order may contain one constant quantity more than the fluxional equation of the second order derived from it, and the absolute primitive may contain two constant quantities which are not found in the fluxional equation of the second order derived from it; and similar conclusions may be drawn relating to fluxional equations of the third or any higher order.

Of Fluxional Equations of the first order.

179. When it is required to find the primitive equation corresponding to a proposed fluxional equation of the first order, we may endeavour to separate the variable quantities, that is, to bring the equation to such a form, that it may be composed of two parts, one of which consists of $\dot{x}$ multiplied or divided by a function of x only, and the other of $\dot{y}$ multiplied or divided by a function of y only. When this separation of the variable quantities can be effected, we have only to take the fluents according to the methods explained in Sect. I. and put their sum $=0$, and we immediately have the primitive equation required.

Ex. Suppose the fluxional equation to be

$$my\dot{x} + nx\dot{y} = 0$$

divide the terms of the equation by xy, and it becomes

$$\frac{m\dot{x}}{x} + \frac{n\dot{y}}{y} = 0.$$

Now the fluent of $\frac{m\dot{x}}{x}$ is $m\,\mathrm{l}.\,x + c'$ (§ 103.) and in like manner the fluent of $\frac{n\dot{y}}{y}$ is $n\,\mathrm{l}.\,y + c''$, therefore

$$m\,\mathrm{l}.\,x + n\,\mathrm{l}.\,y + c' + c'' = 0,$$

or, transposing $c+c''$, and putting a single constant quantity for their sum, which, to be homogeneous with the logarithmic quantities may be $-\log.c$, or $-\mathrm{l}.\,c$,

$$m\,\mathrm{l}.\,x + n\,\mathrm{l}.\,y = \mathrm{l}.\,c, \text{ or } \mathrm{l}.\,(x^m) + \mathrm{l}.\,(y^n) = \mathrm{l}.\,c,$$

$$\text{or } \mathrm{l}.\,(x^m y^n) = \mathrm{l}.\,c, \text{ and hence } x^m y^n = c,$$

which last is the primitive equation required.

180. When a primitive equation is *homogeneous*, that is when the sum of the exponents of the variable quantities x and y is the same in each term, as in this example,

$$ax\dot{x} + by\dot{x} + dx\dot{y} + ey\dot{y} = 0$$

$$\text{or } (ax+by)\dot{x} + (dx+ey)\dot{y} = 0$$

in which the variable part of each term is of the first degree, as also in this equation

$$\left.\begin{array}{l}(ax^2+bxy+dy^2)\dot{x}\\ +(ex^2+fxy+gy^2)\dot{y}\end{array}\right\} = 0$$

in which the variable part of each term is of the second degree, such an equation may be always transformed into another which will admit of the variable quantities being separated. To take a particular example, let us suppose the equation to be $x\dot{x} + y\dot{y} = ny\dot{x}$, or $(x-ny)\dot{x} + y\dot{y} = 0$. We assume $y = xz$ (and the same assumption is to be made for any other homogeneous equation,) then $\dot{y} = z\dot{x} + x\dot{z}$, thus the equation becomes transformed to

$$(x - nxz)\dot{x} + xz(z\dot{x} + x\dot{z}) = 0,$$

but as the terms of this equation have a common factor x, by leaving out that factor, it becomes

$$(1-nz)\dot{x} + z(z\dot{x} + x\dot{z}) = 0$$

which also admits of being expressed thus

$$(1 - nz + z^2)\dot{x} + xz\dot{z} = 0,$$

and, by division

$$\frac{\dot{x}}{x} + \frac{z\dot{z}}{1 - nz + z^2} = 0,$$

and taking the fluents

$$\int\frac{\dot{x}}{x} + \int\frac{z\dot{z}}{1-nz+z^2} = \mathrm{C},$$

where C denotes a constant quantity, or, since $\int\frac{\dot{x}}{x} = \mathrm{l}.\,x$,

$$\mathrm{l}.\,x + \int\frac{z\dot{z}}{1-nz+z^2} = \mathrm{C},$$

 now

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now the particular form of $\int \frac{z\dot{z}}{1-nz+z^2}$ depends upon the value of the number n; for if $\frac{n}{2} > 1$, it will be a logarithmic function, and if $\frac{n}{2} < 1$, it will be expressible by means of a circle, but if $\frac{n}{2} = 1$, then it is an algebraic function, and in each case it may be found by the methods delivered in SECT. I. for finding the fluent of a rational fraction. It may however, be simplified in its form, by observing, that since

$$\frac{z\dot{z}}{1-nz+z^2} = \tfrac{1}{2}\,\frac{2z\dot{z}-n\dot{z}}{1-nz+z^2} + \tfrac{1}{2}\,\frac{n\dot{z}}{1-nz+z^2},$$

therefore (§ 103.) $\int \frac{z\dot{z}}{1-nz+z^2} =$

$$\tfrac{1}{2}\,\mathrm{l.}\,(1-nz+z^2) + \tfrac{1}{2}\int \frac{n\dot{z}}{1-nz+z^2}.$$

If we limit our enquiry to the case of $n=2$, we have

$$\int \frac{n\dot{z}}{1-nz+z^2} = \int \frac{2\dot{z}}{(1-z)^2} = \frac{2}{1-z},$$

let the terms be now collected into one expression, then observing that $\frac{1}{2}\,\mathrm{l.}\,(1-2z+z^2) = \frac{1}{2}\,\mathrm{l.}\,(1-z)^2 = \mathrm{l.}\,(1-z)$, we have

$$\mathrm{l.}\,x + \mathrm{l.}\,(1-z) + \frac{1}{1-z} = C;$$

and, substituting $\frac{y}{x}$ instead of z,

$$\mathrm{l.}\,x + \mathrm{l.}\left(\frac{x-y}{x}\right) + \frac{x}{x-y} = C,$$

or, substituting l. c instead of C, and collecting the logarithmic functions into one,

$$\mathrm{l.}\,\frac{x-y}{c} = \frac{-x}{x-y}$$

therefore, passing from logarithms to numbers, by observing that, as when $a = \mathrm{l.}\,p$, we have by the nature of logarithms $e^a = p$, where e denotes the number of which the Napierean logarithm is 1, so in the present case we have $\frac{x-y}{c} = e^{-\frac{x}{x-y}}$, and hence the primitive equation is found to be

$$x - y - c\,e^{-\frac{x}{x-y}} = 0.$$

As a second example let the fluxional equation be

$$x\dot{y} - y\dot{x} = \dot{x}\sqrt{(x^2+y^2)}$$

which is also homogeneous. Assume as before $y = xz$, then $\dot{y} = x\dot{z} + z\dot{x}$, and substituting these values of y and $\dot{y}$ in the proposed equation, it becomes

$$\dot{x}\sqrt{(1+z^2)} - x\dot{z} = 0,$$

from which we get

$$\frac{\dot{x}}{x} - \frac{\dot{z}}{\sqrt{(1+z^2)}} = 0,$$

and taking the fluents of the terms, observing that each being a logarithm function, their sum may be put equal to a constant logarithm,

$$\mathrm{l.}\,x - \mathrm{l.}\left\{z + \sqrt{(1+z^2)}\right\} = \mathrm{l.}\,c,$$

which expression, by substituting for z its value $\frac{y}{x}$, becomes

$$\mathrm{l.}\,x = \mathrm{l.}\,c + \mathrm{l.}\left\{\frac{y+\sqrt{(x^2+y^2)}}{x}\right\}.$$

If we now consider that

$$(y+\sqrt{x^2+y^2})(y-\sqrt{x^2+y^2}) = -x^2,$$

and therefore that

$$\frac{y+\sqrt{(x^2+y^2)}}{x} = \frac{-x}{y-\sqrt{(x^2+y^2)}},$$

it will appear, that the above equation may be otherwise expressed thus:

$$\mathrm{l.}\,x = \mathrm{l.}\,c + \mathrm{l.}\left\{\frac{-x}{y-\sqrt{(x^2+y^2)}}\right\},$$

from which, by passing from logarithms to their numbers, we find $y-\sqrt{(x^2+y^2)} = -c$, and hence, by so ordering the equation that the radical may disappear, we get $x^2 = c^2 + 2cy$, which is the primitive equation required.

181. An equation which is not homogeneous, may in some cases, by proper transformations, be rendered homogeneous; this is the case in particular with the equation

$$(a+mx+ny)\,\dot{x} + (b+px+qy)\,\dot{y} = 0,$$

which is general of its kind; for this purpose we assume $x = t+\alpha$, and $y = u+\beta$, then $\dot{x} = \dot{t}$, and $\dot{y} = \dot{u}$; by substituting these values of x, y, $\dot{x}$, $\dot{y}$, in the proposed equation it becomes

$$\left.\begin{array}{l}(a+m\alpha+n\beta+mt+nu)\,\dot{t}\\ +\,(b+p\alpha+q\beta+pt+qu)\,\dot{u}\end{array}\right\} = 0.$$

Let us now suppose α and β such that

$$a+m\alpha+n\beta = 0,$$

$$b+p\alpha+q\beta = 0,$$

by these two equations the values of α and β are determined, and the transformed equation is reduced to

$$(mt+nu)\,\dot{t} + (pt+qu)\,\dot{u} = 0,$$

an equation which is homogeneous, and therefore may be treated in the manner explained in last §.

This transformation will not apply however, when $mq - np = 0$, because then the values of α and β would be infinite.

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infinite. In this case we have $q=\frac{np}{m}$, and therefore $p x+q y=\frac{p}{m}(m x+n y)$, hence the original equation may be expressed thus,

$$\left.\begin{array}{c} a\dot{x}+b\dot{y} \\ +(m x+n y)(\dot{x}+\frac{p}{m}\dot{y}) \end{array}\right\}=0.$$

assume now $m x+n y=z$, then $\dot{y}=\frac{\dot{z}}{n}-\frac{m}{n}\dot{x}$; the values of $m x+n y$ and $\dot{y}$ being now substituted in the equation, and the whole reduced to a proper form, it becomes

$$\dot{x}+\frac{(b m+p z)\dot{z}}{a m n-b m^2+(m n-p m) z}=0,$$

The fluent of the second term of this expression will involve logarithms, except that $m n-p m=0$, in which case the primitive equation is

$$x+\frac{2 b m z+p z^2}{2(a m n-b m^2)}=\mathrm{C}.$$

182. When a fluxional equation has this form

$$\dot{y}+\mathrm{P} y \dot{x}=\mathrm{Q}\dot{x},$$

where P and Q denote any functions of x, the variable quantities may be separated in the following manner. Assume $y=\mathrm{X} z$, then, taking the fluxions, we have $\dot{y}=z\dot{\mathrm{X}}+\mathrm{X}\dot{z}$, and by substitution, the proposed equation becomes

$$z\dot{\mathrm{X}}+\mathrm{X}\dot{z}+\mathrm{PX} z\dot{x}=\mathrm{Q}\dot{x};$$

now as in this equation X and z may be supposed to denote indeterminate functions of x, we may divide it into two others, such, that the variable quantities in each may be separable; to effect this we assume

$$\mathrm{X}\dot{z}+\mathrm{PX} z\dot{x}=0, \quad z\dot{\mathrm{X}}=\mathrm{Q}\dot{x};$$

hence, dividing the first equation by X, we have $\dot{z}+\mathrm{P} z\dot{x}=0$, and $\frac{\dot{z}}{z}+\mathrm{P}\dot{x}=0$, and taking the fluents, $\mathrm{l}.\, z+\int \mathrm{P}\dot{x}=0$, and hence, by passing from logarithms to their numbers,

$$z=e^{-\int \mathrm{P}\dot{x}};$$

here no constant quantity is introduced, it being sufficient to add it at the end of the operation; let this value of z be substituted in the second equation, then by deducing from it the value of X we have

$$\dot{\mathrm{X}}=e^{\int \mathrm{P}\dot{x}}\mathrm{Q}\dot{x}$$

$$\text{and}\quad \mathrm{X}=\int e^{\int \mathrm{P}\dot{x}}\mathrm{Q}\dot{x}+c$$

and since $y=\mathrm{X} z$, therefore

$$y=e^{-\int \mathrm{P}\dot{x}}\left\{\int e^{\int \mathrm{P}\dot{x}}\mathrm{Q}\dot{x}+c\right\}.$$

Let us take a particular case, and suppose the equation to be $\dot{y}+y\dot{x}=x^n\dot{x}$, then we have $\mathrm{P}=1$, $\mathrm{Q}=x^n$, and $\int \mathrm{P}\dot{x}=x$, hence in this case the general formula becomes

$$y=e^{-x}\left\{\int e^x x^n\dot{x}+c\right\}.$$

The fluent $\int e^x x^n\dot{x}$ may be found by § 143; let us suppose for example that $n=2$, then we have

$$\int e^x x^2\dot{x}=e^x(x^2-2x+2),$$

so that the fluxional eqnation being

$$\dot{y}+y\dot{x}=x^2\dot{x},$$

the primitive equation is

$$y=x^2-2x+2+c e^{-x}.$$

The general equation $\dot{y}+\mathrm{P} y\dot{x}=\mathrm{Q}\dot{x}$, which involves the simple power only of the variable quantity y, and its fluxion, has been called a *linear equation* of the first order; it has also, with more propriety, been called a fluxional equation of the *first degree*, and of the first order.

183. The equation

$$\dot{y}+\mathrm{P} y\dot{x}=\mathrm{Q} y^n\dot{x},$$

where P and Q as before denote any functions of x, is easily reduced to the form we have been considering; for assume $y^{1-n}=(1-n) z$, then $y^{-n}\dot{y}=\dot{z}$, and $\dot{y}=\dot{z} y^n$, and $y=(1-n) z y^n$; if we now substitute the values of $\dot{y}$ and y in the equation, it becomes

$$y^n\dot{z}+(1-n)\mathrm{P} z y^n\dot{x}=\mathrm{Q} y^n\dot{x};$$

let the terms of this equation be divided by y^n, then, including the factor $(1-n)$ in the indeterminate function P, the result is

$$\dot{z}+\mathrm{P} z\dot{x}=\mathrm{Q}\dot{x}$$

an equation of the very same form as that which has been considered in last §.

184. The most general form that can be given to a fluxional equation of the first order, and consisting of three terms only, is

$$\gamma u^i z^k\dot{z}+\beta u^g z^h\dot{u}=\alpha u^e z^f\dot{u};$$

to give this equation a more simple form let all its terms be divided by $\gamma u^i z^f$, it then becomes

$$z^{k-f}\dot{z}+\frac{\beta}{\gamma}u^{g-i}z^{h-f}\dot{u}=\frac{\alpha}{\gamma}u^{e-i}\dot{u}.$$

Suppose now

$$z^{k-f}\dot{z}=\frac{\dot{y}}{k-f+1}, \quad u^{g-i}\dot{u}=\frac{\dot{x}}{g-i+1},$$

then $z^{k-f+1}=y$, $u^{g-i+1}=x$,

and

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and $\dot{y}+\frac{(k-f+1)\beta}{(g-i+1)\gamma}y^{\frac{h-f}{k-f+1}}\dot{x}$

$$=\frac{(k-f+1)\alpha}{(g-i+1)\gamma}x^{\frac{e-g}{g-i+1}}\dot{x};$$

Let us in order to abridge put

$$\frac{(k-f+1)\beta}{(g-i+1)\gamma}=b,\ \frac{(k-f+1)\alpha}{(g-i+1)\gamma}=a,$$

$$\frac{h-f}{k-f+1}=n,\ \frac{e-g}{g-i+1}=m,$$

then the equation becomes

$$\dot{y}+by^n\dot{x}=ax^m\dot{x}.$$

If we suppose $n=1$, the resulting equation $\dot{y}+by\dot{x}=ax^m\dot{x}$ may have its variable quantities separated by the method explained in § 183; but if we go only one step farther, and suppose $n=2$ so that the equation is

$$\dot{y}+by^2\dot{x}=ax^m\dot{x},$$

the difficulty of separating the variable quantities *generally* is so great as to have hitherto baffled the utmost efforts of the most expert analysts. This equation is commonly called RICCATI's *equation*, on account of its having been first treated of by an Italian mathematician of that name, who succeeded in separating the variable quantities in some particular cases, namely, when m is equal to $\frac{-4p}{2p\pm1}$, where p denotes any whole positive number.

185. If the separating of the variable quantities generally be a problem of insurmountable difficulty when the equation consists of only three terms, its solution can much less be expected, when the equation consists of four, or any greater number. There are, however, particular cases in which some of the most skilful analysts have, by employing happy and peculiar artifices, succeeded in resolving the problem, but the methods of proceeding are, generally speaking, not reducible to any determinate rules.

186. When the expression which constitutes a fluxional equation is such as would be produced by taking the fluxion of some function of x and y, in which case it may be said to be a complete fluxion, then, without attempting to separate the variable quantities, we have only to add a constant quantity to that function, and the result put $=0$, will evidently be the primitive equation required.

If, for example, the equation be $x\dot{y}+y\dot{x}=0$, it is obvious that the expression $x\dot{y}+y\dot{x}$ is immediately produced by taking the fluxion of the function xy (y being also considered as a function of x), therefore the primitive equation is $xy+c=0$.

From the view which has been given in § 174. of the origin of fluxional equations it appears, that in passing from a primitive equation to its fluxional equation, the terms of the latter in many cases will not constitute a complete fluxion, by reason of some multiplier, or divisor, which was common to them all, having disappeared. In such cases, however, if we can by any means discover that factor, by restoring it we shall immediately have a complete fluxion, the fluent of which, with the addition of a constant quantity, when put $=0$, will be the primitive equation.

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For example, if the equation be $x\dot{y}-y\dot{x}=0$, here $x\dot{y}-y\dot{x}$ cannot be immediately produced by taking the fluxion of a function of x and y; but, if we divide the equation by x^2 so as to give it this form $\frac{x\dot{y}-y\dot{x}}{x^2}=0$, we obtain the expression $\frac{x\dot{y}-y\dot{x}}{x^2}$ which is a complete fluxion, viz. that of the fraction $\frac{y}{x}$, therefore $\frac{y}{x}+c=0$, or $y+cx=0$, is the primitive equation.

In like manner, the equation $mx\dot{y}+ny\dot{x}=0$, which does not in its present form express a complete fluxion, yet becomes so when multiplied by $x^{n-1}\ y^{m-1}$, for then it is

$$mx^ny^{m-1}\dot{y}+nx^{n-1}\ y^m\dot{x}=0$$

from which it appears that the primitive equation in this case must be $x^ny^m+c=0$.

187. That we may be able to discover whether the terms of any proposed fluxional equation constitute a complete fluxion, and also from what expression such a fluxion has been derived, we must attend to the process, by which we find the fluxion of an expression composed of two variable quantities, one of which is a function of the other.

To avoid very general reasoning, we shall take for granted what is evidently possible, that any function of x and y may be generally expressed by a formula of this nature.

$$Ax^my^n+Bx^py^q+Cx^ry^s+\ \&c.$$

where A, B, C, &c. denote constant quantities, and the exponents m, n, &c. given numbers, the number of terms being supposed either finite or infinite. Now the fluxion of the whole expression is the sum of the fluxions of its terms, but in taking the fluxion of each term, beginning with the first Ax^my^n, the fluxion of which is

$$mAx^{m-1}\ y^n\dot{x}+nAx^my^{n-1}\dot{y},$$

it is evident that the result is composed of two parts, one of which is the expression we would find for its fluxion, if x only were considered as variable, and y as constant, and the other is the expression for its fluxion, if y only were considered as variable and x as constant; hence it follows, that the sum of the fluxions of all the terms will have the very same property; so that, if u be put for the whole expression, we shall in every case have

$$\dot{u}=M\dot{x}+N\dot{y}$$

where $M\dot{x}$ denotes the result that will be found if the fluxion of u be taken upon the hypothesis that x alone, is is variable, and $N\dot{y}$ is the fluxion of u, supposing y alone to be variable.

188. Resuming the consideration of the general expression

$$Ax^m y^n + Bx^p y^q + Cx^r y^s + \&c.$$

let the fluxion of every one of its terms, for example, $Ax^m y^n$, be taken, supposing x alone variable, and the result is $mAx^{m-1}y^n\dot{x}$. Again, let the fluxion of this result be taken, supposing y alone variable, and we find it to be $mnAx^{m-1}y^{n-1}\dot{x}\dot{y}$. Now, if we first take the fluxion of $Ax^m y^n$, supposing y variable, we get $nAx^m y^{n-1}\dot{y}$, and then, the fluxion of this result, considering x alone as variable, we get $mnAx^{m-1}y^{n-1}\dot{x}\dot{y}$, which is the very same expression as was found by proceeding in a contrary order; and as the same must hold true of all the terms, we may conclude, that if the fluxion of u any function of x and y be taken, considering x only as variable, and then the fluxion of that result, considering y only as variable, the very same final result will be obtained as if we were first to take the fluxion of u supposing y variable, and then the fluxion of that result, supposing x variable; but the fluxion of u being expressed thus, $M\dot{x}+N\dot{y}$, it has been shewn that $M\dot{x}$ is the fluxion of u, if x only be supposed variable, and $N\dot{y}$ is its fluxion, if y only be variable, therefore, if we take the fluxion of $M\dot{x}$ upon the supposition that y only is variable, also the fluxion of $N\dot{y}$ upon the supposition that x only is variable, the results must be identical. This property affords the following rule, by which we may always determine whether any proposed expression constitutes an exact fluxion or not. *Let the expression be put under this form* $M\dot{x}+N\dot{y}$; *let* $M'\dot{y}$ *be the fluxion of* M, *supposing* y *alone variable, and* $N'\dot{x}$ *the fluxion of* N *supposing* x *alone variable, then, if* M' *and* N' *are identical,* $M\dot{x}+N\dot{y}$ *is a complete fluxion; and if they are not,* $M\dot{x}+N\dot{y}$ *is not a complete fluxion.*

189. It is easy to see, how, from a complete fluxion $\dot{u}=M\dot{x}+N\dot{y}$ we may determine u its fluent; for as $M\dot{x}$ has been deduced from u by considering x as variable, and y as constant, on which account all the terms of u that involved y only must have vanished, it follows on the contrary, that if we put Y to denote those terms, we shall have

$$u=\int M\dot{x}+Y$$

the fluent of $M\dot{x}$ being taken, regarding x only as variable. The function Y may be determined, by comparing the fluxion of the expression thus obtained with the given fluxion $M\dot{x}+N\dot{y}$.

Ex. 1. Let the fluxion be $\dfrac{a\dot{y}+2x\dot{x}+y\dot{x}+x\dot{y}}{2\sqrt{(ay+x^2+xy)}}$, this expression when reduced to the form $\dot{u}=M\dot{x}+N\dot{y}$ is

$$\dot{u}=\frac{(2x+y)\dot{x}}{2\sqrt{(ay+x^2+xy)}}+\frac{(a+x)\dot{y}}{2\sqrt{(ay+x^2+xy)}}$$

hence $M=\dfrac{2x+y}{2\sqrt{(ay+x^2+xy)}}$, $N=\dfrac{a+x}{2\sqrt{(ay+x^2+xy)}}$, the fluxion of M, supposing y only variable, gives us

$$\dot{M}=M'\dot{y}=\frac{(ay+xy-2ax)\dot{y}}{4(ay+x^2+xy)^{\frac{3}{2}}},$$

and in like manner the fluxion of N, supposing x only variable, gives

$$\dot{N}=N'\dot{x}=\frac{(ay+xy-2ax)\dot{x}}{4(ay+x^2+xy)^{\frac{3}{2}}},$$

hence it appears that $M'=N'$, and therefore that the proposed expression is an exact fluxion. To determine its fluent, the formula $u=\int M\dot{x}+Y$ gives us

$$u=\sqrt{(ay+x^2+xy)}+Y$$

the fluxion of this expression taken, upon the supposition that both x and y are variable, is

$$\dot{u}=\frac{a\dot{y}+2x\dot{x}+y\dot{x}+x\dot{y}}{2\sqrt{(ay+x^2+xy)}}+\dot{Y}$$

this result, compared with the original fluxion, shews that $\dot{Y}=0$, and $Y=c$, a constant quantity.

Ex. 2. Suppose the fluxion to be

$$\dot{x}\sqrt{(a^2+y^2)}+\dot{y}\frac{(a^2+xy+2y^2)}{\sqrt{(a^2+y^2)}}$$

Here $M=\sqrt{(a^2+y^2)}$, $N=\dfrac{a^2+xy+2y^2}{\sqrt{(a^2+y^2)}}$, and by proceeding, as in last example, we shall find $M'=N'=\dfrac{y}{\sqrt{(a^2+y^2)}}$, hence it follows that the expression is a complete fluxion, and the formula $u=\int M\dot{x}+Y$ shews that $u=\int\dot{x}\sqrt{(a^2+y^2)}+Y$

$$=x\sqrt{(a^2+y^2)}+Y.$$

To determine Y, we take the fluxion of this expression, supposing x and y both variable, and find it to be

$$\dot{u}=\dot{x}\sqrt{(a^2+y^2)}+\frac{xy\dot{y}}{\sqrt{(a^2+y^2)}}+\dot{Y},$$

and this compared with the original fluxion

$$\dot{u}=\dot{x}\sqrt{(a^2+y^2)}+\frac{(a^2+xy+2y^2)\dot{y}}{\sqrt{(a^2+y^2)}},$$

shews that $\dot{Y}=\dfrac{(a^2+2y^2)\dot{y}}{\sqrt{(a^2+y^2)}}$, hence

$$Y=\int\frac{(a^2+2y^2)\dot{y}}{\sqrt{(a^2+y^2)}}=y\sqrt{(a^2+y^2)}$$

therefore the fluent required is

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$$u=x\sqrt{(a^2+y^2)}+y\sqrt{(a^2+y^2)}+C$$
$$=(x+y)\sqrt{(a^2+y^2)}+C,$$

where C denotes a constant quantity.

190. It may be demonstrated, that as often as a fluxional equation does not constitute a complete fluxion, there is always an infinite number of factors, such, that if the equation were multiplied by any one of them, the result would be a complete fluxion. A general method of determining some one of these factors, however, seems to be a problem of such difficulty, that its solution, except in some particular cases, is not to be expected.

191. When a fluxional equation involves the second or higher powers of $\dot{x}$ and $\dot{y}$, as in this example

$$\dot{y}^2-a^2\dot{x}^2=0,$$

which may be put under this form,

$$\frac{\dot{y}^2}{\dot{x}^2}-a^2=0,$$

we may, by the theory of algebraic equations, deduce from it the values of $\frac{\dot{y}}{\dot{x}}$, considering this quantity as a root of the equation; thus, in the present example, by resolving the quadratic equation $\frac{\dot{y}^2}{\dot{x}^2}-a^2=0$, we have $\frac{\dot{y}}{\dot{x}}=\pm a$, so that $\dot{y}-a\dot{x}=0$, and $\dot{y}+a\dot{x}=0$, hence

$$y-ax+c=0, \quad y+ax+c'=0,$$

are two primitive equations, from either of which the fluxional equation $\dot{y}^2-a^2\dot{x}^2=0$ may be derived, and it may also be deduced from their product

$$(y-ax+c)(y+ax+c')=0.$$

192. As often as the equation contains only one of the two variable quantities, for example x, by the resolution of the equation we may obtain $\frac{\dot{y}}{\dot{x}}=X$ (where X denotes some function of x), and hence $y=\int X\dot{x}$, but if it be more easy to resolve the equation with respect to x than to $\frac{\dot{y}}{\dot{x}}$ which we shall denote by p, then, instead of seeking the values of p from the equation, we may find that of x, thus we shall have $x=P$, some function of p, and hence $\dot{x}=\dot{P}$, and since $\dot{y}=p\dot{x}$, therefore, $\dot{y}=p\dot{P}$, and $y=\int p\dot{P}=Pp-\int P\dot{p}$. The relation between x and y is now to be found by eliminating p by means of the two equations

$$x=P, \quad y=Pp-\int P\dot{p}.$$

As a particular example, let us suppose the equation to be $x\dot{x}+a\dot{y}=b\sqrt{(\dot{x}^2+\dot{y}^2)}$, from which, by putting $\frac{\dot{y}}{\dot{x}}=p$ we find

$$x=b\sqrt{(1+p^2)}-ap=P,$$

$$y=bp\sqrt{(1+p^2)}-\tfrac{1}{2}ap^2-b\int\dot{p}\sqrt{(1+p^2)}$$

the fluent of $\dot{p}\sqrt{(1+p^2)}$ may be found by the formulas given in § 130 and § 131.

193. When we cannot by any means find an expression for the relation between x and y in finite terms, then we must, as a last resource, have recourse to approximation, that is, we must express the value of y in terms of x by means of a series.

When the form of the series is known, we may determine the coefficients of its terms, by substituting the series and its fluxion instead of y and $\dot{y}$ in the proposed equation.

Suppose, for example, that the equation is

$$\dot{y}+y\dot{x}-mx^n\dot{x}=0$$

we may assume

$$y=Ax^\alpha+Bx^{\alpha+1}+Cx^{\alpha+2}+\&c.$$

then $\dot{y}=\alpha Ax^{\alpha-1}\dot{x}+(\alpha+1)Bx^\alpha\dot{x}$

$$+(\alpha+2)Cx^{\alpha+1}\dot{x}+\&c.$$

Substituting now the values of y and $\dot{y}$ in the equation, and dividing the whole by $\dot{x}$, it becomes

$$\left.\begin{matrix}\alpha Ax^{\alpha-1}+(\alpha+1)B\\ -mx^n+\qquad A\end{matrix}\right\}x^\alpha+\left.\begin{matrix}(\alpha+2)C\\ +\qquad B\end{matrix}\right\}x^{\alpha+1}$$
$$+\left.\begin{matrix}(\alpha+3)D\\ +\qquad C\end{matrix}\right\}x^{\alpha+2}+\&c.=0.$$

This equation becomes identical, if we assume $\alpha-1=n$, or $\alpha=n+1$, and

$$A=\frac{m}{\alpha},\ B=\frac{-m}{\alpha(\alpha+1)},\ C=\frac{m}{\alpha(\alpha+1)(\alpha+2)},$$

$$D=\frac{-m}{\alpha(\alpha+1)(\alpha+2)(\alpha+3)},\ \&c.$$

Hence we have

$$y=m\left\{\frac{x^{n+1}}{n+1}-\frac{x^{n+2}}{(n+1)(n+2)}\right.$$
$$\left.+\frac{x^{n+3}}{(n+1)(n+2)(n+3)}-\&c.\right\}$$

In order that a primitive equation may be general, it ought to contain an indeterminate constant quantity more than is found in the fluxional equation, therefore, this series which contains no such quantity, must be considered as incomplete, or as exhibiting the value of y upon the supposition, that, when $x=0$, then $y=0$. However, we may obtain a value of y that shall be general,

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neral, by proceeding as follows. Let us suppose we know that when $x=a$, then $y=b$; assume $x=a+t$, and $y=b+u$, then it is manifest, that, if the value of u be found by a series involving t, all the terms of the series ought to vanish when $t=0$. From the assumed values of x and y the equation

$$\dot{y}+y\dot{x}-mx^n\dot{x}=0$$

becomes

$$\dot{u}+(b+u)\dot{t}-m(a+t)\dot{t}^n=0.$$

Assume now

$$u=At^\alpha+Bt^{\alpha+1}+Ct^{\alpha+2}+\&c.$$

then, proceeding as before, we find

$$\left.\begin{array}{l} \alpha At^{\alpha-1}+(\alpha+1)Bt^\alpha+(\alpha+2)Ct^{\alpha+1}+\&c. \\ \quad + \quad At^\alpha + \quad Bt^{\alpha+1}+\&c. \\ +b \\ -ma^n-m\frac{n}{1}a^{n-1}t-m\frac{n(n-1)}{1.2}a^{n-2}t^2-\&c. \end{array}\right\}=0.$$

It is necessary, in this equation, to assume $\alpha-1=0$, or $\alpha=1$, and hence we find

$$A=ma^n-b,\quad B=\frac{mna^{n-1}-ma^n+b}{2},$$

$$C=\frac{mn(n-1)a^{n-2}-mna^{n-1}+ma^n-b}{2.3},$$

&c.

If we now substitute $x-a$, and $y-b$ for t and u respectively, the result will have all the generality that belongs to a primitive equation, expressing the relation between x and y.

Of Fluxional Equations of the second or higher orders.

194. Whatever difficulties occur in finding the primitive equation of a fluxional equation of the first order, it will easily be conceived, that these difficulties must be greater and more numerous when we have to consider fluxional equations of the second and higher orders.

One of the most simple cases of an equation of the second order is this

$$\ddot{y}-X\dot{x}^2=0,\text{ or }\frac{\ddot{y}}{\dot{x}^2}=X,$$

where X denotes a function of x, the variable quantity whose fluxion is supposed to be constant; in this case, because $\frac{\ddot{y}}{\dot{x}}=X\dot{x}$, we have $\frac{\dot{y}}{\dot{x}}=\int X\dot{x}$. Let P denote that function of which $X\dot{x}$ is the fluxion, and c, as usual, an indeterminate constant quantity, then $\frac{\dot{y}}{\dot{x}}=P+c$, and $\dot{y}=P\dot{x}+c\dot{x}$, and taking the fluents a second time

$$y=\int P\dot{x}+cx+c'$$

where c' denotes a second indeterminate constant quantity.

$$\text{As}\int P\dot{x}=Px-\int\dot{P}x=x\int X\dot{x}-\int Xx\dot{x}$$

we have also

$$y=x\int X\dot{x}-\int Xx\dot{x}+cx+c'.$$

Suppose, for example, that the equation is $\ddot{y}-ax\dot{x}^2=0$, so that $\frac{\ddot{y}}{\dot{x}^2}=ax$; here $X=ax$, and therefore

$$y=x\int ax\dot{x}-\int ax^2\dot{x}+cx+c'$$

$$=\tfrac{1}{2}ax^3-\tfrac{1}{3}ax^3+cx+c'$$

$$=\tfrac{1}{6}ax^3+cx+c'.$$

In the very same manner we may deduce from the equation of the third order

$$\dddot{y}-X\dot{x}^3=0,\text{ or }\frac{\dddot{y}}{\dot{x}^3}=X$$

its primitive equation; thus we have

$$\frac{\dddot{y}}{\dot{x}^2}=X\dot{x},\quad \frac{\ddot{y}}{\dot{x}^2}=\int X\dot{x}=P+c,$$

where P denotes such a function of x, that its fluxion is $X\dot{x}$, and c represents a constant quantity. Again

$$\frac{\ddot{y}}{\dot{x}}=P\dot{x}+c\dot{x},$$

$$\frac{\dot{y}}{\dot{x}}=\int P\dot{x}+cx+c'=Q+cx+c';$$

here Q is put for $\int P\dot{x}$, and c' for a second constant quantity. In like manner we have

$$\dot{y}=Q\dot{x}+cx\dot{x}+c'\dot{x},$$

$$\text{and }y=\int Q\dot{x}+\tfrac{1}{2}cx^2+c'x+c'';$$

and as P and Q are functions of x, the fluents of $P\dot{x}$ and $Q\dot{x}$ may be found by the methods formerly explained.

195. Let us next consider such equations as involve only $\frac{\ddot{y}}{\dot{x}^2}$, $\frac{\dot{y}}{\dot{x}}$ and constant quantities. In order to abridge let us put $\frac{\dot{y}}{\dot{x}}=p$, then such an equation may be generally expressed thus $\frac{\ddot{y}}{\dot{x}^2}=P$, where P denotes some

known

known function of p; now as $\frac{\dot y}{\dot x}=p$, by taking the fluxions, and obſerving that $\dot x$ is conſtant, we have $\frac{\ddot y}{\dot x^2}=\frac{\dot p}{\dot x}$, hence $\frac{\dot p}{\dot x}=\mathrm{P}$, and $\dot x=\frac{\dot p}{\mathrm{P}}$, and $x=\int\frac{\dot p}{\mathrm{P}}$; let the value of $\dot x$ be ſubſtituted inſtead of it in the equation $\dot y=p\,\dot x$, and it becomes $\dot y=\frac{p\dot p}{\mathrm{P}}$ and hence $y=\int\frac{p\dot p}{\mathrm{P}}$; thus it appears that if we can find the fluents $\int\frac{\dot p}{\mathrm{P}}$ and $\int\frac{p\dot p}{\mathrm{P}}$ we ſhall have the primitive equation when we eliminate p by means of theſe two equations

$$x=c+\int\frac{\dot p}{\mathrm{P}},\quad y=c'+\int\frac{p\dot p}{\mathrm{P}},$$

where c and c' denote the two indeterminate conſtant quantities that ought to enter into the primitive equation.

Suppoſe for example that the equation is

$$\frac{(\dot x^2+\dot y^2)^{\frac{3}{2}}}{-\dot x\,\ddot y}=a$$

which, by putting p for $\frac{\dot y}{\dot x}$, and $\frac{\dot p}{\dot x}$ for $\frac{\ddot y}{\dot x^2}$ becomes transformed to

$$-\frac{(1+p^2)^{\frac{3}{2}}\dot x}{\dot p}=a;$$

hence we have

$$\dot x=\frac{-a\,\dot p}{(1+p^2)^{\frac{3}{2}}},\qquad \dot y=p\,\dot x=\frac{-a\,p\,\dot p}{(1+p^2)^{\frac{3}{2}}},$$

$$x=c-\frac{a\,p}{\sqrt{(1+p^2)}},\qquad y=c'+\frac{a}{\sqrt{(1+p^2)}};$$

when by means of theſe equations we eliminate p we obtain $(x-c)^2+(y-c')^2=a^2$.

The fluxional equation is evidently formed by putting the general expreſſion for the radius of curvature (given in § 97.) equal to a conſtant quantity, and the primitive equation is accordingly an equation to a circle having that conſtant quantity for its radius, as it ought to be.

196. Suppoſe now that the equation has this form

$$\frac{\ddot y}{\dot x^2}=\mathrm{Y},$$

where Y denotes a function of y, then putting as before $\frac{\dot y}{\dot x}=p$, we have $\frac{\ddot y}{\dot x^2}=\frac{\dot p}{\dot x}=\frac{p\dot p}{\dot y}$, hence the equation $\frac{\ddot y}{\dot x^2}=\mathrm{Y}$ becomes $\frac{p\dot p}{\dot y}=\mathrm{Y}$, and $p\dot p=\mathrm{Y}\,\dot y$, and $p^2=2\int\mathrm{Y}\,\dot y+c$, hence $p=\frac{\dot y}{\dot x}=\sqrt{(c+2\int\mathrm{Y}\,\dot y)}$ and

$$x=\int\frac{\dot y}{\sqrt{(c+2\int\mathrm{Y}\,\dot y)}}+c'$$

where c and c' denote two conſtant quantities.

To take a particular example let us ſuppoſe the equation to be $\ddot y-y\,\dot x^2=a\,\dot x^2$, or $\frac{\ddot y}{\dot x^2}=a+y$, here $\mathrm{Y}=a+y$, and $2\int\mathrm{Y}\,\dot y=2\,a\,y+y^2$, hence (and by § 127.),

$$x=\int\frac{\dot y}{\sqrt{(c+2\,a\,y+y^2)}}+c'$$

$$=\text{l.}\left\{a+x+\sqrt{(a+2\,a\,y+y^2)}\right\}+c'.$$

197. When the equation contains $\frac{\dot y}{\dot x}$, $\frac{\ddot y}{\dot x^2}$ and x, it may be transformed to a fluxional equation of the firſt order by ſubſtituting in it $p\,\dot x$, and $\dot p\,\dot x$ inſtead of $\dot y$, and $\ddot y$; if we can find the primitive of that fluxional equation, and thence the value of p in terms of x, we ſhall have the value of y from the formula $y=\int p\,\dot x$, or if we have the value of x in terms of p, then, becauſe $\int p\,\dot x=p\,x-\int x\,\dot p$, we ſhall have

$$y=p\,x-\int x\,\dot p.$$

Suppoſe the equation to be

$$\frac{(\dot x^2+\dot y^2)^{\frac{3}{2}}}{-\dot x\,\ddot y}=\mathrm{X},\text{ or }-\frac{(1+p^2)^{\frac{3}{2}}\dot x}{\dot p}=\mathrm{X},$$

where X denotes any function of x, then,

$$\frac{\dot x}{\mathrm{X}}=\frac{-\dot p}{(1+p^2)^{\frac{3}{2}}},\text{ and }\int\frac{\dot x}{\mathrm{X}}=\frac{-p}{\sqrt{(1+p^2)}};$$

Let us repreſent $\int\frac{\dot x}{\mathrm{X}}$ by V, then $p=\frac{\mathrm{V}}{\sqrt{(1-\mathrm{V}^2)}}$, and

$$y=\int p\,\dot x=\int\frac{\mathrm{V}\,\dot x}{\sqrt{(1-\mathrm{V}^2)}}.$$

This equation evidently expreſſes the nature of a curve ſuch, that $\frac{(\dot x^2+\dot y^2)^{\frac{3}{2}}}{-\dot x\,\ddot y}$, its radius of curvature (§ 97.), is equal to X a function of x one of its coordinates.

198. If the propoſed fluxional equation of the ſecond order contains $\frac{\dot y}{\dot x}$, $\frac{\ddot y}{\dot x^2}$ and y, to transform it we muſt exterminate $\dot x$ by means of its value $\frac{\dot y}{p}$ deduced from the equation $\dot y=p\,\dot x$, thus we ſhall have

$$\frac{\ddot{y}}{\dot{x}^2}=\frac{\dot{p}}{\dot{x}}=\frac{p\,\dot{p}}{y}$$

and the result will be an equation of the first order containing only p, $\dot{p}$ and $\dot{y}$; when its primitive equation can be found, and thence the value of p in terms of y, we may find x by the formula $x=\int\frac{\dot{y}}{p}$, and by the formula $x=\frac{y}{p}+\int\frac{y\dot{p}}{p^2}$ when y is expressed by means of p.

199. As an example of the manner in which fluxional equations of the second order are to be resolved by approximation, we shall take the particular equation

$$\ddot{y}+a\,x^n y\,\dot{x}^2=0.$$

If the value of y which satisfies the equation be supposed to have this form

$$Ax^{\alpha}+Bx^{\alpha+\delta}+Cx^{\alpha+2\delta}+\&c.$$

and that the series of exponents goes on increasing, or that δ is positive, we may, by supposing x to be a very small quantity, conceive that the expression for y is reduced to its first term, because in that case each of the following terms will be inconsiderable in respect of that term. According to this hypothesis we shall have

$$y=Ax^{\alpha},\ \ddot{y}=\alpha(\alpha-1)Ax^{\alpha-2}\,\dot{x}^2$$

and thus the proposed equation becomes

$$\alpha(\alpha-1)A\,x^{\alpha-2}+a\,Ax^{\alpha+n}=0.$$

It will not be possible to give to α such a value that the two exponents $\alpha-2$ and $\alpha+n$ shall become equal, except in the particular case of $n=-2$; but if we suppose x very small the equation may be satisfied in two ways, namely, by taking $\alpha=0$, and $\alpha=1$, because upon either supposition the term $\alpha(\alpha-1)Ax^{\alpha-2}$, which is the greatest, vanishes, and therefore A is left indeterminate; thus we have two series, one beginning with A, and the other with Ax.

Assuming therefore successively

$$y=A+Bx^{\delta}+Cx^{2\delta}+\&c.$$

$$y=Ax+Bx^{1+\delta}+Cx^{1+2\delta}+\&c.$$

and substituting these values as well as their corresponding values of $\ddot{y}$ in the proposed equation, we shall find by arranging the terms, that δ ought to be $=2$; afterwards by determining the cofficients A, B, C, &c. in the usual manner (ALGEBRA, § 261.) we obtain two series, one of these is

$$A-\frac{aAx^{n+2}}{(n+1)(n+2)}+\frac{a^2Ax^{2n+4}}{(n+1)(n+2)(2n+3)(2n+4)}$$
$$-\frac{a^3Ax^{3n+6}}{(n+1)(n+2)(2n+3)(2n+4)(3n+5)(3n+6)}+\&c.$$

and the other

$$Ax-\frac{aAx^{n+3}}{(n+2)(n+3)}+\frac{a^2Ax^{2n+5}}{(n+2)(n+3)(2n+4)(2n+5)}$$
$$-\frac{a^3Ax^{3n+7}}{(n+2)(n+3)(2n+4)(2n+5)(3n+6)(3n+7)}+\&c.$$

As a primitive equation in its general form ought to contain two constant quantities which do not appear in the fluxional equation of the second order derived from it (§ 177.), the value of y to be complete ought to contain two arbitrary constant quantities, but as each of these series contains only one such quantity, namely A, it must be considered as expressing only a particular value of y. The fluxional equation $\ddot{y}+a\,x^n y\,\dot{x}^2=0$ is however of such a nature that from two particular values of y we may deduce its general value; for let us denote these values by z and Z, then, as each of them must satisfy the fluxional equation, we have

$$\ddot{z}+a\,x^n z\,\dot{x}^2=0,\ \ddot{Z}+a\,x^n Z\,\dot{x}^2=0;$$

let c and C denote two arbitrary constant quantities, then we have also

$$c\,\ddot{z}+c\,a\,x^n z\,\dot{x}^2=0,\ C\ddot{Z}+C\,a\,x^n Z\dot{x}^2=0,$$

and as each of these equations is identical, their sum must also be identical, that is

$$c\,\ddot{z}+C\ddot{Z}+a\,x^n(c\,z+CZ)\dot{x}^2=0;$$

but the very same result will be obtained if we substitute $c\,z+CZ$ instead of y in the proposed fluxional equation, therefore $c\,z+CZ$ is also a value of y, and as it involves two arbitrary constant quantities c and C, it possesses all the generality of which the value of y is susceptible. Hence it follows that that if c be put instead of A in one of the two series which we have found for the value of y, and C instead of A in the other series, the sum of the two results will be a general expression for the value of y.

200. Having now explained the theory of fluxional equations at as great length as we conceive to be compatible with the nature of this work we shall conclude this treatise by resolving a few problems which produce fluxional equations.

Prob. 1. Having given any *hyperbolic*, or as it may more properly be called *Napierean* logarithm, it is required to find a general expression for its corresponding natural number.

Let the number be denoted by $1+x$, and its logarithm by y, then $\dot{y}=\frac{\dot{x}}{1+x}$ (§ 57.), or

$$\dot{y}+x\,\dot{y}-\dot{x}=0,$$

and the problem requires that from this equation we deduce an expression for x.

As when $y=0$, then $x=0$, we may assume

$$x=Ay+By^2+Cy^3+\ \&c.$$

then $\dot{x}=A\dot{y}+2By\dot{y}+3Cy^2\dot{y}+\&c.$

and our equation becomes

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$$\left.\begin{array}{l}\dot y + Ay\dot y + By^2\dot y + Cy^3\dot y + \&c.\\ -A\dot y - 2By\dot y - 3Cy^2\dot y - 4Dy^3\dot y - \&c.\end{array}\right\} = 0.$$

Hence, by comparing the coefficients of the like terms it appears that $A=1$, $2B=A$, $3C=B$, $4D=C$, &c. so that $A=1$, $B=\frac{1}{2}$, $C=\frac{1}{2.3}$, $D=\frac{1}{2.3.4}$, &c.

therefore $x=y+\frac{y^2}{2}+\frac{y^3}{2.3}+\frac{y^4}{2.3.4}+$ &c. and

$$1+x=1+y+\frac{y^2}{2}+\frac{y^3}{2.3}+\frac{y^4}{2.3.4}+\ \&c.$$

Fig. 38. *Prob.* 2. Let AB, AC be two straight lines given by position meeting each other at right angles in A, let C be a given point in AC one of the lines, and let a straight line PQ meet them in P and Q, and cut off from them equal segments AP, CQ adjacent to the given points A,C, it is required to find the nature of the curve to which PQ is a tangent.

Let D be the point in which the tangent PQ meets the curve, draw DE perpendicular to AC, and DF to AP, put $CA=a$, $CE=x$ $ED=y$, then AE or DF $=a-x$, and since $EQ=\frac{y\dot x}{\dot y}$ (§ 73.) and EQ : ED :: DF : FP, therefore $FP=\frac{(a-x)\dot y}{\dot x}$; hence $PA=$ $(PF+FA=)\frac{(a-x)\dot y}{\dot x}+y$, and $CQ=(CE-EQ=)$ $x-\frac{y\dot x}{\dot y}$, and as by hypothesis $AP=CQ$, therefore

$$y+\frac{(a-x)\dot y}{\dot x}=x-\frac{y\dot x}{\dot y}$$

This expression belongs to a class of fluxional equations which have the singular property of being more easily resolved by first taking their fluxion, considering the fluxion of one of the variable quantities as constant; thus, in the present case, making $\dot x$ constant, we find

$$\dot y-\frac{\dot x\dot y-(a-x)\ddot y}{\dot x}=\dot x-\frac{\dot x\dot y^2-y\dot x\ddot y}{\dot y^2}$$

$$\text{or } \frac{(a-x)\ddot y}{\dot x}=\frac{y\dot x\ddot y}{\dot y^2}$$

hence dividing by $\ddot y$, the equation is easily reduced to

$$\frac{\dot y}{\sqrt y}=\frac{\dot x}{\sqrt{(a-x)}}$$

and taking the fluents

$$\sqrt y=c-\sqrt{(a-x)}$$

but when $x=0$, then $y=0$, therefore $c=\sqrt a$, and

$$\sqrt y=\sqrt a-\sqrt{(a-x)},\ \text{or}\ x=2\sqrt{ay}-y,$$

which equation belongs to the common parabola.

Fig. 39. *Prob.* 3. Let APQ be one of any number of curves of the parabolic kind, having the same vertex A, and axis AE, and the nature of which is defined by the equation $px^m=y^n$, where x denotes the abscissa AB, and y the ordinate PB, and p an indeterminate quantity which is the same for the whole of any one of the parabolas, but different for different parabolas; it is required to find the nature of a curve that shall intersect them all in a given angle.

Inverse Method.

Let the curve whose nature is required meet any one of the parabolas in P, let PT, P t tangents to the two curves meet the axis in T and t, then, from the nature of the problem, the lines PT, P t must contain a given angle, let a denote its numerical tangent.

Because PT touches the parabola, the tangent of the angle PTB will be equal to $\frac{\dot y}{\dot x}$ (§ 75.) the value of this expression being supposed deduced from the equation $px^m=y^n$; but taking the fluxion of this equation, and eliminating the indeterminate quantity p by means of the two equations, we find $\frac{\dot y}{\dot x}=\frac{my}{nx}$, therefore tan. $T=\frac{my}{nx}$.

Again, by considering x and y as the abscissa and ordinate of the curve whose equation is sought, and to which P t is a tangent, we have the tangent of the angle t equal to $\frac{\dot y}{\dot x}$ (§ 75.). Now the angle TPt being the difference of the two angles PTB, PtB it follows from the formula for finding the tangent of the difference of two angles, (ALGEBRA, § 368.) that

$$a=\frac{\frac{\dot y}{\dot x}-\frac{my}{nx}}{1+\frac{my\dot y}{nx\dot x}},$$

hence we have

$$a(nx\dot x+my\dot y)+my\dot x-nx\dot y=0,$$

a fluxional equation expressing the nature of the curve, which being homogeneous may be treated according to the method explained in § 180.

If the curves be supposed to cut each other at right angles, then, a being infinite, the part of the equation which is not multiplied by a vanishes in respect of the other, which is multiplied by it; hence we have

$$nx\dot x+my\dot y=0$$

and taking the fluents

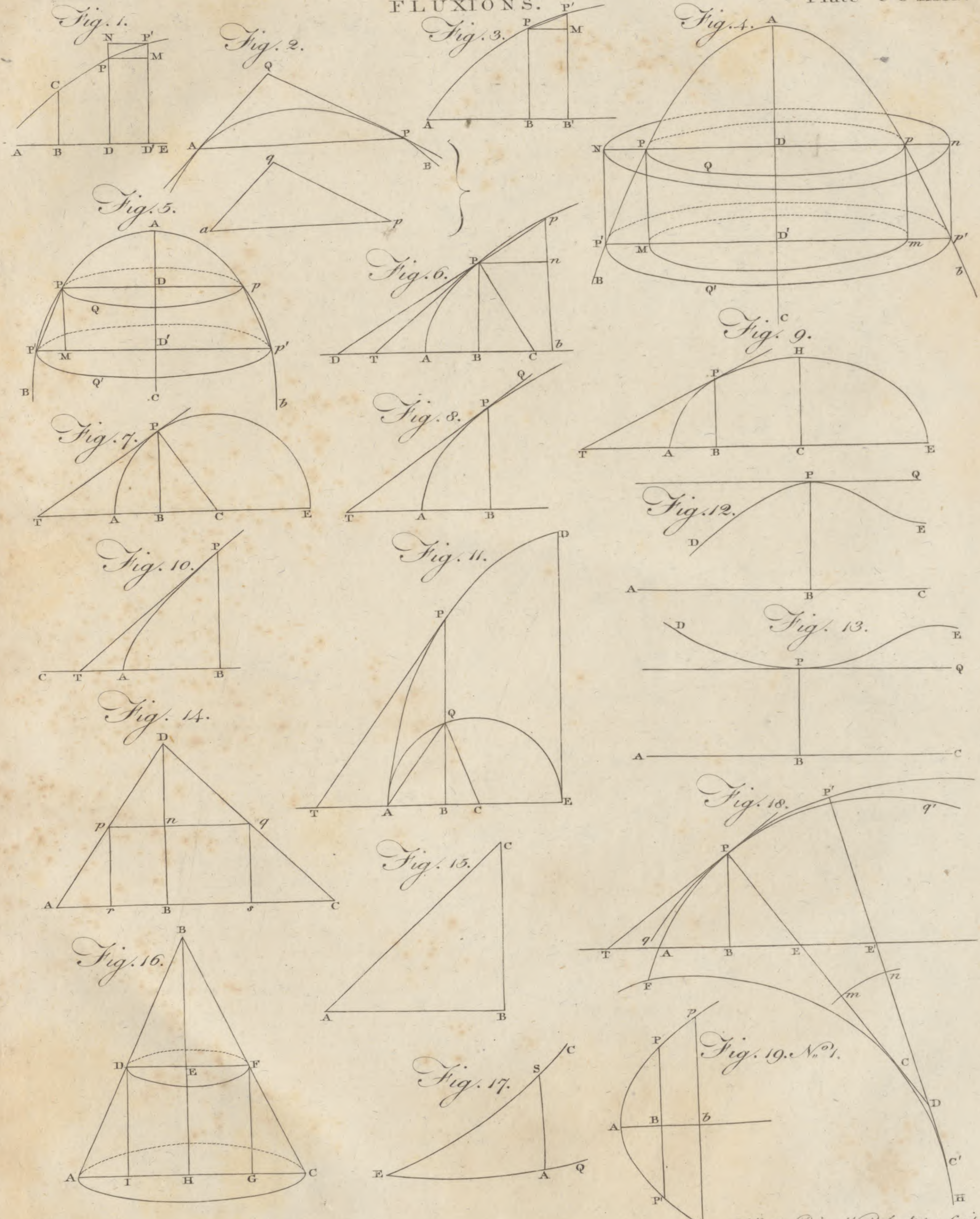
$$nx^2+my^2=c$$

where c is put for a constant quantity. This equation shews that the curve is an ellipse the centre of which is at A the common vertex of all the parabolas.

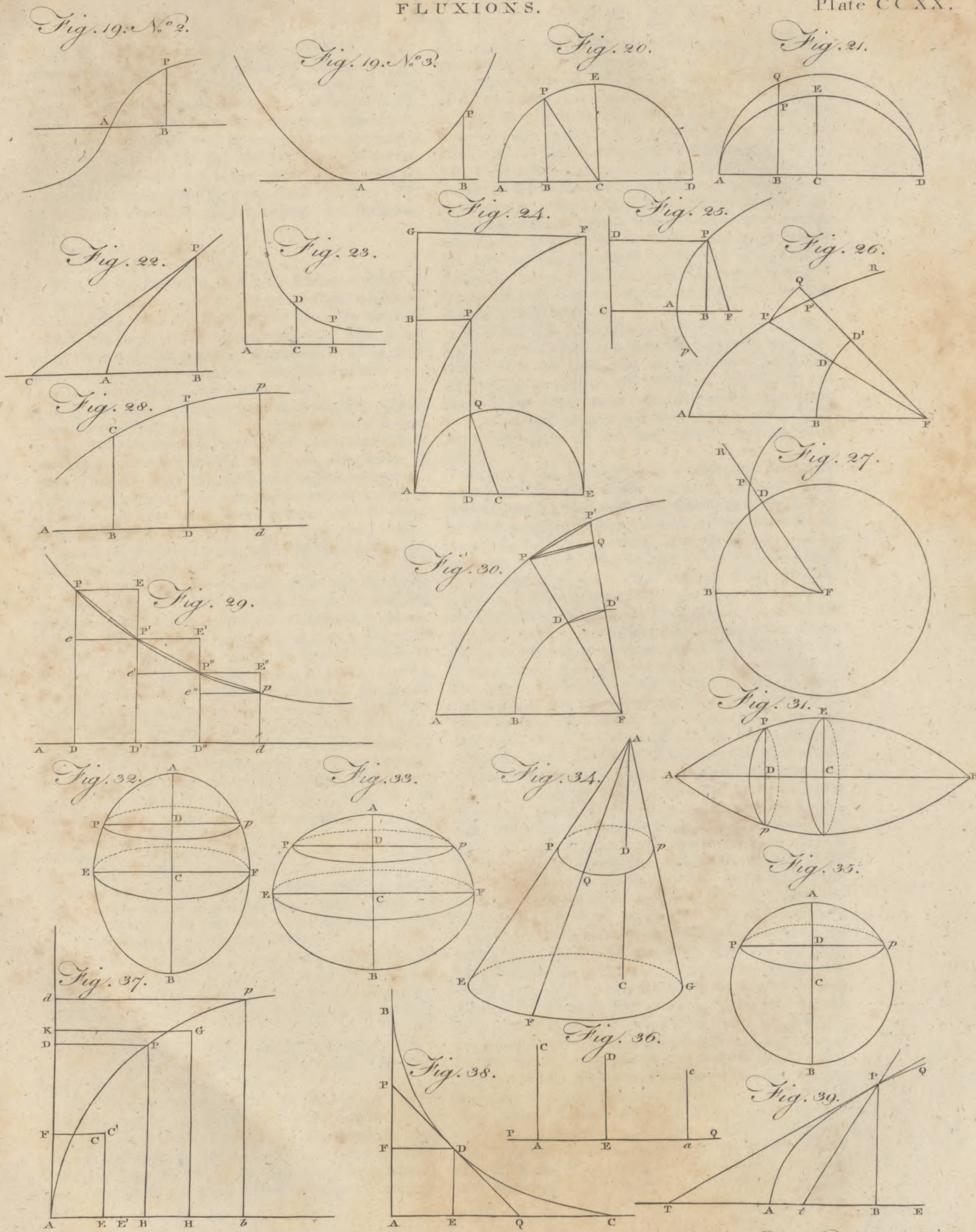
The problem which we have here resolved is only a particular case of one more general, and which has for its object *To determine the nature of the curve which intersects all other curves of a given kind in a given angle.* The problem thus generalised is known by the name of the *Problem of Trajectories*; it was originally proposed by *Leibnitz* as a challenge to the English mathematicians, and resolved by *Newton*, on the day he received it.

FLY,

FLUXIONS. Plate CCXIX.



A. Bell Prin. Wal. Sculptor fecit.



A. Bell Prin. Wal. Sculptor fecit.

FLY, in *Zoology*, a large order of infects, the diftinguifhing characteriftic of which is, that their wings are tranfparent. By this they are diftinguifhed from beetles, butterflies, grafhoppers, &c. Flies are fubdivided into thofe which have four, and thofe which have two wings. Of thofe with four wings there are feveral genera or kinds; as the ant, the bee, the ichneumon, &c. Of thofe with two wings, there are likewife feveral kinds, as the gad-fly, gnat, houfe-fly, &c. For their claffification and natural hiftory, fee ENTOMOLOGY.

Houfe FLY. See MUSCA.

Peftilential FLY. See ABYSSINIA.

FLY, in mechanics, a crofs with leaden weights at its ends; or rather, a heavy wheel at right angles to the axis of a windlafs, jack, or the like; by means of which, the force of the power, whatever it is, is not only preferved, but equally diftributed in all parts of the revolution of the machine. See MECHANICS.

FLIES for Fifhing. See *FISHING Fly*.

Vegetable FLY, a curious natural production chiefly found in the Weft Indies. "Excepting that it has no wings, it refembles the drone both in fize and colour more than any other Britifh infect. In the month of May it buries itfelf in the earth, and begins to vegetate. By the latter end of July, the tree is arrived at its full growth, and refembles a coral branch; and is about three inches high, and bears feveral little pods, which dropping off become worms, and from thence flies, like the Britifh caterpillar."

Phil. Tranf. for 1763. Such was the account originally given of this extraordinary production. But feveral boxes of thefe flies having been fent to Dr Hill for examination, his report was this: "There is in Martinique a fungus of the clavaria kind, different in fpecies from thofe hitherto known. It produces foboles from its fides; I call it therefore *clavaria fobolifera*. It grows on putrid animal bodies, as our *fungus ex pede equino* from the dead horfe's hoof. The cicada is common in Martinique; and in its nympha ftate, in which the old authors call it *tettigometra*, it buries itfelf under dead leaves to wait its change; and when the feafon is unfavourable, many perifh. The feeds of the clavaria find a proper bed on this dead infect, and grow. The tettigometra is among the cicadæ in the Britifh mufeum; the clavaria is juft now known. This is the fact, and all the fact; though the untaught inhabitants fuppofe a fly to vegetate, and though there is a Spanifh drawing of the plant's growing into a trifoliate tree, and it has been figured with the creature flying with this tree upon its back." See Edwards' Gleanings of Natural Hiftory.

FLY-Boat, or *Flight*, a large flat-bottomed Dutch veffel, whofe burden is generally from 600 to 1200 tons. It is diftinguifhed by a very high ftern, refembling a Gothic turret, and by very broad buttocks below.

FLY-Catcher, in *Zoology*. See MUSCICAPA.

Venus's FLY-Trap, a kind of fenfitive plant. See *DIONÆA Mufcipula*, BOTANY *Index*.

FLY-Tree, in *Natural Hiftory*, a name given by the common people of America to a tree, whofe leaves, they fay, at a certain time of the year produce *flies*. On examining thefe leaves about the middle of fummer, the time at which the flies ufe to be produced, there are found on them a fort of bags of a tough matter, of about the fize of a filbert, and of a dufky greenifh colour. On opening one of thefe bags with a knife, there is ufually found a fingle full grown fly, of the gnat kind, and a number of fmall worms, which in a day or two more have wings and fly away in the form of their parent. The tree is of the mulberry kind, and its leaves are ufually very largely ftocked with thefe infect bags; and the generality of them are found to contain the infects in their worm ftate; when they become winged, they foon make their way out. The bags begin to appear when the leaves are young, and afterwards grow with them; but they never rumple the leaf or injure its fhape. They are of the kind of leaf-galls, and partake in all refpects, except fize, of a fpecies we have frequent on the large maple, or, as it is called, the *fycamore*.

FLYERS, in architecture, fuch ftairs as go ftraight, and do not wind round, or have the fteps made tapering; but the fore and back part of each ftair and the ends refpectively parallel to one another: So that if one flight do not carry you to your defigned height, there is a broad half fpace; and then you fly again, with fteps everywhere of the fame breadth and length as before.

FLYERS, the performers in a celebrated exhibition among the Mexicans, which was made on certain great feftivals, and is thus defcribed by Clavigero in his Hiftory of that people. "They fought in the woods for an extremely lofty tree, which, after ftripping it of its branches and bark, they brought to the city, and fixed in the centre of fome large fquare. They cafed the point of the tree in a wooden cylinder, which, on account of fome refemblance in its fhape, the Spaniards called a *mortar*. From this cylinder hung four ftrong ropes, which ferved to fupport a fquare frame. In the fpace between the cylinder and the frame, they fixed four other thick ropes, which they twifted as many times round the tree as there were revolutions to be made by the flyers. Thefe ropes were drawn through four holes, made in the middle of the four planks of which the frame confifted. The four principal flyers, difguifed like eagles, herons, and other birds, mounted the tree with great agility, by means of a rope which was laced about it from the ground up to the frame; from the frame they mounted one at a time fucceffively upon the cylinder, and after having danced there a little, they tied themfelves round with the ends of the ropes, which were drawn through the holes of the frame, and launching with a fpring from it, began their flight with their wings expanded. The action of their bodies put the frame and the cylinder in motion; the frame by its revolutions gradually untwifted the cords by which the flyers fwung; fo that as the ropes lengthened, they made fo much the greater circles in their flight. Whilft thefe four were flying, a fifth danced upon the cylinder, beating a little drum, or waving a flag, without the fmalleft apprehenfion of the danger he was in of being precipitated from fuch a height. The others who were upon the frame (10 or 12 perfons generally mounted), as foon as they faw the flyers in their laft revolution, precipitated themfelves by the fame ropes, in order to reach the ground at the fame time amidft the acclamations of the populace. Thofe who precipitated themfelves in this manner by the ropes, that they might make a ftill greater difplay of their agility,

agility, frequently paſſed from one rope to another, at that part where, on account of the little diſtance between them, it was poſſible for them to do ſo. The moſt eſſential point of this performance conſiſted in proportioning ſo juſtly the height of the tree with the length of the ropes, that the flyers ſhould reach the ground with 13 revolutions, to repreſent by ſuch number their century of 52 years, compoſed in the manner we have already mentioned. This celebrated diverſion is ſtill in uſe in that kingdom; but no particular attention is paid to the number of the revolutions of the flyers; as the frame is commonly hexagonal or octagonal, and the flyers ſix or eight in number. In ſome places they put a rail round the frame, to prevent accidents, which were frequent after the conqueſt; as the Indians became much given to drinking, and uſed to mount the tree when intoxicated with wine or brandy, and were unable to keep their ſtation on ſo great a height, which was uſually 60 feet.

FLYING, the progreſſive motion of a bird, or other winged animal, in the air.

The parts of birds chiefly concerned in flying are the wings and tail; by the firſt, the bird ſuſtains and wafts himſelf along; and by the ſecond, he is aſſiſted, in aſcending and deſcending, to keep his body poiſed and upright, and to obviate the vacillations thereof.

It is by the ſize and ſtrength of the pectoral muſcles, that birds are ſo well diſpoſed for quick, ſtrong, and continued flying. Theſe muſcles, which in men are ſcarcely a 70th part of the muſcles of the body, in birds exceed and outweigh all the other muſcles taken together; upon which Mr Willoughby makes this reflection, that if it be poſſible for a man to fly, his wings muſt be ſo contrived and adapted, that he may make uſe of his legs, and not his arms, in managing them.

The tail, Meſſrs Willoughby, Ray, and many others, imagine to be principally employed in ſteering and turning the body in the air, as a rudder; but Borelli has put it beyond all doubt, that this is the leaſt uſe of it, which is chiefly to aſſiſt the bird in its aſcent and deſcent in the air, and to obviate the vacillations of the body and wings; for, as to turning to this or that ſide, it is performed by the wings and inclination of the body, and but very little by the help of the tail. The flying of a bird, in effect, is quite a different thing from the rowing of a veſſel. Birds do not vibrate their wings towards the tail, as oars are ſtruck towards the ſtern, but waft them downwards; nor does the tail of the bird cut the air at right angles as the rudder does the water; but is diſpoſed horizontally, and preſerves the ſame ſituation what way ſoever the bird turns. In effect, as a veſſel is turned about on its centre of gravity to the right, by a briſk application of the oars to the left; ſo a bird, in beating the air with its right wing alone, towards the tail, will turn its fore part to the left. Thus pigeons changing their courſe to the left, would labour it with their right wing, keeping the other almoſt at reſt. Birds of a long neck alter their courſe by the inclination of their head and neck; which altering the courſe of gravity, the bird will proceed in a new direction.

The manner of FLYING is thus. The bird firſt bends his legs, and ſprings with a violent leap from the ground; then opens and expands the joints of his wings, ſo as to make a right line perpendicular to the ſides of his body: thus the wings, with all the feathers therein, conſtitute one continued lamina. Being now raiſed a little above the horizon, and vibrating the wings with great force and velocity perpendicularly againſt the ſubject air, that fluid reſiſts thoſe ſuccuſſions, both from its natural inactivity and elaſticity, by means of which the whole body of the bird is protruded. The reſiſtance the air makes to the withdrawing of the wings, and conſequently the progreſs of the bird, will be ſo much the greater, as the waft or ſtroke of the fan of the wing is longer: but as the force of the wing is continually diminiſhed by this reſiſtance, when the two forces continue to be *in equilibrio*, the bird will remain ſuſpended in the ſame place; for the bird only aſcends ſo long as the arch of air the wing deſcribes makes a reſiſtance equal to the exceſs of the ſpecific gravity of the bird above the air. If the air, therefore, be ſo rare as to give way with the ſame velocity as it is ſtruck withal, there will be no reſiſtance, and conſequently the bird can never mount. Birds never fly upwards in a perpendicular line, but always in a parabola. In a direct aſcent, the natural and artificial tendency would oppoſe and deſtroy each other, ſo that the progreſs would be very ſlow. In a direct deſcent they would aid one another, ſo that the fall would be too precipitate.

Artificial FLYING, that attempted by men, by the aſſiſtance of mechanics.

The art of flying has been attempted by ſeveral perſons in all ages. The Leucadians, out of ſuperſtition, are reported to have had a cuſtom of precipitating a man from a high cliff into the ſea, firſt fixing feathers, variouſly expanded, round his body, in order to break the fall.

Friar Bacon, who lived near 500 years ago, not only affirms the art of flying poſſible, but aſſures us, that he himſelf knew how to make an engine wherein a man ſitting might be able to convey himſelf through the air like a bird; and further adds, that there was then one who had tried it with ſucceſs. The ſecret conſiſted in a couple of large thin hollow copper globes, exhauſted of air; which being much lighter than air, would ſuſtain a chair whereon a perſon might ſit. Father Franciſco Lana, in his *Prodromo*, propoſes the ſame thing, as his own thought. He computes, that a round veſſel of plate braſs, 14 feet in diameter, weighing three ounces the ſquare foot, will only weigh 1848 ounces; whereas a quantity of air of the ſame bulk will weigh 2155⅓d ounces; ſo that the globe will not only be ſuſtained in the air, but will carry with it a weight of 373⅓d ounces; and by increaſing the bulk of the globe, without increaſing the thickneſs of the metal, he adds, a veſſel might be made to carry a much greater weight.—But the fallacy is obvious: a globe of the dimenſions he deſcribes, Dr Hook ſhows, would not ſuſtain the preſſure of the air, but be cruſhed inwards. Beſides, in whatever ratio the bulk of the globe were increaſed, in the ſame muſt the thickneſs of the metal, and conſequently the weight be increaſed: ſo that there would be no advantage in ſuch augmentation. See AEROSTATION.

The ſame author deſcribes an engine for flying, invented by the Sieur Beſnier, a ſmith of Sable, in the county of Maine. *Vid. Philoſoph. Collect.* N° 1.

The

The philosophers of King Charles the second's reign were mightily busied about this art. The famous Bishop Wilkins was so confident of success in it, that he says, he does not question but in future ages it will be as usual to hear a man call for his wings, when he is going a journey, as it is now to call for his boots.

Flying Bridge. See Bridge.

Flying Fish, a name given to several species of fish, which, by means of long fins, can keep themselves out of the water for some time. See Exocoetus, Ichthyology *Index*.

Flying Pinion, is part of a clock, having a fly or fan whereby to gather air, and so bridle the rapidity of the clock's motion, when the weight descends in the striking part.

FO, or Foe; an idol of the Chinese. He was originally worshipped in the Indies, and transported from thence into China, together with the fables with which the Indian books were filled. He is said to have performed most wonderful things, which the Chinese have described in several volumes, and represented by cuts.

Sect of Fo. See China, N° 104.

Fo-Kien. See Fokien.

FOAL, or *Colt and Filly*; the young of the horse kind. The word *colt*, among dealers, is understood of the male, as *filly* is of the female. See Colt.

FOCUS, in *Geometry* and *Conic Sections*, is applied to certain points in the parabola, ellipsis, and hyperbola, where the rays reflected from all parts of these curves concur and meet. See *Conic Sections*.

Focus, in *Optics*, a point in which any number of rays, after being reflected or refracted, meet.

FODDER, any kind of meat for horses or other cattle. In some places, hay and straw, mingled toghether, is peculiarly denominated *fodder*.

Fodder, in the civil law, is used for a prerogative that the prince has, to be provided with corn and other meats for his horses, by the subjects, in his warlike expeditions.

Fodder, among miners, a measure containing 22 hundred and a half weight; in London the fodder is only 20 hundred weight.

FODDERING a ship. See Fothering.

FOENUGREEK. See Trigonella, Botany *Index*.

FOENUS nauticum. Where money was lent to a merchant, to be employed in a beneficial trade, with condition to be repaid with extraordinary interest, in case such voyage was safely performed. The agreement was sometimes called *fœnus nauticum*, sometimes *usura maritima*. But as this gave an opening for usurious and gaming contracts, 19 Geo. II. c. 37. enacts, that all money lent on bottomry, or at *respondentia*, on vessels bound to or from the East Indies, shall be expressly lent only upon the ship or merchandise; the lender to have the benefit of salvage, &c. *Blackst. Com.* ii. 459. *Mol. de Jur. Mar.* 361.

FOETOR, in *Medicine*, fetid effluvia arising from the body or any part thereof.

FOETUS, the young of all viviparous animals whilst in the womb, and of oviparous animals before being hatched: the name is transferred by botanists to the *embryos of vegetables*.

Strictly, the name is applied to the young after it is perfectly formed; previous to which it is usually called Embryo. See Anatomy *Index*.

In the human fœtus are several peculiarities not to be found in the adult; some of them are as follow. 1. The arteries of the navel string, which are continuations of the hypogastrics, are, after the birth, shrivelled up, and form the ligamenta umbilic. infer. 2. The veins of the navel string are formed by the union of all the venous branches in the placenta, and passing into the abdomen become the falciform ligament of the liver. 3. The lungs, before being inflated with air, are compact and heavy, but after one inspiration they become light, and as it were spongy; and it may be noted here, that the notion of the lungs sinking in water before the child breathes, and of their swimming after the reception of air, are no certain proofs that the child had or had not breathed, much less that it was murdered: for the uninflated lungs become specifically lighter than water as soon as any degree of putrefaction takes place in them; and this soon happens after the death of the child; besides, where the utmost care hath been taken to preserve the child, it hath breathed once or twice, and then died. 4. The thymus gland is very large in the fœtus, but dwindles away in proportion as years advance. 5. The foramen ovale in the heart of a fœtus, is generally closed in an adult.

FOG, or Mist, a meteor, consisting of gross vapours, floating near the surface of the earth.

Mists, according to Lord Bacon, are imperfect condensations of the air, consisting of a large proportion of the air, and a small one of the aqueous vapour; and these happen in the winter, about the change of the weather from frost to thaw, or from thaw to frost; but in the summer, and in the spring, from the expansion of the dew.

If the vapours, which are raised plentifully from the earth and waters, either by the solar or subterraneous heat, do at their first entrance into the atmosphere meet with cold enough to condense them to a considerable degree, their specific gravity is by that means increased, and so they will be stopped from ascending; and either return back in form of dew or of drizzling rain, or remain suspended some time in the form of a fog. Vapours may be seen on the high grounds as well as the low, but more especially about marshy places. They are easily dissipated by the wind, as also by the heat of the sun. They continue longest in the lowest grounds, because these places contain most moisture, and are least exposed to the action of the wind.

Hence we may easily conceive, that fogs are only low clouds, or clouds in the lowest region of the air; as clouds are no other than fogs raised on high. See Cloud.

When fogs stink, then the vapours are mixed with sulphureous exhalations, which smell so. Objects viewed through fogs appear larger and more remote than through the common air. Mr Boyle observes, that upon the coast of Coromandel, and most maritime parts of the East Indies, there are, notwithstanding the heat of the climate, annual fogs so thick, as to occasion people of other nations who reside there, and even the more tender sort of the natives, to keep their houses close shut up.

Fogs are commonly strongly electrified, as appears from

from Mr Cavallo's obfervations upon them. See ELECTRICITY.

FOGAGE, in the foreft law, is rank grafs not eaten up in fummer.

FOGO, or FUEGO. See FUEGO.

FOHI. See FE; and CHINA, N° 7.

FOIBLE, a French term, frequently ufed alfo in our language. It literally fignifies *weak;* and in that fenfe is applied to the body of animals and the parts thereof, as *foible* reins, *foible* fight, &c. being derived from the Italian *fievole*, of the Latin *flebilis*, to be "lamented, pitied."

But it is chiefly ufed with us fubftantively, to denote a defect or flaw in a perfon or thing. Thus we fay, Every perfon has his foible; and the great fecret confifts in hiding it artfully: Princes are gained by flattery, that is their foible. The foible of young people is pleafure; the foible of old men is avarice; the foible of the great and learned is vanity; the foible of women and girls, coquetry, or an affectation of having gallants: You fhould know the forte and the foible of a man before you employ him: We fhould not let people perceive that we know their foible.

FOIL, in fencing, denotes a blunt fword, or one that has a button at the end covered with leather, ufed in learning the art of fencing.

FOIL, among glafs-grinders, a fheet of tin, with quickfilver, or the like, laid on the backfide of a looking-glafs, to make it reflect. See FOLIATING.

FOIL, among jewellers, a thin leaf of metal placed under a precious ftone, in order to make it look tranfparent, and give it an agreeable different colour, either deep or pale: thus, if you want a ftone to be of a pale colour, put a foil of that colour under it; or if you would have it deep, lay a dark one under it.

Thefe foils are made either of copper, gold, or gold and filver together. The copper foils are commonly known by the name of *Nuremberg* or *German foils;* and are prepared as follows: Procure the thinneft copper plates you can get: beat thefe plates gently upon a well-polifhed anvil, with a polifhed hammer, as thin as poffible; and placing them between two iron plates as thin as writing paper, heat them in the fire; then boil the foil in a pipkin, with equal quantities of tartar and falt, conftantly ftirring them till by boiling they become white; after which, taking them out and drying them, give them another hammering, till they are made fit for your purpofe: however, care muft be taken not to give the foils too much heat, for fear of melting; nor muft they be too long boiled, for fear of attracting too much falt.

The manner of polifhing thefe foils is as follows: Take a plate of the beft copper, one foot long and about five or fix inches wide, polifhed to the greateft perfection; bend this to a long convex, faften it upon a half roll, and fix it to a bench or table; then take fome chalk, wafhed as clean as poffible, and filtered through a fine linen cloth, till it be as fine as you can make it; and having laid fome thereof on the roll, and wetted the copper all over, lay your foils on it, and with a polifhing ftone and the chalk polifh your foils till they are as bright as a looking-glafs; after which they muft be dried, and laid up fecure from duft.

FOKIEN, a province of China in Afia, commodioufly fituated for navigation and commerce, part of it bordering on the fea, in which they catch large quantities of fifh, which they fend falted to other parts of the empire. Its fhores are very uneven, by reafon of the number and variety of its bays; and there are many forts built thereon to guard the coaft. The air is hot, but pure and wholefome.

The mountains are almoft everywhere difpofed into a kind of amphitheatres, by the labour of the inhabitants, with terraces placed one above another. The fields are watered with rivers and fprings, which iffue out of the mountains, and which the hufbandmen conduct in fuch a manner as to overflow the fields of rice when they pleafe, becaufe it thrives beft in watery ground. They make ufe of pipes of bamboo for this purpofe.

They have all commodities in common with the reft of China; but more particularly mufk, precious ftones, quickfilver, filk, hempen cloth, callico, iron, and all forts of utenfils wrought to the greateft perfection. From other countries they have cloves, cinnamon, pepper, fandal wood, amber, coral, and many other things. The capital city is Fou-tcheou Fou; or, as others would have it written, Fucherofu. But as for Fokien, which moft geographers make the capital, Grofier informs us there is no fuch place.

FOLARD, CHARLES, an eminent Frenchman, famous for his fkill and knowledge in the military art, was born at Avignon in 1669, of a noble family, but not a rich one. He difcovered an early turn for the fciences, and a ftrong paffion for arms; which laft was fo inflamed by reading Cæfar's Commentaries, that he enlifted at 16 years of age. His father got him off, and fhut him in a monaftery: but he made his efcape in about two years after, and entered himfelf a fecond time in quality of cadet. His inclination for military affairs, and the great pains he took to accomplifh himfelf in that way, recommended him to notice; and he was admitted into the friendfhip of the firft rate officers. M. de Vendome, who commanded in Italy in 1720, made him his aid-de-camp, having conceived the higheft regard for him; and foon after fent him with part of his forces into Lombardy. He was entirely trufted by the commander of that army; and no meafures were concerted, or fteps taken, without confulting him. By purfuing his plans, many places were taken, and advantages gained; and fuch, in fhort, were his fervices, that he had a penfion of 400 livres fettled upon him, and was honoured with the crofs of St Louis. He diftinguifhed himfelf greatly, Auguft 15. 1705, at the battle of Caffano; where he received a wound upon his left hand, which deprived him of the ufe of it ever after. It was at this battle that he conceived the firft idea of that fyftem of columns, which he afterwards prefixed to his Commentaries upon Polybius. The duke of Orleans fending De Vendome again into Italy in 1706, Folard had orders to throw himfelf into Modena to defend it againft Eugene: where, though he acquitted himfelf with his ufual fkill, he was very near being affaffinated. The defcription which he has given of the conduct and character of the governor of this town, may be found in his Treatife of the Defence of Places, and deferves to be read. He received a dangerous wound on the thigh at the battle of Malplaquet, and was fome time after made prifoner by Prince Eugene. Being exchanged in 1711, he was made

made governor of Bourbourg. In 1714, he went to Malta, to aſſiſt in defending that iſland againſt the Turks. Upon his return to France, he embarked for Sweden, having a paſſionate deſire to ſee Charles XII. He acquired the eſteem and confidence of that famous general, who ſent him to France to negotiate the re-eſtabliſhment of James II. upon the throne of England; but that project being dropped, he returned to Sweden, followed Charles XII. in his expedition to Norway, and ſerved under him at the ſiege of Frederickſhall, where that prince was killed, Dec. 11. 1718. Folard then returned to France; and made his laſt campaign in 1719, under the duke of Berwick, in quality of colonel. From that time he applied himſelf intenſely to the ſtudy of the military art as far as it could be ſtudied at home; and built his theories upon the foundation of his experience and obſervations on facts. He contracted an intimacy with Count Saxe, who, as he then declared, would one day prove a very great general. He was choſen a fellow of the Royal Society of London in 1749; and, in 1751, made a journey to Avignon, where he died in 1752, aged 83 years. He was the author of ſeveral works, the principal of which are; 1. Commentaries upon Polybius, in ſix volumes, 4to. 2. A Book of New Diſcoveries in War. 3. A Treatiſe concerning the Defence of Places, &c. in French. Thoſe who would know more of this eminent ſoldier, may conſult a French piece, entitled, *Memoires pour ſervir à l'Hiſtoire de M. le Chevalier de Folard. Ratiſbone*, 1753, 12mo.

FOLC-LANDS, (Sax.) copyhold lands ſo called in the time of the Saxons, as charter-lands were called *boc-lands*, Kitch. 174. *Folkland* was *terra vulgi* or *popularis*; the land of the vulgar people, who had no certain eſtate therein, but held the ſame, under the rents and ſervices accuſtomed or agreed, at the will only of their lord the thane; and it was therefore not put in writing, but accounted *prædium ruſticum et ignobile*. Spelm. of Feuds, c. 5.

FOLCMOTE, or FOLKMOTE, (Sax. *Folcgemote*, i. e. *conventus populi*), is compounded of *folk*, *populus*, and *mote*, or *gemote*, *convenire*; and ſignified originally, as Somner in his Saxon Dictionary informs us, a general aſſembly of the people, to conſider of and order matters of the commonwealth. And Sir Henry Spelman ſays, the *folcmote* was a ſort of annual parliament or convention of the biſhops, thanes, aldermen, and freemen, upon every May-day yearly; where the laymen were ſworn to defend one another and the king, and to preſerve the laws of the kingdom; and then conſulted of the common ſafety. But Dr Brady infers from the laws of the Saxon kings of England, that it was an inferior court, held before the king's *reeve* or ſteward, every month, to do *folk* right, or compoſe ſmaller differences, from whence there lay appeal to the ſuperior courts; *Gloſſ.* p. 48. Squire ſeems to think the *folcmote* not diſtinct from the *ſhiremote*, or common general meeting of the county. See his *Angl. Sax. Gov.* 155. *n.*

Manwood mentions *folcmote* as a court holden in London, wherein all the *folk* and people of the city did complain of the mayor and aldermen, for miſgovernment within the ſaid city; and this word is ſtill in uſe among the Londoners, and denotes *celebrem ex tota civitate conventum. Stow's Survey.* According to Kennet, the *folcmote* was a common council of all the inhabitants of a city, town, or borough, convened often by ſound of bell, to the *Mote Hall*, or *Houſe*; or it was applied to a larger congreſs of all the freemen within a county, called the *ſhiremote*, where formerly all knights and military tenants did fealty to the king, and elected the annual ſheriff on the 1ſt of October; till this popular election, to avoid tumults and riots, devolved to the king's nomination, anno 1315, 3 Edw. I. After which the city *folkmote* was ſwallowed up in a ſelect committee or common council, and the country *folkmote* in the ſheriff's tourn and aſſizes.

The word *folkmote* was alſo uſed for any kind of popular or public meeting; as of all the tenants at the *court leet*, or *court baron*, in which ſignification it was of a leſs extent. *Paroch. Antiq.* 120.

FOLENGIO, THEOPHILUS, an Italian poet, was a native of Mantua. He was known alſo by the title of *Merlin Coccaye*, a name which he gave to a poem, and which has been adopted ever ſince for all trifling performances of the ſame ſpecies, conſiſting of buffoonery, puns, anagrams, wit without wiſdom, and humour without good ſenſe. His poem was called The Macaroni, from an Italian cake of the ſame name, which is ſweet to the taſte, but has not the leaſt alimentary virtue, on the contrary palls the appetite and cloys the ſtomach. Theſe idle poems, however, became the reigning taſte in Italy and in France; they gave birth to macaroni academies; and, reaching England, to macaroni clubs; till, in the end, every thing inſipid, contemptible, and ridiculous, in the character, dreſs, or behaviour, of both men and women, is now ſummed up in the deſpicable appellation of *a macaroni*. Folengio died in 1544.

FOLIA, among botaniſts, particularly ſignify the leaves of plants; thoſe of flowers being expreſſed by the word *petals*. See BOTANY.

FOLIAGE, a cluſter or aſſemblage of flowers, leaves, branches, &c.

FOLIAGE, is particularly uſed for the repreſentations of ſuch flowers, leaves, branches, rinds, &c. whether natural or artificial, as are uſed for enrichments on capitals, friezes, pediments, &c.

FOLIATING *of* LOOKING-GLASSES, the ſpreading the plates over, after they are poliſhed, with quickſilver, &c. in order to reflect the image. It is performed thus: A thin blotting paper is ſpread on the table, and ſprinkled with fine chalk; and then a fine lamina or leaf of tin, called *foil*, is laid over the paper; upon this is poured mercury, which is to be diſtributed equally over the leaf with a hare's foot or cotton; over this is laid a clean paper, and over that the glaſs plate, which is preſſed down with the right hand, and the paper gently drawn out with the left: this being done, the plate is covered with a thicker paper, and loaded with a greater weight, that the ſuperfluous mercury may be driven out and the tin adhere more cloſely to the glaſs. When it is dried, the weight is removed, and the looking-glaſs is complete.

Some add an ounce of marcaſite, melted by the fire; and, leſt the mercury ſhould evaporate in ſmoke, they pour it into cold water; and when cooled, ſqueeze through a cloth, or through leather.

Some add a quarter of an ounce of tin and lead to the marcaſite, that the glaſs may dry the ſooner.

FOLIATING *of Globe looking-glaſſes*, is done as follows:

lows: Take five ounces of quickſilver and one ounce of biſmuth; of lead and tin, half an ounce each: firſt put the lead and tin into fuſion, then put in the biſmuth; and when you perceive that in fuſion too, let it ſtand till it is almoſt cold, and pour the quickſilver into it: after this, take the glaſs globe, which muſt be very clean, and the inſide free from duſt: make a paper funnel, which put into the hole of the globe, as near the glaſs as you can, ſo that the amalgam, when you pour it in, may not ſplaſh, and cauſe the glaſs to be full of ſpots; pour it in gently, and move it about, ſo that the amalgam may touch everywhere: if you find the amalgam begin to be curdly and fixed, then hold it over a gentle fire, and it will eaſily flow again; and if you find the amalgam too thin, add a little more lead, tin, and biſmuth to it. The finer and clearer your globe is, the better will the looking glaſs be.

Dr Shaw obſerves, that this operation has conſiderable advantages, as being performable in the cold; and that it is not attended with the danger of poiſonous fumes from arſenic, or other unwholeſome matters, uſually employed for this purpoſe: beſides, how far it is applicable to the more commodious foliating of the common looking glaſſes, and other ſpeculums, he thinks, may deſerve to be conſidered.

FOLIO, in merchants books, denotes a page, or rather both the right and left hand pages, theſe being expreſſed by the ſame figure, and correſponding to each other. See BOOK-KEEPING.

FOLIO, among printers and bookſellers, the largeſt form of books, when each ſheet is ſo printed that it may be bound up in two leaves only.

FOLIS. See FOLLIS.

FOLIUM, or LEAF, in *Botany*. See LEAF.

FOLKES, MARTIN, a philoſopher and antiquarian of conſiderable eminence, was born in Weſtminſter in the year 1690. A Mr Cappel, once profeſſor of Hebrew at Saumur, was his private tutor. When 17 years of age, he was ſent to Clare-hall, Cambridge, where he ſucceſsfully applied himſelf to the ſtudy of philoſophy and the mathematics; and when only twenty-three years of age he was choſen a fellow of the Royal Society. His ingenious communications acquired him ſo much applauſe, that he was frequently choſen into its council. He was in habits of friendſhip with the illuſtrious Newton, at that time preſident, and by his influence was elected one of the vice-preſidents in the year 1723. Mr Folkes became a candidate for the chair on the death of Sir Iſaac Newton; but the ſuperior intereſt of Sir Hans Sloane rendered his application ineffectual. In 1733, and the two ſubſequent years, his reſidence was for the moſt part in Italy, with the view of improving himſelf in the knowledge of claſſical antiquities. To aſcertain the weight and value of ancient coins, he carefully conſulted the cabinets of the curious; and on his return home he preſented to the Antiquarian Society, of which he was a member, a diſſertation on this ſubject. He read before the ſame learned body, a diſſertation on the meaſurement of Trajan's and Antonine's pillars, together with other remains of antiquity. The fruits of his obſervations he preſented to the Royal Society; and, in particular, "Remarks on the ſtandard meaſure preſerved in the Capitol of Rome," and the model of an ancient globe in the Farneſian palace. He viſited Paris in 1739, where he was received with great reſpect, and honoured with the company of the moſt eminent literary characters in that metropolis. This reſpect indeed he was entitled to by his unwearied application to many branches of knowledge which were both curious and uſeful. His valuable work, entitled "A table of Engliſh ſilver coins, from the Norman Conqueſt to the preſent time, with their weights, intrinſic values, and ſome remarks upon the ſeveral pieces," was printed in the year 1745. Among the many honours conferred upon Mr Folkes, he was created doctor of laws by both univerſities, and choſen preſident of the Antiquarian Society. He continued to furniſh the Philoſophical Tranſactions with many learned papers, till his career was ſtopped by a paralytic ſtroke, which terminated his uſeful life in the year 1754. He was a man of very extenſive knowledge and great accuracy; but the chief benefit to ſcience which reſulted from his labours, was his treatiſe on the intricate ſubject of coins, weights, and meaſures. His cabinet and library were large and valuable, and expoſed to public ſale after his death. His private character was diſtinguiſhed for politeneſs, generoſity, and friendſhip.

FOLKESTONE, a town of Kent, between Dover and Hythe, 72 miles from London, appears to have been a very ancient place, from the Roman coins and Britiſh bricks often found in it. Stillingfleet and Tanner take it for the *Lapis Tituli* of Nennius. It was burnt by Earl Godwin, and by the French in the reign of Edward III. It had five churches, now reduced to one. It is a member of the town and port of Dover: and has a weekly market and an annual fair. It is chiefly noted for the multitude of fiſhing-boats that belong to its harbour, which are employed in the ſeaſon in catching mackerel for London; to which they are carried by the mackerel boats of London and Barking. About Michaelmas, the Folkeſtone barks, with others for Suſſex, go away to the Suffolk and Norfolk coaſts, to catch herrings for the merchants of Yarmouth and Leoſtoff.—Folkeſtone gives the title of *Viſcount* to William Henry Bouverie, whoſe grandfather, Jacob, was ſo created in 1747. It has been obſerved of ſome hills in this neighbourhood, that they have viſibly ſunk and grown lower within memory.

FOLKLAND, and FOLKMOTE. See FOLCLAND.

FOLLICULUS, (from *follis*, "a bag,") a ſpecies of ſeed-veſſel firſt mentioned by Linnæus in his *Delineatio Plantæ*, generally conſiſting of one valve, which opens from bottom to top on one ſide, and has no ſuture for faſtening or attaching the ſeeds within it.

FOLLICULI are likewiſe defined by the ſame author to be ſmall glandular veſſels diſtended with air, which appear on the ſurface of ſome plants; as at the root of water-milfoil, and on the leaves of aldrovanda. In the former, the veſſels in queſtion are roundiſh, and furniſhed with an appearance like two horns; in the latter, pot-ſhaped, and ſemicircular.

FOLLIS, or FOLIS, anciently ſignified a little bag or purſe; whence it came to be uſed for a ſum of money, and very different ſums were called by that name: thus the ſcholiaſt on the Baſilics mentions a follis of copper which was worth but the 24th part of the miliarenſis; the gloſſæ nomicæ, quoted by Gronovius and others, one of 125 miliarenſes, and another of 250 denarii, which was the ancient ſeſtertium; and three different ſums of eight, four, and two pound of gold, were each

each called *follis*. According to the account of the scholiast, the ounce of silver, which contained five miliarenses of 60 in the pound, was worth 120 folles of copper. The glossographer, describing a follis of 250 denarii, says it was equal to 312 pounds 6 ounces of copper, and as the denarius of that age was the 8th part of an ounce, an ounce of silver must have been worth 120 ounces of copper; and therefore the scholiast's follis was an ounce of copper, and equal to the glossographer's nummus. But as Constantine's copper money weighed a quarter of a Roman ounce, the scholiast's follis and the glossographer's nummus contained four of them, as the ancient nummus contained four asses.

FOLLY, according to Mr Locke, consists in the drawing of false conclusions from just principles; by which it is distinguished from madness, which draws just conclusions from false principles.

But this seems too confined a definition; *folly*, in its most general acceptation, denoting a weakness of intellect or apprehension, or some partial absurdity in sentiment or conduct.

FOMAHAUT, in *Astronomy*, a star of the first magnitude in the constellation AQUARIUS.

FOMENTATION, in *Medicine*, is a fluid externally applied, usually as warm as the patient can bear it, and in the following manner. Two flannel cloths are dipped into the heated liquor, one of which is wrung as dry as the necessary speed will admit, then immediately applied to the part affected; it lies on until the heat begins to go off, and the other is in readiness to apply at the instant in which the first is removed: thus these flannels are alternately applied, so as to keep the affected part constantly supplied with them warm. This is continued 15 or 20 minutes, and repeated two or three times a-day.

Every intention of relaxing and soothing by fomentations may be answered as well by warm water alone as when the whole tribe of emollients are boiled in it; but when discutients or antiseptics are required, such ingredients must be called in as are adapted to that end.

The degree of heat should never exceed that of producing a pleasing sensation; great heat produces effects very opposite to that intended by the use of fomentations.

FONG-YANG, a city of China, in the province of *KIANG-NAN*. It is situated on a mountain, which hangs over the Yellow river, and encloses with its walls several fertile little hills. Its jurisdiction is very extensive: for it comprehends 18 cities; five of which are of the second, and 13 of the third class. As this was the birth-place of the emperor Hong-vou, chief of the preceding dynasty, this prince formed a design of rendering it a famous and magnificent city, in order to make it the seat of empire. After having expelled the Western Tartars, who had taken possession of China, he transferred his court hither, and named the city *Fong-yang*; that is to say, "The Place of the Eagle's Splendour." His intention, as we have said, was to beautify and enlarge it; but the inequality of the ground, the scarcity of fresh water, and above all the vicinity of his father's tomb, made him change his design. By the unanimous advice of his principal officers, this prince established his court at NAN-KING, a more beautiful and commodious place. When he had formed this resolution, a stop was put to the intended works: the imperial palace which was to have been enclosed by a triple wall, the walls of the city to which a circumference of nine leagues were assigned, and the canals that were begun, all were abandoned; and nothing was finished, but three monuments that still remain. The extent and magnificence of these sufficiently show what the beauty of this city would have been, had the emperor pursued his original design. The first is the tomb of the father of Hong-vou, to decorate which no expence was spared; it is called *Hoan-lin*, or the *Royal Tomb*. The second is a tower built in the middle of the city, which is of an oblong form, and 100 feet high. The third is a magnificent temple erected to the god Fo. At first it was only a pagod, to which Hong-vou retired after having lost his parents, and where he was admitted as an inferior domestic; but, having soon become weary of this kind of life, he enlisted with the chief of a band of banditti, who had revolted from the Tartars. As he was bold and enterprising, the general made choice of him for his son-in-law; soon after, he was declared his successor by the unanimous voice of the troops. The new chief, seeing himself at the head of a large party, had the presumption to carry his views to the throne. The Tartars, informed of the progress of his arms, sent a numerous army into the field; but he surprised and attacked them with so much impetuosity, that they were obliged to fly; and, though they several times returned to the charge, they were still defeated, and at length driven entirely out of China. As soon as he mounted the throne, he caused the superb temple which we have mentioned to be raised out of gratitude to the Bonzes, who had received him in his distress, and assigned them a revenue sufficient for the maintenance of 300 persons, under a chief of their own sect, whom he constituted a mandarin, with power of governing them, independent of the officers of the city. This pagod was supported as long as the preceding dynasty lasted; but that of the Eastern Tartars, which succeeded, suffered it to fall to ruin.

FONG-Choui, the name of a ridiculous superstition among the Chinese. See CHINA, N° 105.

FONT, among ecclesiastical writers, a large bason in which water is kept for the baptizing of infants or other persons.

FONT, in the art of printing, denotes a complete assortment of letters, accents, &c. used in printing. See FOUNT.

FONTAINE, JOHN, the celebrated French poet, and one of the first-rate geniuses of his age, was born at Chateau-Thierri in Champagne, the 8th of July 1621, of a good family. At the age of 19 he entered amongst the Oratorians, but quitted that order 18 months after. He was 22 years of age before he knew his own talents for poetry; but hearing an ode of Malherbe read, upon the assassination of Henry IV. he was so taken with admiration of it, that the poetical fire, which had before lain dormant within him, seemed to be enkindled from that of the other great poet. He applied himself to read, to meditate, to repeat, in fine to imitate, the works of Malherbe. The first essays of his pen he confined to one of his relations who made him read the best Latin authors, Horace, Virgil, Terence, Quintilian, &c. and then the best

best compositions in French and Italian. He applied himself likewise to the study of the Greek authors, particularly Plato and Plutarch. Some time afterwards his parents made him marry a daughter of a lieutenant-general, a relation of the great Racine. This young lady, besides her very great beauty, was remarkable for the delicacy of her wit, and Fontaine never composed any work without consulting her. But as her temper was none of the best, to avoid dissension, he separated himself from her company as often as he well could. The famous duchess of Bouillon, niece to Cardinal Mazarine, being exiled to Chateau-Thierri, took particular notice of Fontaine. Upon her recal, he followed her to Paris; where by the interest of one of his relations, he got a pension settled upon him. He met with great friends and protectors amongst the most distinguished persons of the court, but Madame de la Sabliere was the most particular. She took him to live at her house, and it was then that Fontaine, divested of domestic concerns, led a life conformable to his disposition, and cultivated an acquaintance with all the great men of the age. It was his custom, after he was fixed at Paris, to go every year, during the month of September, to his native place of Chateau-Thierri, and pay a visit to his wife, carrying with him Racine, Despreaux, Chapelle, or some other celebrated writers. When he has sometimes gone thither alone by himself, he has come away without remembering even to call upon her; but seldom omitted selling some part of his lands, by which means he squandered away a considerable fortune. After the death of Madame de la Sabliere, he was invited into England, particularly by Madame Mazarine, and by St Evremond, who promised him all the sweets and comforts of life; but the difficulty of learning the English language, and the liberality of the duke of Burgundy, prevented his voyage.

About the end of the year 1692 he fell dangerously ill; and, as is customary upon these occasions in the Romish church, he made a general confession of his whole life to P. Poguet, an Oratorian; and, before he received the sacrament, he sent for the gentlemen of the French Academy, and in their presence declared his sincere compunction for having composed his Tales; a work he could not reflect upon without the greatest repentance and detestation; promising that if it should please God to restore his health, he would employ his talents only in writing upon matters of morality or piety. He survived this illness two years, living in the most exemplary and edifying manner, and died the 13th of March 1695, being 74 years of age. When they stripped his body, they found next his skin a hair shirt; which gave room for the following expression of the younger Racine:

Et l'Auteur de Jaconde est orné d'un Cilice.

Fontaine's character is remarkable for a simplicity, candour, and probity, seldom to be met with. He was of an obliging disposition; cultivating a real friendship with his brother poets and authors; and what is very rare, beloved and esteemed by them all. His conversation was neither gay nor brilliant, especially when he was not amongst his intimate friends. One day being invited to a dinner at a farmer general's, he ate a great deal, but did not speak. Rising up from table very early, under pretext of going to the academy, one of the company represented to him that it was not yet a proper time: "Well (says he), if it is not, I will stay a little longer." He had one son by his wife in the year 1660. At the age of 14, he put him into the hands of M. de Harley, the first president, recommending to him his education and fortune. It is said, that having been a long time without seeing him, he happened to meet him one day visiting, without recollecting him again, and mentioned to the company that he thought that young man had a good deal of wit and understanding. When they told him it was his own son, he answered in the most tranquil manner, "Ha! truly I am glad on't." An indifference, or rather an absence of mind, influenced his whole conduct, and rendered him often insensible to the inclemency of the weather. Madame de Bouillon going one morning to Versailles, saw him, abstracted in thought, sitting in an arbour; returning at night, she found him in the same place, and in the same attitude, although it was very cold, and had rained almost the whole day. He carried this simplicity so far, that he was scarcely sensible of the bad effects some of his writings might occasion, particularly his Tales. In a great sickness, his confessor exhorting him to prayer and alms deeds: "As for alms deeds (replied Fontaine), I am not able, having nothing to give; but they are about publishing a new edition of my Tales, and the bookseller owes me a hundred copies; you shall have them to sell, and distribute their amount amongst the poor." Another time P. Poguet exhorting him to repent of his faults, "If he has committed any (cried the nurse), I am sure it is more from ignorance than malice, for he has as much simplicity as an infant." One time having composed a tale, wherein he made a profane application of those words of the Gospel, "Lord, five talents thou didst deliver to me," he dedicated it, by a most ingenious prologue, to the celebrated Arnauld, telling him, it was to show to posterity the great esteem he had for the learned doctor. He was not sensible of the indecency of the dedication, and the profane application of the text, till Boileau and Racine represented it to him. He addressed another, by a dedication in the same manner, to the archbishop of Paris. His Fables are an immortal work, exceeding every thing in that kind, both ancient and modern, in the opinion of the learned. People of taste, the oftener they read them, will find continually new beauties and charms, not to be met with elsewhere. The descendants of this great poet are exempted in France from all taxes and impositions; a privilege which the intendants of Soissons to this day think it an honour to confirm to them.

FONTAINBLEAU, a town in the Isle of France, and in the Gatinois, remarkable for its fine palace, which has been the place where the kings of France used to lodge when they went a hunting. It was first embellished by Francis I. and every successive king has added something to it; so that it may now be called the finest pleasure house in the world. It stands in the midst of a forest, consisting of 26,424 arpents of land, each containing 100 square perches, and each perch 18 feet. E. Long. 2. 33. N. Lat. 40. 22.

FONTAINES, Peter Francis, a French critic, was born of a good family at Rouen in 1685. At 15, he entered into the society of the Jesuits; and at 30, quitted

quitted it, for the ſake of returning to the world. He was a prieſt, and had a cure in Normandy; but left it, and was, as a man of wit and letters, ſome time with the cardinal d'Auvergne. Having excited ſome attention at Paris by certain critical productions, the Abbé Bignon in 1724 committed to him the *Journal des Sçavans*. He acquitted himſelf well in this department, and was peaceably enjoying the applauſes of the public, when his enemies, whom by critical ſtrictures in his Journal he had made ſuch, formed an accuſation againſt him of a moſt abominable crime, and procured him to be impriſoned. By the credit of powerful friends, he was ſet at liberty in 15 days: the magiſtrate of the police took upon himſelf the trouble of juſtifying him in a letter to the Abbé Bignon; and this letter having been read amidſt his fellow labourers in the Journal, he was unanimouſly re-eſtabliſhed in his former credit. This happened in 1725. But with whatever repute he might acquit himſelf in this Journal, frequent diſguſts made him frequently abandon it. He laboured meanwhile in ſome new periodical works, from which he derived his greateſt fame. In 1731, he began one under the title of *Nouvelliſte du Parnaſſe, ou Reflections ſur les Ouvrages nouveaux*: but only proceeded to two volumes; the work having been ſuppreſſed by authority, from the inceſſant complaints of authors ridiculed therein. About three years after, in 1735, he obtained a new privilege for a periodical production, entitled, *Obſervations ſur les Ecrits Modernes*; which, after continuing to 33 volumes, was ſuppreſſed again in 1743. Yet the year following, 1774, he publiſhed another weekly paper, called, *Jugemens ſur les Ouvrages nouveaux*, and proceeded to 11 volumes: the two laſt being done by other hands. In 1745, he was attacked with a diſorder in the breaſt, which ended in a dropſy that proved fatal in five weeks. "He was (ſays M. Freron) born a ſentimental perſon; a philoſopher in conduct as well as in principle; exempt from ambition; and of a noble firm ſpirit, which would not ſubmit to ſue for preferments or titles. In common converſation he appeared only a common man: but when ſubjects of literature, or any thing out of the ordinary way, were agitated, he diſcovered great force of imagination and wit." Beſides the periodical works mentioned above, he was the author of many others: his biographer gives us no leſs then 17 articles; many of them critical, ſome hiſtorical, and ſome tranſlations from Engliſh writers, chiefly from Pope, Swift, Fielding, &c. The Abbé de la Porte, publiſhed, in 1757, *L'Eſprit de l'Abbé des Fontaines*, in 4 vols. 12mo; prefixed to which is the Life of Fontaines, a catalogue of his works, and another catalogue of writings againſt him.

FONTANELLA, in *Anatomy*, imports the quadrangular aperture found betwixt the os frontis and oſſa ſincipitis, in children juſt born; which is alſo called *fons pulſatilis*.

FONTARABIA, a ſea port town of Spain, in Biſcay, and in the territory of Guipuſcoa, ſeated on a peninſula on the ſea ſhore, and on the river Bidaſſoa. It is ſmall, but well fortified both by nature and art; and has a good harbour, though dry at low water. It is built in the form of an amphitheatre, on the declivity of a hill, and ſurrounded on the land ſide by the lofty Pyrenean mountains. It is a very important place, being accounted the key of Spain on that ſide. W. Long. 1. 43. N. Lat. 43. 23.

FONTENELLE, Bernard le Bovier de, was a man of letters, born at Rouen in 1657, the moſt univerſal genius of the age of Louis XIV. in the eſtimation of Voltaire. He received his education in the college of Jeſuits at Rouen, where the quickneſs of his parts became conſpicuous at a very early period. He was capable of writing Latin verſes when only 13, which were deemed worthy of being publiſhed. He ſtudied the law at the deſire of his father; but as he loſt the very firſt cauſe in which he was employed as an advocate, he became diſguſted with his profeſſion, and devoted himſelf entirely to literature and philoſophy. He compoſed a conſiderable part of the operas of Pſyche and Bellerophon, which were printed under the name of his uncle Thomas Corneille. He wrote a tragedy called *Aſpar*, but as it did not ſucceed, he conſigned the manuſcript to the flames, and never afterwards attempted that ſpecies of compoſition. His Dialogues of the dead were publiſhed in the year 1683, which were well received, as a ſpecimen of elegant compoſition, combining morality with the charms of literature. His "Lettres du Chevalier d'Her," publiſhed in 1685 without his name, diſcovered much wit and ingenuity, but at the ſame time no ſmall ſhare of affectation. His "Entretiens ſur la Pluralité des Mondes," has been regarded as one of his ableſt performances, combining ſcience and philoſophy with vivacity and humour, a talent which may be ſaid to belong almoſt excluſively to the French. It was peruſed by all, and tranſlated into ſeveral foreign languages.

In his "Hiſtory of Oracles," he ſupported the opinion that oracles were forgeries, in oppoſition to thoſe who contended that they were ſupernatural operations of evil ſpirits, put to ſilence by the appearing of Chriſt, and of conſequence he expoſed himſelf to clerical animadverſion. His "Paſtoral Poems" appeared in the year 1688, with a diſcourſe on the nature of the eclogue, which were very much admired for their delicacy of ſentiment, as was alſo his opera of "Thetis and Peleus;" but his "Æneas and Lavinia" was not ſo ſucceſsful. In the year 1699, Fontenelle was choſen ſecretary of the Academy of Sciences, which office he held during the long period of 42 years. He publiſhed a volume annually of the hiſtory of that learned body, filled with analyſes of memoirs, and eulogiums on deceaſed members.

As a poet, he did not riſe above elegance and ingenuity; as a man of ſcience, he rather excelled in throwing light on the inventions of others, than in diſcovering any new truth himſelf, and as a general writer, he united ſolid ſenſe with the delicacy and refinement of a man of wit. He ſtudied his own happineſs as much as moſt men, but he never ſacrificed to the promotion of it, the duties of a man of honour and virtue. He had many friends, and towards the cloſe of life, ſcarcely a ſingle enemy. He was never married, and for a man of letters he acquired conſiderable affluence. Although of a delicate conſtitution, he reached the great age of 90 without any complaint but dullneſs of hearing. He died on the 9th of January 1757, being almoſt a hundred years of age. When aſked by a certain

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person how he could pass so easily through the world, he replied, "by virtue of these two axioms; All is possible, and every one is in the right."

FONTENOY, a town or village of the Austrian Netherlands, in the province of Hainault, and on the borders of Flanders; remarkable for a battle fought between the allies and the French on the first of May 1745. The French were commanded by Mareschal Saxe, and the allies by the Duke of Cumberland. On account of the superior numbers of the French army, and the superior generalship of their commander, the allies were defeated with great slaughter. The British troops behaved with great intrepidity, as their enemies themselves acknowledged. It has been said, that the battle was lost through the cowardice of the Dutch, who failed in their attack on the village of Fontenoy, on which the event of the day depended. E. Long. 2. 20. N. Lat. 50. 35.

FONTENOY, a village of France, in the duchy of Burgundy, remarkable for a bloody battle fought there in 841, between the Germans and the French, in which were killed above 100,000 men; and the Germans were defeated. E. Long. 3. 48. N. Lat. 47. 28.

FONTEVRAUD, or FRONTEVAUX, Order of, in ecclesiastical history, a religious order instituted about the latter end of the 11th century, and taken under the protection of the holy see by Pope Pascal II. in 1106, confirmed by a bull in 1113, and invested by his successors with very extraordinary privileges. The chief of this order is a female, who is appointed to inspect both the monks and nuns. The order was divided into four provinces, which were those of France, Aquitaine, Auvergne, and Bretagne, in each of which they had formerly several priories.

FONTICULUS, or FONTANELLA, in *Surgery*, an issue, seton, or small ulcer, made in various parts of the body, in order to excite irritation, or to produce the discharge of matter.

FONTINALIA, or FONTANALIA, in antiquity, a religious feast held among the Romans in honour of the deities who presided over fountains or springs. Varro observes, that it was the custom to visit the wells on those days, and to cast crowns into fountains. Scaliger, in his conjectures on Varro, takes this not to be a feast of fountains in general, as Festus insinuates, but of the fountain which had a temple at Rome, near the Porta Capena, called also *Porta Fontinalis*: he adds, that it is of this fountain Cicero speaks in his second book *De Legibus*. The fontinalia were held on the 13th of October.

FONTINALIS, WATER-MOSS, a genus of plants belonging to the cryptogamia class, and to the order of musci. See BOTANY *Index*.

FOOD, in the most extensive signification of the word, implies whatever aliments are taken into the body, whether solid or fluid; but in common language, it is generally used to signify only the solid part of our aliment.

We are told, that in the first ages men lived upon acorns, berries, and such fruits as the earth spontaneously produces; then they proceeded to eat the flesh of wild animals taken in hunting: But their numbers decreasing and mankind multiplying, necessity taught them the art of cultivating the ground, to sow corn, &c. By and by they began to assign to each other, by general consent, portions of land to produce them their supply of vegetables; after this, reason suggested the expedient of domesticating certain animals, both to assist them in their labours and supply them with food. Hogs were the first animals of the domestic kind that appeared upon their tables; they held it to be ungrateful to devour the beasts that assisted them in their labours.—When they began to make a free use of domestic animals, they roasted them only: boiling was a refinement in cookery which for ages they were strangers to; and fish living in an element men were unused to, were not eaten till they grew somewhat civilized. Menelaus complains, in the Odyssey, that they had been constrained to feed upon them.

The most remarkable distinction of foods, in a medical view, is into those which are already assimilated into the animal nature, and such as are not. Of the first kind are animal substances in general; which if not entirely similar, are nearly so, to our nature. The second comprehends vegetables, which are much more difficultly assimilated. But as the nourishment of all animals, even those which live on other animals, can be traced originally to the vegetable kingdom, it is plain, that the principle of all nourishment is in vegetables.

Though there is perhaps no vegetable which does not afford nourishment to some species of animals or other; yet, with regard to mankind, a very considerable distinction is to be made. Those vegetables which are of a mild, bland, agreeable taste, are proper nourishment; while those of an acrid, bitter, and nauseous nature, are improper. We use, indeed, several acrid substances as food; but the mild, the bland, and agreeable, are in the largest proportion in almost every vegetable. Such as are very acrid, and at the same time of an aromatic nature, are not used as food, but as spices or condiments, which answer the purposes of medicines rather than any thing else. Sometimes, indeed, acrid and bitter vegetables seem to be admitted as food. Thus celeri and endive are used in common food, though both are substances of considerable acrimony; but it must be observed, that, when we use them, they are previously blanched, which almost totally destroys their acrimony. Or if we employ other acrid substances, we generally, in a great measure, deprive them of their acrimony by boiling. In different countries, the same plants grow with different degrees of acrimony. Thus, garlic here seldom enters our food; but in the southern countries, where the plants grow more mild, they are frequently used for that purpose. The plant which furnishes cassada, being very acrimonious, and even poisonous, in its recent state, affords an instance of the necessity of preparing acrid substances even in the hot countries: and there are other plants, such as arum root, which are so exceedingly acrimonious in their natural state, that they cannot be swallowed with safety; yet, when deprived of that acrimony, will afford good nourishment.

Cullen on the Mat. Med. 1st edit.

The most remarkable properties of different vegetable substances as food, are taken notice of under their different names: here we shall only compare vegetable foods in general with those of the animal kind.

I. *In the Stomach*, they differ remarkably, in that the vegetables always have a tendency to acidity, while animal

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animal food of all kinds rather tends to alkalefcency and putrefaction. Some animal foods, indeed, turn manifeftly acid before they putrefy; and it has been afferted, that fome degree of acefcency takes place in every kind of animal food before digeftion. This acefcency of animal food, however, never comes to any morbid degree, but the difeafe is always on the fide of putrefcency. The acefcency of vegetables is more frequent, and ought to be more attended to, than the alkalefcency of animal food; which laft, even in weak ftomachs, is feldom felt; while acefcency greatly affects both the ftomach and fyftem.

With regard to their difference of *folution*:—Heavinefs, as it is called, is feldom felt from vegetables, except from tough farinaceous pafte, or the moft vifcid fubftances; while the heavinefs of animal food is more frequently noticed, efpecially when in any great quantity. Difficulty of folution does not depend fo much on firmnefs of texture (as a man, from fifh of all kinds, is more oppreffed than from firmer fubftances) as on vifcidity; and hence it is more frequent in animal food, efpecially in the younger animals.

With regard to *mixture*:—There is no inftance of difficult mixture in vegetables, except in vegetable oils; while animal foods, from both vifcidity and oilinefs, efpecially the fatter meats, are refractory in this refpect. Perhaps the difference of animal and vegetable foods might be referred to this head of mixture. For vegetable food continues long in the ftomach, giving little ftimulus: Now the fyftem is affected in proportion to the extent of this ftimulus, which is incomparably greater from the animal vifcid oily food, than from the vegetable, firmer, and more aqueous. However, there are certain applications to the ftomach, which have a tendency to bring on the cold fit of fever, independent of ftimulus, merely by their refrigeration: and this oftener arifes from vegetables; as we fee, in thofe hot countries where intermittents prevail, they are oftener induced from a furfeit of vegetable than of animal food. A proof of this is, that when one is recovering of an intermittent, there is nothing more apt to caufe a relapfe than cold food, efpecially if taken on thofe days when the fit fhould return, and particularly acefcent, fermentable vegetables, as falads, melons, cucumbers, &c. *acido-dulces*, &c. which, according to Dr Cullen, are the moft frequent caufes of epidemics; therefore, when an intermittent is to be avoided, we fhun vegetable diet, and give animal foods, although their ftimulus be greater.

II. *In the Inteftines*. When the putrefcency of animal food has gone too far, it produces an active ftimulus, caufing diarrhœa, dyfentery, &c. But thefe effects are but rare; whereas from vegetable food and its acid, which, united with the bile, proves a pretty ftrong ftimulus, they more frequently occur; but, luckily, are of lefs confequence, if the refrigeration is not very great. In the autumnal feafon, when there is a tendency to dyfentery, if it is obferved that eating of fruits brings it on, it is rather to be afcribed to their cooling than ftimulating the inteftines.

As to *ftool*:—Wherever neither putrefaction nor acidity has gone a great length, animal food keeps the belly more regular. Vegetable food gives a greater proportion of fucculent matter, and, when exficcated by the ftomach and inteftines, is more apt to ftagnate, and produce flow belly and coftivenefs, than animal ftimulating food; which, before it comes to the great guts, where ftoppage is made, has obtained a putrefactive tendency, and gives a proper ftimulus: and thus thofe who are coftive from the ufe of vegetables; when they have recourfe to animal food are in this refpect better.

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III. *In the blood-veffels*. They both give a blood of the fame kind, but of different quality. Animal food gives it in greater quantity, being in great part, as the expreffion is, convertible *in fuccum et fanguinem*, and of eafy digeftion; whereas vegetable is more watery, and contains a portion of unconquerable faline matter, which caufes it to be thrown out of the body by fome excretion. Animal food affords a more denfe ftimulating elaftic blood than vegetable; ftretching and caufing a great refiftance in the folids, and again exciting their ftronger action. It has been fuppofed that acefcency of vegetable food is carried into the blood-veffels, and there exerts its effects; but the tendency of animal fluids is fo ftrong to alkalefcency, that the exiftence of an acid acrimony in the blood feems very improbable. Animal food alone will foon produce an alkalefcent acrimony; and if a perfon who lives entirely on vegetables were to take no food for a few days, his acrimony would be alkalefcent.

IV. We are next to take notice of the *quantity of nutriment* thefe different foods afford. Nutriment is of two kinds: the firft repairs the wafte of the folid fibres; the other fupplies certain fluids, the chief of which is oil. Now, as animal food is eafier converted, and alfo longer retained in the fyftem, and as it contains a greater proportion of oil, it will afford both kinds of nutriment more copioufly than vegetables.

V. Laftly, *As to the different degrees of perfpirability of thefe foods*. This is not yet properly determined. Sanctorius conftantly fpeaks of mutton as the moft perfpirable of all food, and of vegetables as checking perfpiration. This is a confequence of the different ftimulus thofe foods give to the ftomach, fo that perfons who live on vegetables have not their perfpiration fo fuddenly excited. In time of digeftion, perfpiration is ftopped from whatever food, much more fo from cooling vegetables. Another reafon why vegetables are lefs perfpirable is, becaufe their aqueo-faline juices determine them to go off by urine, while the more perfectly mixed animal food is more equally diffufed over the fyftem, and fo goes off by perfpiration. Hence Sanctorius's accounts may be underftood; for vegetable aliment is not longer retained in the body, but moftly takes the courfe of the kidneys. Both are equally perfpirable in this refpect, viz. that a perfon living on either returns once a-day to his ufual weight; and if we confider the little nourifhment of vegetables, and the great tendency of animal food to corpulency, we muft allow that vegetable is more quickly perfpired than animal food.

As to the queftion, Whether man was originally defigned for animal or vegetable food, fee the article CARNIVOROUS.

With regard to the effects of thefe foods on men, it muft be obferved, that there are no perfons who live entirely on vegetables. The Pythagoreans themfelves ate milk; and thofe who do fo moftly, as thefe Pythagoreans, are weakly, fickly, and meagre, labour-

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ing under a conſtant diarrhœa and ſeveral other diſeaſes. None of the hardy, robuſt, live on theſe; but chiefly ſuch as gain a livelihood by the exertion of their mental faculties, as (in the Eaſt Indies) factors and brokers; and this method of life is now confined to the hot climates, where vegetable diet, without inconvenience, may be carried to great exceſs. Though it be granted, therefore, that man is intended to live on theſe different foods promiſcuouſly, yet the vegetable ſhould be in very great proportion. Thus the Laplanders are ſaid to live entirely on animal food: but this is contradicted by the beſt accounts; for Linnæus ſays, that beſides milk, which they take ſour, to obviate the bad effects of animal food, they uſe alſo calamenyanthes, and many other plants, copiouſly. So there is no inſtance of any nation living entirely either on vegetable or animal food, though there are indeed ſome who live particularly on one or other in the greateſt proportion. In the cold countries, *e. g.* the inhabitants live chiefly on animal food, on account of the rigour of the ſeaſon, their ſmaller perſpiration, and little tendency to putrefaction.

Of more importance, however, is the following than the former queſtion, viz. *In what proportion animal and vegetable food ought to be mixed?*

1. *Animal* food certainly gives moſt ſtrength to the ſyſtem. It is a known aphoriſm of Sanctorius, that *pondus addit robur;* which may be explained from the impletion of the blood-veſſels, and giving a proper degree of tenſion for the performance of ſtrong oſcillations. Now animal food not only goes a greater way in ſupplying fluid, but alſo gives the fluid more denſe and elaſtic. The art of giving the utmoſt ſtrength to the ſyſtem is beſt underſtood by thoſe who breed fighting cocks. Theſe people raiſe the cocks to a certain weight, which muſt bear a certain proportion to the other parts of the ſyſtem, and which at the ſame time is ſo nicely proportioned, as that, on loſing a few ounces of it, their ſtrength is very conſiderably impaired. Dr Robinſon of Dublin has obſerved, that the force and weight of the ſyſtem ought to be determined by the largeneſs of the heart, and its proportion to the ſyſtem: for a large heart will give large blood-veſſels, while at the ſame time the viſcera are leſs, particularly the liver; which laſt being increaſed in ſize, a greater quantity of fluid is determined into the cellular texture, and leſs into the ſanguineous ſyſtem. Hence we ſee how animal food gives ſtrength, by filling the ſanguiferous veſſels. What pains we now beſtow on cocks, the ancients did on the athletæ, by proper nouriſhment bringing them to a great degree of ſtrength and agility. It is ſaid that men were at firſt fed on figs, a proof of which we have from their nutritious quality: however, in this reſpect they were ſoon found to fall far ſhort of animal food; and thus we ſee, that men, in ſome meaſure, will work in proportion to the quality of their food. The Engliſh labour more than the Scots; and wherever men are expoſed to hard labour, their food ſhould be animal.—Animal food, although it gives ſtrength, yet loads the body; and Hippocrates long ago obſerved, that the athletic habit, by a ſmall increaſe, was expoſed to the greateſt hazards. Hence it is only proper for bodily labours, and entirely improper for mental exerciſes; for whoever would keep his mind acute and penetrating, will exceed rather on the ſide of vegetable food. Even the body is oppreſſed with animal food; a full meal alwas produces dulneſs, lazineſs, and yawning; and hence the feeding of gameſters, whoſe mind muſt be ready to take advantage, is always performed by avoiding a large quantity of animal food. Farther, With regard to the ſtrength of the body, animal food, in the firſt ſtage of life, is hardly neceſſary to give ſtrength: in manhood, when we are expoſed to active ſcenes, it is more allowable; and even in the decline of life, ſome proportion of it is neceſſary to keep the body in vigour. There are ſome diſeaſes which come on in the decay of life, at leaſt are aggravated by it; among theſe the moſt remarkable is the gout. This, when it is in the ſyſtem, and does not appear with inflammation in the extremities, has pernicious effects there, attacking the lungs, ſtomach, head, &c. Now to determine this to the extremities, a large proportion of animal food is neceſſary, eſpecially as the perſon is commonly incapable of much exerciſe.

Animal food, although it gives ſtrength, is yet of many hazards to the ſyſtem, as it produces plethora and all its conſequences. As a ſtimulus to the ſtomach and to the whole ſyſtem, it excites fever, urges the circulation, and promotes the perſpiration. The ſyſtem, however, by the repetition of theſe ſtimuli, is ſoon worn out; and a man who has early uſed the athletic diet, is either early carried off by inflammatory diſeaſes, or, if he takes exerciſe ſufficient to render that diet ſalutary, ſuch an accumulation is made of putreſcent fluids, as in his after life lays a foundation for the moſt inveterate chronic diſtempers. Therefore it is to be queſtioned, whether we ſhould deſire this high degree of bodily ſtrength, with all the inconveniences and dangers attending it. Thoſe who are chiefly employed in mental reſearches, and not expoſed to too much bodily labour, ſhould always avoid an exceſs of animal food. There is a diſeaſe which ſeems to require animal food, viz. the hyſteric, or hypochondriac; and which appears to be very much a-kin to the gout, affecting the alimentary canal. All people affected with this diſeaſe are much diſpoſed to aceſcency; which ſometimes goes ſo far, that no other vegetable but bread can be taken in, without occaſioning the worſt conſequences. Here then we are obliged to preſcribe an animal diet, even to thoſe of very weak organs; for it generally obviates the ſymptoms. However, ſeveral inſtances of ſcurvy in exceſs have been produced by a long continued uſe of this diet, which it is always unlucky to be obliged to preſcribe; and when it is abſolutely neceſſary to preſcribe, it ſhould be joined with as much of the vegetable as poſſible, and when a cure is performed we ſhould gradually recur to that again.

2. Next, let us conſider the *vegetable* diet. The chief inconveniency of this is difficulty of aſſimilation; which, however, in the vigorous and exerciſed, will not be liable to occur. In warm climates, the aſſimilation of vegetable aliment is more eaſy, ſo that *there* it may be more uſed, and when joined to exerciſe gives a pretty tolerable degree of ſtrength and vigour; and though the general rule be in favour of *animal* diet, for giving ſtrength, yet there are many inſtances of its being remarkably produced from vegetable. Vegetable diet has this advantage, that it whets the appetite, and that we can hardly ſuffer from a full meal of it. Beſides

the diſorders it is liable to produce in the *primæ viæ*, and its falling ſhort to give ſtrength, there ſeem to be no bad conſequences it can produce in the blood veſſels; for there is no inſtance where its peculiar acrimony was ever carried there, and it is certainly leſs putrefiable than animal food; nor, without the utmoſt indolence, and a ſharp appetite, does it give plethora, or any of its conſequences: ſo that we cannot here but conclude, that a large proportion of vegetable food is uſeful for the generality of mankind.

There is no error in this country more dangerous, or more common, than the neglect of bread: for it is the ſafeſt of vegetable aliments, and the beſt corrector of animal food; and, by a large proportion of this alone, its bad conſequences, when uſed in a hypochondriac ſtate, have been obviated. The French apparently have as much animal food on their tables as the British; and yet, by a greater uſe of bread and the dried acid fruits, its bad effects are prevented; and therefore bread ſhould be particularly uſed by the Engliſh, as they are ſo voracious of animal food. Vegetable food is not only neceſſary to ſecure health, but long life: and, as we have ſaid, in infancy and youth we ſhould be confined to it moſtly; in manhood, and decay of life, uſe animal food; and, near the end, vetable again.

There is another queſtion much agitated, viz. *What are the effects of variety in food?* Is it neceſſary and allowable, or univerſally hurtful? Variety of a certain kind ſeems neceſſary; as vegetable and animal foods have their mutual advantages, tending to correct each other. Another variety, which is very proper, is that of liquid and ſolid food, which ſhould be ſo managed as to temper each other; and liquid food, eſpecially of the vegetable kind, is too ready to paſs off before it is properly aſſimilated, while ſolid food makes a long ſtay. But this does not properly belong to the queſtion, whether variety of the ſame kind is neceſſary or proper, as in animal foods, beef, fiſh, fowl, &c. It doth not appear that there is any inconvenience ariſing from this mixture or difficulty of aſſimilation, provided a moderate quantity be taken. When any inconvenience does ariſe, it probably proceeds from this, that one of the particular ſubſtances in the mixture, when taken by itſelf would produce the *ſame effects;* and, indeed, it would appear, that this effect is not *heightened* by the mixture, but properly *obviated* by it. There are few exceptions to this, if any, e. g. taking a large proportion of aceſcent ſubſtances with milk. The coldneſs, &c. acidity, flatulency, &c. may appear; and it is poſſible that the coagulum, from the aceſcency of the vegetables, being ſomewhat ſtronger induced, may give occaſion to too long retention in the ſtomach, and to acidity in too great degree. Again, the mixture of fiſh and milk often occaſions inconveniences. The theory of this is difficult, though, from univerſal conſent, it muſt certainly be juſt. Can we ſuppoſe that fiſh gives occaſion to ſuch a coagulum as runnet? If it does ſo, it may produce bad effects. Beſides, fiſhes approach ſomewhat to vegetables, in giving little ſtimulus; and are accuſed of the ſame bad effects as theſe, viz. bringing on the cold fit of fever.

Thus much may be ſaid for variety. But it alſo has its diſadvantages, provoking to gluttony; this, and the art of cookery, making men take in more than they properly can digeſt: and hence, perhaps very juſtly, phyſicians have univerſally almoſt preferred ſimplicity of diet; for, in ſpite of rules, man's eating will only be meaſured by his appetite, and ſatiety is ſooner produced by *one* than by *many* ſubſtances. But this is ſo far from being an argument againſt variety, that it is one for it, as the only way of avoiding a full meal of animal food, and its bad effects, is by preſenting a quantity of vegetables. Another mean of preventing the bad effects of animal food, is to take a large proportion of liquid; and hence the bad effects of animal food are leſs felt in Scotland, on account of their drinking much with it, and uſing broths, which are at once excellent correctors of animal food and preventives of gluttony.

With regard to the difference between ANIMAL FOODS, properly ſo called, the firſt regards their ſolubility, depending on a lax or firm texture of their different kinds.

I. SOLUBILITY of animal food ſeems to deſerve leſs attention than is commonly imagined; for there are many inſtances of perſons of a weak ſtomach incapable of breaking down the texture of vegetables, or even of diſſolving a light pudding, to whom hung beef, or a piece of ham, was very grateful and eaſily digeſted. None of the theories given for the ſolution of animal food in the human ſtomach ſeem to have explained the proceſs ſufficiently. Long ago has been diſcarded the ſuppoſition of an active corroſive menſtruum there; and alſo the doctrine of trituration, for which, indeed, there ſeems no mechaniſm in the human body; and, till lately, phyſicians commonly agreed with Boerhaave in ſuppoſing nothing more to be neceſſary than a watery menſtruum, moderate heat, and frequent agitation. This will account for ſolution in ſome caſes, but not entirely. Let us try to imitate it out of the body with the ſame circumſtances, and in ten times the time in which the food is diſſolved in the ſtomach we ſhall not be able to bring about the ſame changes. Take the coagulated white of an egg, which almoſt every body can eaſily digeſt, and yet no artifice ſhall be able to diſſolve it. Hence, then, we are led to ſeek another cauſe for ſolution, viz. fermentation; a notion, indeed, formerly embraced, but on the introduction of mechanical philoſophy, induſtriouſly baniſhed, with every other ſuppoſition of that proceſs taking place at all in the animal economy.

Many of the ancients imagined this fermentation to be putrefactive. But this we deny, as an acid is produced; though hence the fermentation might be reckoned the vinous, which, however, ſeems always to be morbid. Neither, indeed, is the fermentation purely acetous, but modified by putreſcence; for Pringle has obſerved, that animal matters raiſe and even expede the acetous proceſs. The fermentation, then, in the ſtomach is of a mixed nature, between the acetous and putrefactive, mutually modifying each other; though, indeed, in the inteſtines, ſomewhat of the putrefactive ſeems to take place, as may be obſerved from the ſtate of the feces broke down, and from the little diſpoſition of ſuch ſubſtances to be ſo, which are not liable to the putrefactive proceſs, as the firmer parts of vegetables, &c. Upon this view ſolution ſeems to be extremely eaſy, and thoſe ſubſtances to be moſt eaſily broke down which

Food.

which are most subject to putrefaction. See ANATOMY, and GASTRIC *Juice*.

But solution also depends on other circumstances, and hence requires a more particular regard.

1. There is a difference of solubility with respect to the manducation of animal food, for which bread is extremely necessary, in order to keep the more slippery parts in the mouth till they be properly comminuted. From want of proper manducation persons are subject to eructations; and this more frequently from the firm vegetable foods, as apples, almonds, &c. than from the animal, though, indeed, even from animal food, very tendinous, or swallowed in unbroken masses, such sometimes occur. Manducation is so much connected with solution, that some, from imperfectly performing that, are obliged to belch up their food, remanducate it, and swallow it again before the stomach can dissolve it, or proper nourishment be extracted. Another proof of our regard to solubility, is our rejecting the firmer parts of animal food, as bull beef, and generally carnivorous animals.

2. Its effects with regard to solubility seem also to be the foundation of our choice between *fat* and *lean*, *young* and *old meats*. In the *lean* although perhaps a single fibre might be sufficiently tender, yet these, when collected in *fasciculi*, are very firm and compact, and of difficult solution; whereas in the *fat* there is a greater number of vessels, a greater quantity of juice, more interposition of cellular substance, and consequently more solubility. Again, In young animals, there is probably the same number of fibres as in the older, but these more connected: whereas, in the older, the growth depending on the separation of these, and the increase of vessels and cellular substance, the texture is less firm and more soluble; which qualities, with regard to the stomach, are at that time too increased, by the increased alkalescency of the animal. To this also may be referred our choice of castrated animals, viz. on account of their disposition to fatten after the operation.

3. It is with a view to the solubility, that we make a choice between meats recently killed, and those which have been kept for some time. As soon as meat is killed, the putrefactive process begins; which commonly we allow to proceed for a little, as that process is the most effectual breaker down of animal matters, and a great assistance to solution. The length of time during which meat ought to be kept, is proportioned to the meat's tendency to undergo the putrid fermentation, and the degree of those circumstances which favour it: Thus, in the torrid zone, where meat cannot be kept above four or five hours, it is used much more recent than in these northern climates.

4. *Boiled* or *roasted* meats create a difference of solution. By boiling we extract the juices interposed between the fibres, approximate them more to each other, and render them of more difficult solubility; which is increased too by the extraction of the juices, which are much more alkalescent than the fibres: but when we want to avoid the stimulus of alkalescent food, and the quick solution, as in some cases of disease, the roasted is not to be chosen. Of roasted meat it may be asked, which are more proper, those which are most or least roasted? That which is least done is certainly the most soluble: even raw meats are more soluble than dressed, as Dr Cullen was informed by a person who from necessity was obliged, for some time, to eat such. But at the same time that meats little done are very soluble, they are very alkalescent; so that, wherever we want to avoid alkalescency in the *primæ viæ*, the most roasted meats should be chosen. Those who throw away the broths of boiled meat do very improperly; for, besides their supplying a fluid, from their greater alkalescency they increase the solubility of the meat. Here we shall observe, that pure blood has been thought insoluble. Undoubtedly it is very nutritious; and though out of the body, like the white of eggs, it seems very insoluble, yet, like that too, in the body it is commonly easily digested. Moses very properly forbade it the Israelites, as in warm countries it is highly alkalescent; and even here, when it was used in great quantity, the scurvy was more frequent: but to a moderate use of it, in these climates, no such objection takes place.

5. Solubility is varied from another source, viz. viscidity of the juice of aliment. Young animals, then, appear more soluble than old, not only on account of the compaction and firmness of texture in the latter, but also their greater viscidity of juice. And nothing is more common, than to be longer oppressed from a full meal of veal, than from the same quantity of beef, &c. Upon account, too, of their greater viscidity of juice, are the tendinous and ligamentous parts of animals longer retained than the purely muscular, as well as on account of their firmness of texture. Even fishes, whose muscular parts are exceedingly tender, are, on account of their gluey viscosity, longer of solution in the stomach. And eggs, too, which are exceedingly nourishing, have the same effect, and cannot be taken in great quantity: For the stomach is peculiarly sensible to gelatinous substances; and by this means has nature perhaps taught us, as it were by a sort of instinct, to limit ourselves in the quantity of such nutritive substances.

6. With regard to solution, we must take in the oils of animal food; which, when tolerably pure, are the least putrescent part of it, and, by diminishing the cohesion of the fibres, render them more soluble. On this last account is the lean of fat meat more easily dissolved than other lean. But when the meat is exposed to much heat, this oil is separated, leaving the solid parts less easily soluble, and becoming itself empyreumatic, rancescent, and of difficult mixture in the stomach. Fried meats, from the reasons now given, and baked meats, for the same, as well as for the tenacity of the paste, are preparations which diminish the solubility of the food. From what has been said, the preparation of food by fattening it, and keeping it for some time after being killed, although it may administer to gluttony, will yet, it must be confessed, increase the solution of the food.

II. The second difference of animal food is with regard to ALKALESCENCY.

Of this we have taken a little notice already under the head of *Solubility*.

1. From their too great alkalescency we commonly avoid the carnivorous animals, and the *feræ*; and choose rather the granivorous. Some birds, indeed, which live on insects, are admitted into our food; but no

no man, without *nauſea*, can live upon theſe alone for any length of time. Fiſhes, too, are an exception to this rule, living almoſt univerſally on each other. But in theſe the alkaleſcency does not proceed ſo far; whether from the viſcidity of their juice, their want of heat, or ſome peculiarity in their economy, is not eaſy to determine.

2. Alkaleſcency is determined by difference of age. The older animals are always more alkaleſcent than the young, from their continual progreſs to putrefaction. Homberg always found, in his endeavours to extract an acid from human blood, that more was obtained from the young than from the old animals.

3. A third circumſtance which varies the alkaleſcency of the food, is the wildneſs or tameneſs of the animal; and this again ſeems to depend on its exerciſe. Dr Cullen knew a gentleman who was fond of cats for food; but he always uſed to feed them on vegetable food, and kept them from exerciſe; and in the ſame manner did the Romans rear up their rats, when intended for food. In the ſame way the fleſh of the partridge and the hen ſeems to be much the ſame; only, from its being more on the wing, the one is more alkaleſcent than the other. Again, Tame animals are commonly uſed without their blood; whereas the wild are commonly killed in their blood, and upon that account, as well as their greater exerciſe, are more alkaleſcent.

4. The alkaleſcency of food may be determined from the quantity of volatile ſalt it affords. The older the meat is, it is found to give the greater proportion of volatile ſalt.

5. The alkaleſcency of aliment may alſo, in ſome meaſure, be determined from its colour, the younger animals being whiter and leſs alkaleſcent. We alſo take a mark from the colour of the gravy poured out, according to the redneſs of the juices judging of the animal's alkaleſcency.

6. The reliſh of food is found to depend much on its alkaleſcency, as does alſo the ſtimulus it gives and the fever it produces in the ſyſtem. Theſe effects are alſo complicated with the viſcidity of the food, by which means it is longer detained in the ſtomach, and the want of alkaleſcency ſupplied.

Having mentioned animal food as differing in ſolubility and alkaleſcency, which often go together in the ſame ſubject, we come to the third difference, viz.

III. Quantity of Nutriment. Which is either abſolute or relative: abſolute with reſpect to the quantity it really contains, ſufficient powers being given to extract it; relative, with reſpect to the aſſimilatory powers of thoſe who uſe it. The abſolute nutriment is of ſome conſequence; but the relative, in the robuſt and healthy, and except in caſes of extraordinary weakneſs, may, without much inconvenience, be diſregarded. In another caſe is the quantity of nouriſhment relative, viz. with regard to its *perſpirability;* for if the food is ſoon carried off by the excretions, it is the ſame thing as if it contained a leſs proportion of nouriſhment. For, giving more fluid, that which is longer retained affords moſt; and, for the repair of the ſolids, that retention alſo is of advantage. Now, gelatinous ſubſtances are long retained; and beſides, are themſelves animal ſubſtances diſſolved: ſo that, both abſolutely and relatively, ſuch ſubſtances are nutritious. Of this kind are eggs, ſhell fiſh, &c. In adults, though it is diſputed whether their ſolids need any repair, yet at any rate, at this period, fluid is more required; for this purpoſe the alkaleſcent foods are moſt proper, being moſt eaſily diſſolved. They are, at the ſame time, the moſt perſpirable; on one hand that alkaleſcency leading to diſeaſe, while on the other their perſpirability obviates it. Adults, therefore, as writers juſtly obſerve, are better nouriſhed on the alkaleſcent; the young and growing, on gelatinous foods. All this leads to a compariſon of young and old meats; the firſt being more gelatinous, and the laſt more alkaleſcent. This however, by experience, is not yet properly aſcertained. Mr Geoffroy is the only perſon who has been taken up with the analyſis of foods. See *Memoires de l'Academie*, l'an. 1731 & 1732. His attempt was certainly laudable, and in ſome reſpects uſefully performed; but, in general, his experiments were not ſufficiently repeated, nor are indeed ſufficiently accurate. He has not been on his guard againſt the various circumſtances which affect meats; the cow-kind liking a moiſt ſucculent herbage, which is not to be got in warm climates; while the ſheep are fond of dry food, and thrive beſt there. Again, Some of his experiments ſeem contradictory. He ſays, that veal gives more ſolution than beef, while lamb gives leſs than mutton, which is much to be doubted. If both he and Sanctorius had examined Engliſh beef, the reſult probably would have been very different as to its perſpirability, &c. Beſides, Mr Geoffroy has only analyzed beef and veal when raw; has made no proper circumſtantial compariſons between quadrupeds and birds; and has examined theſe laſt along with their bones, and not their muſcles, &c. by themſelves, as he ought to have done, &c. If a ſet of experiments of this kind were properly and accurately performed, they might be of great uſe; but at preſent, for the purpoſe of determining our preſent ſubject, we muſt have recourſe to our alkaleſcency, ſolubility, &c.

IV. The fourth difference of animal food is, *The Nature of the Fluids they afford.* The whole of this will be underſtood from what has been ſaid on alkaleſcency; the fluid produced being more or leſs denſe and ſtimulating, in proportion as that prevails.

V. The fifth difference of animal foods is with reſpect to their

Perspirability. The ſum of what can be ſaid on this matter is this, that ſuch foods as promote an accumulation of fluid in our veſſels and diſpoſe to plethora, are the leaſt perſpirable, and commonly give moſt ſtrength; that the more alkaleſcent foods are the moſt perſpirable, though the viſcid and leſs alkaleſcent may attain the ſame property by long retention in the ſyſtem. The authors on perſpirability have determined the perſpiration of foods as imperfectly as Mr Geoffroy has done the ſolubility, and in a few caſes only. We muſt not lay hold on what Sanctorius has ſaid on the perſpirability of mutton, becauſe he has not examined in the ſame way other meats in their perfect ſtate; far leſs on what Keil ſays of oyſters, as he himſelf was a valetudinarian, and conſequently an unfit ſubject for ſuch experiments, and probably of a peculiar temperament.

As to the effects of Food on the Mind, we have already hinted at them above. It is plain, that delicacy

cacy of feeling, livelinefs of imagination, quicknefs of apprehenfion, and acutenefs of judgment, more frequently accompany a weak ftate of the body. True it is indeed, that the fame ftate is liable to timidity, fluctuation and doubt; while the ftrong have that fteadinefs of judgment, and firmnefs of purpofe, which are proper for the higher and more active fcenes of life. The moft valuable ftate of the mind, however, appears to refide in fomewhat lefs firmnefs and vigour of body. Vegetable aliment, as never over-diftending the veffels or loading the fyftem, never interrupts the ftronger motions of the mind; while the heat, fulnefs, and weight, of animal food, are an enemy to its vigorous efforts. Temperance, then, does not fo much confift in the quantity, for that always will be regulated by our appetite, as in the quality, viz. a large proportion of vegetable aliment.

A confiderable change has now taken place in the articles made ufe of as food by the ancients, by fubftituting, inftead of what were then ufed, particularly of the vegetable kind, a number of more bland, agreeable, and nutritive juices. The acorns and nuts of the primitive times have given way to a variety of fweeter farinaceous feeds and roots. To the malvaceous tribe of plants fo much ufed by the Greeks and Romans, hath fucceeded the more grateful fpinach: and to the blite, the garden orach. The rough borage is fupplanted by the acefcent forrel: and afparagus has banifhed a number of roots recorded by the Roman writers under the name of *bulbs;* but Linnæus is of opinion, that the parfnip has undefervedly ufurped the place of the fkirret. The bean of the ancients, improperly fo called, being the roots as well as other parts of the *nymphæa melumbo*, or Indian water-lily, is fuperfeded by the kidney bean. The garden rocket, eaten with and as an antidote againft the chilling qualities of the lettuce, is banifhed by the more agreeable crefs and tarragon; the apium by the meliorated celery; the pompion, and others of the cucurbitaceous tribe, by the melon; and the fumach berries, by the fragrant nutmeg. The filphium, or fuccus Cyrenaicus, which the Romans purchafed from Perfia and India at a great price, and is thought by fome to have been the afafœtida of the prefent time, is no longer ufed in preference to the alliaceous tribe.

To turn from the vegetable to fome of the animal fubftitutes, we may mention the carp among fifhes as having excluded a great number held in high eftimation among the Romans; the change of oil for butter; of honey for fugar; of mulfa, or liquors made of wine, water, and honey, for the wines of modern times; and that of the ancient zythus for the prefent improved malt liquors; not to mention alfo the *Callida* of the Roman taverns, analogous to our tea and coffee.

Food of Plants. See AGRICULTURE *Index.*

FOOL, according to Mr Locke, is a perfon who makes falfe conclufions from right principles; whereas a madman, on the contrary, draws right conclufions from wrong principles. See FOLLY.

Fool-Stones. See ORCHIS, BOTANY *Index.*

FOOSHT, an ifland in the Red fea; fituated, according to the obfervations of Mr Bruce, in N. Lat. 13° 59′ 43″. It is defcribed by him as about five miles in length from north to fouth, though only *nine* in circumference. It is low and fandy in the fouthern part, but the north rifes in a black hill of inconfiderable height. It is covered with a kind of bent grafs, which never arifes at any great length by reafon of want of rain and the conftant browzing of the goats. There are great appearances of the black hill having once been a volcano; and near the north cape the ground founds hollow like the Solfaterra in Italy. There are a vaft number of beautiful fifh met with upon the coafts, but few fit for eating, and our traveller obferved, that the moft beautiful were the moft noxious when eaten; none indeed, being falutary food excepting thofe which refembled the fifh of the northern feas. There are many beautiful fhell-fifh, as the concha veneris, of feveral colours and fizes; fea urchins, &c. Sponges are likewife found all along the coaft. There are alfo pearls, but neither large nor of a good-water; in confequence of which they fell at no great price. They are produced by a fpecies of bivalve fhells. Several large fhells, from the fifh named *biffer*, are met with upon ftones of ten or twelve tons weight along the coaft. They are turned upon their faces and funk into the ftones, as into a pafte, the ftone being raifed all about them in fuch a manner as to cover the edge of the fhell; "a proof (fays Mr Bruce) that this ftone muft fome time lately have been foft or liquefied: for had it been long ago, the fun and air would have worn the furface of the fhell; but it feems perfectly entire, and is fet in that hard brown rock as the ftone of a ring is in a golden chafing."—The water in this ifland is very good.

The inhabitants of Foosht are poor fifhermen of a fwarthy colour; going naked, excepting only a rag about their waift. They have no bread but what they procure in exchange for the fifh they catch. What they barter in this manner is called *feajan.* But befides this they catch another fpecies, which is flat, with a long tail, and the fkin made ufe of for fhagreen, of which the handles of knives and fwords are made. There is a fmall town on the ifland, confifting of about 30 huts, built with faggots of bent grafs or fpartum, fupported by a few fticks, and thatched with grafs of the fame kind of which they are built.

FOOT, a part of the body of moft animals whereon they ftand, walk, &c. See ANATOMY.

FOOT, in the Latin and Greek poetry, a metre or meafure, compofed of a certain number of long and fhort fyllables.

Thefe feet are commonly reckoned 28: of which fome are fimple, as confifting of two or three fyllables, and therefore called *diffyllabic* or *trifyllabic feet;* others are compound, confifting of four fyllables, and are therefore called *tetrafyllabic feet.*

The diffyllabic feet are four in number, viz. the pyrrhichius, fpondeus, iambus, and trocheus. See PYRRHICHIUS, &c.

The trifyllabic feet are eight in number, viz. the dactylus, anapæftus, tribrachys, moloffus, amphibrachys, amphimacer, bacchius, and antibacchius. See DACTYL, &c.

The tetrafyllabic are in number 16, viz. the proceleufmaticus, difpondeus, choriambus, antifpaftus, diiambus, dichoreus, ionicus a majore, ionicus a minore, epitritus primus, epitritus fecundus, epitritus tertius, epitritus

Foot, Foote.

epitritus quartus, pæon primus, pæon secundus, pæon tertius, and pæon quartus. See PROCELEUSMATICUS, &c.

FOOT is also a long measure consisting of 12 inches. Geometricians divide the foot into 10 digits, and the digit into 10 lines.

Foot-Halt, the name of a disorder peculiar to sheep. It is occasioned by an insect, which, when it comes to a certain maturity, resembles a worm of two, three, or four inches in length. See FARRIERY *Index*.

Foot Square, is the same measure both in breadth and length, containing 144 square or superficial inches.

Cubic or *Solid Foot*, is the same measure in all the three dimensions, length, breadth, and depth or thickness, containing 1728 cubic inches.

Foot of a Horse, in the manege, the extremity of the leg, from the coronet to the lower part of the hoof.

Foot Level, among artificers, an instrument that serves as a foot rule, a square, and a level. See LEVEL, RULE, and SQUARE.

FOOTE, SAMUEL, Esq. the modern Aristophanes, was born at Truro, in Cornwall; and was descended from a very ancient family. His father was member of parliament for Tiverton, in Devonshire, and enjoyed the post of commissioner of the prize office and fine-contract. His mother was heiress of the Dinely and Goodere families. In consequence of a fatal misunderstanding between her two brothers, Sir John Dinely Goodere, Bart. and Samuel Goodere, Esq. captain of his majesty's ship the Ruby, which ended in the death of both, a considerable part of the Goodere estate, which was better than 5000l. per annum, descended to Mr Foote.

He was educated at Worcester college, Oxford, which owed its foundation to Sir Thomas Cookes Winford, Bart. a second cousin of our author's. On leaving the university, he commenced student of law in the Temple; but as the dryness of this study did not suit the liveliness of his genius, he soon relinquished it. He married a young lady of a good family and some fortune; but their tempers not agreeing, a perfect harmony did not long subsist between them. He now launched into all the fashionable foibles of the age, gaming not excepted, and in a few years spent his whole fortune. His necessities led him to the stage, and he made his first appearance in the character of Othello. He next performed Fondlewife with much more applause; and this, indeed, was ever after one of his capital parts. He attempted Lord Foppington likewise, but prudently gave it up. But as Mr Foote was never a capital actor in the plays of others, his salary was very unequal to his gay and extravagant turn; and he contracted debts which forced him to take refuge within the verge of the court. On this occasion, he relieved his necessities by the following stratagem. Sir Fr—s D—l—l had long been his intimate friend, and had dissipated his fortune by similar extravagance. Lady N-ff-u P—let, who was likewise an intimate acquaintance of Foote's, and who was exceedingly rich, was fortunately at that time bent upon a matrimonial scheme. Foote strongly recommended to her to consult upon this momentous affair the conjurer in the Old Bailey, whom he represented as a man of surprising skill and penetration. He employed an acquaintance of his own to personate the conjurer; who depicted Sir Fr—s D—l—l at full length; described the time when, the place where, and the dress in which she would see him. The lady was so struck with the coincidence of every circumstance, that she married D—l—l in a few days. For this service Sir Francis settled an annuity upon Foote; and this enabled him once more to emerge from obscurity.

Foote

In 1747 he opened the little theatre in the Haymarket, taking upon himself the double character of author and performer; and appeared in a dramatic piece of his own composing, called the *Diversions of the Morning*. This piece consisted of nothing more than the exhibition of several characters well known in real life; whose manner of conversation and expression this author very happily hit off in the diction of his drama, and still more happily represented on the stage, by an exact and most amazing imitation, not only of the manner and tone of voice, but even of the very persons, of those whom he intended to take off. In this performance, a certain physician, Dr L—n, well known for the oddity and singularity of his appearance and conversation, and the celebrated Chevalier Taylor, who was at that time in the height of his popularity, were made objects of Foote's ridicule; the latter, indeed very deservedly; and, in the concluding part of his speech, under the character of a theatrical director, Mr Foote took off, with great humour and accuracy, the several styles of acting of every principal performer on the English stage. This performance at first met with some opposition from the civil magistrates of Westminster, under the sanction of the act of parliament for limiting the number of playhouses, as well as from the jealousy of one of the managers of Drury-lane playhouse; but the author being patronized by many of the principal nobility, and other persons of distinction, this opposition was over-ruled: and having altered the title of his performance, Mr Foote proceeded, without further molestation, to give *Tea in a Morning* to his friends, and represented it through a run of 40 mornings to crowded and splendid audiences.—The ensuing season he produced another piece of the same kind, which he called *An Auction of Pictures*. In this performance he introduced several new and popular characters; particularly Sir Thomas de Veil, then the acting justice of peace for Westminster, Mr Cock the celebrated auctionier, and the equally famous Orator Henley. This piece also had a very great run. —His *Knights*, which was the produce of the ensuing season, was a performance of somewhat more dramatic regularity: but still, although his plot and characters seemed less immediately personal, it was apparent that he kept some particular real persons strongly in his eye in the performance; and the town took upon themselves to fix them where the resemblance appeared to be the most striking. Thus Mr Foote continued from time to time to select, for the entertainment of the public, such characters, as well general as individual, as seemed most likely to engage their attention. His dramatic pieces, exclusive of the interlude called *Piety in Pattens*, are as follow: Taste, the Knights, The Author, The Englishman in Paris, The Englishman returned from Paris, The Mayor of Garrat, The Liar, The Patron, The Minor, The Orators, The

 Commissary,

Commiſſary, The Devil upon Two Sticks, The Lame Lover, The Maid of Bath, The Nabob, The Cozeners, The Capuchin, The Bankrupt, and an unfiniſhed comedy called The Slanderer. All theſe works are only to be ranked among the *petites pieces* of the theatre. In the execution they are ſomewhat looſe, negligent, and unfiniſhed; the plots are often irregular, and the cataſtrophes not always concluſive: but, with all theſe deficiencies, they contain more ſtrength of character, more ſtrokes of keen ſatire, and more touches of temporary humour, than are to be found in the writings of any other modern dramatiſt. Even the language ſpoken by his characters, incorrect as it may ſometimes ſeem, will on a cloſer examination be found entirely dramatical; as it abounds with thoſe natural minutiæ of expreſſion which frequently form the very baſis of character, and which render it the trueſt mirror of the converſation of the times in which he wrote.

In the year 1766, being on a party of pleaſure with the late duke of York, Lord Mexborough, and Sir Francis Delaval, Mr Foote had the misfortune to break his leg, by a fall from his horſe; in conſequence of which, he was compelled to undergo an amputation. This accident ſo ſenſibly affected the duke, that he made a point of obtaining for Mr Foote a patent for life; whereby he was allowed to perform, at the little theatre in the Haymarket, from the 15th of May to the 15th of September every year.

He now became a greater favourite of the town than ever: his very laughable pieces, with his more laughable performance, conſtantly filled his houſe; and his receipts were ſome ſeaſons almoſt incredible. Parſimony was never a vice to be aſcribed to Mr Foote; his hoſpitality and generoſity were ever conſpicuous; he was viſited by the firſt nobility, and he was ſometimes honoured even by royal gueſts.

The attack made upon his character by one of his domeſtics, whom he had diſmiſſed for miſbehaviour, is too well known to be particularized here. Suffice it to ſay, he was honourably acquitted of that charge: but it is believed by ſome, that the ſhock which he received from it accelerated his death; others pretend, that his literary altercation with a certain *then* ducheſs, or rather her agents, much affected him, and that from that time his health declined. It is probable, however, that his natural volatility of ſpirits could ſcarcely fail to ſupport him againſt all impreſſions from either of theſe quarters.

Mr Foote, finding his health decline, entered into an agreement with Mr Colman, for his patent of the theatre; according to which, he was to receive from Mr Colman, 1600l. per annum, beſides a ſtipulated ſum whenever he choſe to perform. Mr Foote made his appearance two or three times in ſome of the moſt admired characters; but being ſuddenly affected with a paralytic ſtroke one night whilſt upon the ſtage, he was compelled to retire. He was adviſed to bathe; and accordingly repaired to Brighthelmſtone, where he apparently recovered his former health and ſpirits, and was what is called the *fiddle of the company* who reſorted to that agreeable place of amuſement. A few weeks before his death, he returned to London; but, by the advice of his phyſicians, ſet out with an intention to ſpend the winter at Paris and in the ſouth of France. He had got no farther than Dover, when he was ſuddenly attacked by another ſtroke of the palſy, which in a few hours terminated his exiſtence. He died on the 21ſt of October 1777, in the 56th year of his age, and was privately interred in the cloiſters of Weſtminſter abbey.

FOP, probably derived from the *vappa* of Horace, applied in the firſt ſatire of his firſt book to the wild and extravagant Nævius, is uſed among us to denote a perſon who cultivates a regard to adventitious ornament and beauty to exceſs.

FORAMEN, in *Anatomy*, a name given to ſeveral apertures or perforations in divers parts of the body; as, 1. The external and internal foramina of the cranium or ſkull. 2. The foramina in the upper and lower jaw. 3. Foramen lachrymale. 4. Foramen membranæ tympani.

Foramen Ovale, an oval aperture or paſſage through the heart of a fœtus, which cloſes up after birth. It ariſes from the coronal vein, near the right auricle, and paſſes directly into the left auricle of the heart, ſerving for the circulation of the blood in the fœtus, till ſuch time as the infant breathes, and the lungs are open: in this the fœtus differs from the adult; although almoſt all anatomiſts, Mr Cheſelden excepted, aſſure us, that the foramen ovale has ſometimes been found in adults. See Foetus.

FORBES, Duncan, Eſq. of Culloden, lord preſiden of the court of ſeſſion in Scotland, was born in the year 1685. In his early life, he was brought up in a family remarkable for hoſpitality; which, perhaps, led him afterwards to a freer indulgence in ſocial pleaſures. His natural diſpoſition inclined him to the army: but, as he ſoon diſcovered a ſuperior genius, by the advice of his friends he applied himſelf to letters. He directed his ſtudies particularly to the civil law; in which he made a quick progreſs, and in 1709 was admitted an advocate. From 1722 to 1737, he repreſented in parliament the boroughs of Inverneſs, Fortroſe, Nairn, and Forres. In 1725, he was made king's advocate; and lord preſident of the court of ſeſſion in 1737. In the rebellions which broke out in Scotland in 1715 and 1745 he eſpouſed the royal cauſe; but with ſo much prudence and moderation did he conduct himſelf at this delicate conjuncture, that not a whiſper was at any time heard to his prejudice. The glory he acquired in advancing the proſperity of his country, and in contributing to re-eſtabliſh peace and order, was the only reward of his ſervices. He had even impaired, and almoſt ruined, his private fortune in the cauſe of the public: but government did not make him the ſmalleſt recompenſe. The miniſter, with a meanneſs for which it is difficult to account, deſired to have a ſtate of his diſburſements. Shocked at the incivility and rudeneſs of this treatment, he left the miniſter without making any reply. Throughout the whole courſe of his life he had a lively ſenſe of religion, without the leaſt taint of ſuperſtition; and his charity was extended to every ſect and denomination of religioniſts indiſcriminately. He was well verſed in the Hebrew language; and wrote in a flowing and oratorial ſtyle, concerning religion natural and revealed; ſome important diſcoveries in theology and philoſophy, and concerning the ſources of incredulity. He died in 1747, in the 62d year of his age; and his works have ſince been publiſhed in two volumes octavo.

FORCE, in *Philoſophy*, denotes the cauſe of the change

change in the ſtate of a body, when, being at reſt, it begins to move, or has a motion which is either not uniform or not direct. While a body remains in the ſame ſtate, either of reſt or of uniform and rectilinear motion, the cauſe of its remaining in ſuch a ſtate is in the nature of the body, and it cannot be ſaid that any extrinſic force has acted on it. This internal cauſe or principle is called *inertia*.

Mechanical forces may be reduced to two ſorts: one of a body at reſt, the other of a body in motion.

The force of a body at reſt, is that which we conceive to be in a body lying ſtill on a table, or hanging by a rope, or ſupported by a ſpring, &c. and this is called by the names of *preſſure*, *tenſion*, *force*, or *vis mortua*, *ſolicitatio*, *conatus movendi*, *conamen*, &c. To this claſs alſo of forces we muſt refer centripetal and centrifugal forces, though they reſide in a body in motion; becauſe theſe forces are homogeneous to weights, preſſures, or tenſions of any kind.

The force of a body in motion is a power reſiding in that body ſo long as it continues its motion; by means of which it is able to remove obſtacles lying in its way; to leſſen, deſtroy, or overcome the force of any other moving body which meets it in an oppoſite direction; or to ſurmount any dead preſſure or reſiſtance, as tenſity, gravity, friction, &c. for ſome time; but which will be leſſened or deſtroyed by ſuch reſiſtance as leſſens or deſtroys the motion of the body. This is called *moving force*, *vis motrix*, and by ſome late writers *vis viva*, to diſtinguiſh it from the *vis mortua* ſpoken of before; and by theſe appellations, however different, the ſame thing is underſtood by all mathematicians; namely, that power of diſplacing, of withſtanding oppoſite moving forces, or of overcoming any dead reſiſtance, which reſides in a moving body, and which, in whole or in part, continues to accompany it, ſo long as the body moves. See MECHANICS.

We have ſeveral curious as well as uſeful obſervations in Deſaguliers's Experimental Philoſophy, concerning the comparative forces of men and horſes, and the beſt way of applying them. A horſe draws with the greateſt advantage when the line of direction is level with his breaſt; in ſuch a ſituation, he is able to draw 200lb. eight hours a-day, walking about two miles and a half an hour. And if the ſame horſe is made to draw 240lb. he can work but ſix hours a-day, and cannot go quite ſo faſt. On a carriage, indeed where friction alone is to be overcome, a middling horſe will draw 1000lb. But the beſt way to try a horſe's force, is by making him draw up out of a well, over a ſingle pulley or roller; and, in ſuch a caſe, one horſe with another will draw 200lb. as already obſerved.

Five men are found to be equal in ſtrength to one horſe, and can, with as much eaſe, puſh round the horizontal beam of a mill, in a walk 40 feet wide; whereas three men will do it in a walk only 19 feet wide.

The worſt way of applying the force of a horſe, is to make him carry or draw up hill: for if the hill be ſteep, three men will do more than a horſe, each man climbing up faſter with a burden of 100lb. weight, than a horſe that is loaded with 300lb.; a difference which is owing to the poſition of the parts of the human body being better adapted to climb than thoſe of a horſe.

On the other hand, the beſt way of applying the force of a horſe, is in a horizontal direction, wherein a man can exert leaſt force; thus a man weighing 140lb. and drawing a boat along by means of a rope coming over his ſhoulders, cannot draw above 27lb. or exert above one ſeventh part of the force of a horſe employed to the ſame purpoſe.

The very beſt and moſt effectual poſture in a man, is that of rowing, in which he not only acts with more muſcles at once for overcoming the reſiſtance, than in any other poſition; but as he pulls backward, the weight of his body aſſiſts by way of lever. See Deſaguliers, Exp. Phil. vol. i. p. 241. where we have ſeveral other obſervations relative to force acquired by certain poſitions of the body, from which that author accounts for moſt feats of ſtrength and activity. See alſo a *Memoire* on this ſubject by M. de la Hire, in Mem. Roy. Acad. Sc. 1629; or in Deſaguliers, Exp. &c. 267, &c. who has publiſhed a tranſlation of part of it, with remarks.

Citizen Regnier has invented an inſtrument for aſcertaining the relative ſtrength of men and animals, for an account of which, ſee DYNAMOMETER; and for a fuller deſcription of the apparatus, the reader may conſult the original paper on the ſubject in *Jour. de l'Ecole Polytech.* vol. ii. or the tranſlation in Phil. Mag. vol. i.

FORCE, in *Law*, ſignifies any unlawful violence offered to things or perſons, and is divided into ſimple and compound. *Simple force* is what is ſo committed, that it has no other crime attending it; as where a perſon by force enters on another's poſſeſſion, without committing any other unlawful act. *Compound force*, is where ſome other violence is committed, with ſuch an act which of itſelf alone is criminal; as if one enters by force into another's houſe, and there kills a perſon, or raviſhes a woman. There is likewiſe a force implied in law, as in every treſpaſs, reſcue, or diſſeiſin, and an actual force with weapons, number of perſons, &c.—Any perſon may lawfully enter a tavern, inn, or victualling houſe; ſo may a landlord his tenant's houſe to view repairs, &c. But if, in theſe caſes the perſon that enters commits any violence or force, the law will intend that he entered for that purpoſe.

FORCEPS, in *Surgery*, &c. a pair of ſciſſars for cutting off, or dividing, the fleſhy membranous parts of the body, as occaſion requires. See SURGERY.

FORCER, in *Mechanics*, is properly a piſton without a valve. For, by drawing up ſuch a piſton, the air is drawn up, and the water follows; then puſhing the piſton down again, the water, being prevented from deſcending by the lower valve, is forced up to any height above, by means of a ſide branch between the two.

FORCIBLE ENTRY, is a violent and actual entry into houſes or lands; and a forcible detainer, is where one by violence withholds the poſſeſſion of lands, &c. ſo that the perſon who has a right of entry is barred, or hindered, therefrom.

At common law, any perſon that had a right to enter into lands, &c. might retain poſſeſſion of it by force. But this liberty being abuſed, to the breach of the peace, it was therefore found neceſſary that the ſame ſhould be reſtrained: Though, at this day, he who

who is wrongfully dispossessed of goods may by force retake them. By statute, no persons shall make an entry on any lands or tenements, except where it is given by law, and in a peaceable manner, even though they have title of entry, on pain of imprisonment: and where a forcible entry is committed, justices of peace are authorized to view the place, and inquire of the force by a jury, summoned by the sheriff of the county; and they may cause the tenements, &c. to be restored, and imprison the offenders till they pay a fine. Likewise a writ of forcible entry lies, where a person seised of freehold, is by force put out thereof.

Forcible Marriage, of a woman of estate, is felony. For by the statute 3 H. VII. c. 2. it is enacted, "That if any persons shall take away any woman having lands or goods, or that is heir apparent to her ancestor, by force, and against her will, and *marry* or *defile* her; the takers, procurers, abettors, and receivers, of the woman taken away against her will, and knowing the same, shall be deemed principal felons; but as to procurers and accessories before the fact, they are to be excluded the benefit of clergy, by 39 Elizabeth c. 9. The indictment on the statute H. VII. is expressly to set forth, that the woman taken away had lands or goods, or was heir apparent; and also that she was married or defiled, because no other case is within the statute; and it ought to allege that the taking was for lucre. It is no excuse that the woman at first was taken away with her consent: for if she afterwards refuse to continue with the offender, and be forced against her will, she may from that time properly be said to be taken against her will; and it is not material whether a woman so taken away be at last married or defiled with her own consent or not, if she were under force at the time; the offender being in both cases equally within the words of the act.

Those persons who, after the fact, receive the offender, are but accessories after the offence, according to the rules of common law; and those that are only privy to the damage, but not parties to the forcible taking away, are not within the act, H. P. C. 119. A man may be indicted for taking away a woman by force in another country; for the continuing of the force in any country, amounts to a forcible taking there. *Ibid.* Taking away any woman-child under the age of 16 years and unmarried, out of the custody and without the consent of the father or guardian, &c. the offender shall suffer fine and imprisonment; and if the woman agrees to any contract of matrimony with such person, she shall forfeit her estate during life, to the next of kin, to whom the inheritance should descend, &c. stat. 4 & 5. P. & M. c. 8. This is a force against the parents: and an information will lie for seducing a young man or woman from their parents, against their consents, in order to marry them, &c. See Marriage.

FORCING, in *Gardening*, a method of producing ripe fruits from trees before their natural season. See Gardening *Index*.

Forcing, in the wine trade, a term used by the wine coopers for the fining down wines, and rendering them fit for immediate draught. The principal inconvenience of the common way of fining down the white wines with isinglass, and the red with whites of eggs, is the slowness of the operation; these ingredients not performing their office in less than a week, or sometimes a fortnight, according as the weather proves favourable, cloudy or clear, windy or calm: this appears to be matter of constant observation. But the wine merchant frequently requires a method that shall, with certainty, make the wines fit for tasting in a few hours. A method of this kind there is, but it is kept in a few hands a valuable secret. Perhaps it depends upon a prudent use of a tartarized spirit of wine, and the common forcing, as occasion is, along with gypsum, as the principal; all which are to be well stirred about in the wine, for half an hour before it is suffered to rest.

FORDOUN, John of, the father of Scottish history, flourished in the reign of Alexander III. towards the end of the 13th century. But of his life there is nothing known with certainty, though there was not a monastery that possessed not copies of his work. The first five books of the history which bears his name were written by him: the rest were fabricated from materials left by him, and from new collections by different persons. A manuscript in vellum of this historian is in the library of the university of Edinburgh.

FORDWICH, a town of Kent, called in Doomsday Book "the little borough of Fordwich," is a member of the port of Sandwich, and was anciently incorporated by the style of the barons of the town of Fordwich, but more lately by the name of the mayor, jurats, and commonalty, who enjoy the same privileges as the cinque ports. This place is famous for excellent trouts in its river Stour.

END OF THE EIGHTH VOLUME.

ERRATA IN FLUXIONS.

Page.	Col.	Line.	
700	1	27	for *Mauclaurin* read *Maclaurin.*
706	1	22	for $u=p$, read $u=p\dot{x}$.
—	2	12	for ${}^{3}x$, read x^{3}.
708	2	8	for $u\,v$, read u, v.
—	—	37	inſert $p\,p'\,h^2$ below $u\,q\,h^2$.
—	—	38	for $(v\,q'+w\,q)h^2$, read $(v\,q'+p\,p'+w\,q)h^2$.
710	2	12	for $a=$, read $u=$.
713	1	1	for *function*, read *fraction*.
714	1	32	prefix the ſign $+$ to the line.
715	1	5	for $(4l-a^2)$, read $(4\,b-a^2)$.
716	2	11	read $\dot{u}=\mathrm{A}\,a^x\dot{x}$.
717	2	6	from bottom of page, for coſ. x coſ. h, read ſin. x coſ. h.
724	2	15	from bottom, for $2\,a\,x$, read $2\,a\,\dot{x}$.
730	2	13	for $x^3-a\,x^2+a^2x-a^3$, read $x^3-a\,x^2-a^2x+a^3$.
731	2	23	for P, read c, and line 39 for γ, read r.
732	2	2	read $\sqrt{(\dot{x}^2+\dot{y}^2)}=$.
—	—	5	from bot. read $\dfrac{(a^2c^2+4(a^2-c^2)(a\,x-x^2))^{\frac{3}{2}}}{2\,a^4c}$.
733	2	7	from bottom, for $p-$, read $p=$.
734	1		laſt line for $y-$, read $y=$.
735	2	9	for § 101, read § 104.
738	1	6	for $(\text{tan.}=\dfrac{x}{\beta})$, read $(\text{tan.}=\dfrac{x+\alpha}{\beta})$.
739	1	12	for *the laſt*, read *the laſt but one.*
741	1	24	add $\}$ after B, ſo as to include $-\mathrm{A}(\alpha\pm\beta\sqrt{-1})+\mathrm{B}$ between brackets.
—	2	11	for B read B″.
744	2	9	for n read m, and line 21, for coſ. $2=1\pi$, read coſ. $2\pi=1$.
748	2	19	for $x=$, read $x^n=$.
—	—	6	from bot. in the exponent of the denominator, for $\dfrac{m}{n}+p+1$ read $\dfrac{m}{n}+\dfrac{p}{q}+1$.
750	1	6	for $\int{}^{m-1}\dot{x}$ read $\int x^{m-1}\dot{x}$.
751	1	7	for $\int\dfrac{x\,\dot{x}}{\sqrt{(1-x^2)}}=$ read $\int\dfrac{x^3\dot{x}}{\sqrt{(1-x^2)}}=$.
753	1		laſt line, for π read $\dfrac{\pi}{2}$.
754	2	14	from bottom, for $\dfrac{1.5}{4}$ read $\dfrac{1.3}{4.6}$.
764	1	10	for *or*, read *for;* and line 12, for, $\dfrac{8\,\pi\,a^2b}{15}$ read $\dfrac{8\,\pi\,d^2b}{15}$.
765	1	19	from bottom, read $s=\pi\left\{\dfrac{a^2-4y^2)^{\frac{3}{2}}-a^3}{6\,a}\right\}$.
—	2	20	from bottom, inſert a comma between $x\,z$ and flux.
766	2	11	read $\dfrac{\int x\,\dot{s}}{s}$, and line 13 read $\dfrac{\int{}^{2}\,\dot{x}}{\int y^2\,\dot{}}$.
—	—	11	from bottom read $\mathrm{X}=\dfrac{\int x\,\dot{z}}{z}=\dfrac{a}{z}\int(z-\dot{y})$.
767	2	2	read $\dfrac{\frac{2}{3}a\,x^3-\frac{1}{4}x^4+c}{a\,x^2-\frac{1}{3}x^3+c'}$.
769	1	19	read $\ddot{y}x-\dot{x}\,\dot{y}=0$.
773	1	6	for *every* read *any.*
776	2	8	for $\mathrm{l}\left\{a+x+\right.$, read $\mathrm{l}\left\{a+y+\right.$.

DIRECTIONS FOR PLACING THE PLATES OF VOL. VIII.

PART I.

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CCXIX. CCXX. }	778